

REPORT

for

LIMPOPO DEPARTMENT OF AGRICULTURE RESIS PROGRAMME



by the
**INSTITUTE FOR SOIL CLIMATE AND WATER
AGRICULTURAL RESEARCH COUNCIL**



RESIS PROJECT: SOIL SURVEY FOR LOWER CORK AND BELFAST IRRIGATION SCHEMES

Report No GW/A/2007/06
Map No GW/B/13047

By

J.P. Nell & J.G. Dreyer

January 2007

Institute for Soil, Climate and Water, Private Bag X79,
Pretoria 0001, South Africa

Tel: (012) 310 2600
Int: (27 12) 310 2600

Fax: (012) 323 1157
Int: (27 12) 323 1157

	Page
EXECUTIVE SUMMARY	iv
1. TERMS OF REFERENCE	1
2. SITE CHARACTERISTICS	1
2.1. Location	1
2.2. Terrain	1
2.3. Climate	1
2.4. Geology	2
2.5. Vegetation	2
3. METHODOLOGY	4
4. SOILS	7
4.1. Irrigation potential	7
4.2. Soil physical status	8
4.3. Soil chemical status	8
4.4. Description of the dominant soil forms	9
5. WATER QUALITY	15
6. SUMMARY	16
REFERENCES	17
APPENDIX 1: SOIL DESCRIPTIONS	20
APPENDIX 2: WATER QUALITY	24
APPENDIX 3: GLOSSARY OF TERMS	26

LIST OF TABLES

Table	Page
1 Climate Data	3
2 Soil analysis results of Lower Cork, JPN 80	11
3 Soil analysis results of Lower Cork, JPN 83	12
4 Soil analysis results of Belfast, JPN 106	13
5 Soil mapping units and irrigation classes	14
6 Irrigation Potential Classes	16
7 Water holding capacity and expected infiltration rate	16

LIST OF FIGURES

- 1 Locality Map of the Belfast and Lower Cork Irrigation Schemes.
- 2 Soil Map of the Belfast and Lower Cork Irrigation Schemes.
- 2.2 Clay Content Map (A-horizon 0-300 mm) of the Belfast and Lower Cork Irrigation Schemes.
- 2.3 Clay Content Map (B-horizon 300- 600 mm) of the Belfast and Lower Cork Irrigation Schemes. Irrigation Scheme
- 2.4 Soil Depth Map of the Belfast and Lower Cork Irrigation Scheme.
- 2.5 Irrigation Potential of the Belfast and Lower Cork Irrigation Scheme.

Irrigation potential classes

Irrigation Potential Classes Lower Cork					Total
Class 1	Class 2	Class 3	Class 4	Class 5	
13.2 ha	42.4 ha	21.9 ha	22.6 ha	43.9 ha	144
9.17%	29.44%	15.22%	15.7 %	30.49 %	100 %
Irrigation Potential Classes Belfast					
Class 1	Class 2	Class 3	Class 4	Class 5	
7.5 ha	-	8.8 ha	2.6 ha	14.5 ha	33.4 ha
22.45%	-	26.34%	7.78%	43.41%	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 Belfast and Lower 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 soils of Irrigation Potential Class 1 and 2 cover an area of 62.9 ha (35.45 %). The soils of Irrigation Potential Class 4 and 5 are not suitable for irrigation and cover an area of 83.6 ha (47.13 %).

About 67.76 % of the area has a clay content between 10% and 20% in the A horizon and in the B horizon. The relatively high clay content is an indication of relatively low infiltration and hydraulic conductivity rates, low drainage capacity, but high water and nutrient retention.

The infiltration rate is 40 mm/h for the soils in Irrigation Potential Class 1 and 35 mm/h for soils in Irrigation Potential Class 2. The water holding capacity of the soils in Irrigation Potential Class 1 ranges from 80 to 120 mm/m and for soils in Irrigation Potential Class 2 from 120 to 160 mm/m.

The soil reaction is slightly acid to strongly alkaline, with a pH_{water} range between 6.47 and 8.62. The high alkalinity may result in deficiency and/or toxicity of some elements in certain crops. 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 quality is suitable for domestic and livestock use. The water is, however, not in chemical equilibrium and it would be corrosive. The quality of 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 Lower Cork and Belfast 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 20 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°57'S to 2°59'S and 31°19'E to 31°23'E. A total of 177.4 ha 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 consist of gently sloping footslopes with 1 to 3 percent slopes. The slopes are mostly straight.

2.3 Climate

The climate of the region is obtained from the Hazyview weather station (Agro Met No. 0556/212LO) 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 30.5°C and 19.4°C for January to 24.6°C and 7.7°C 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 coarse-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.

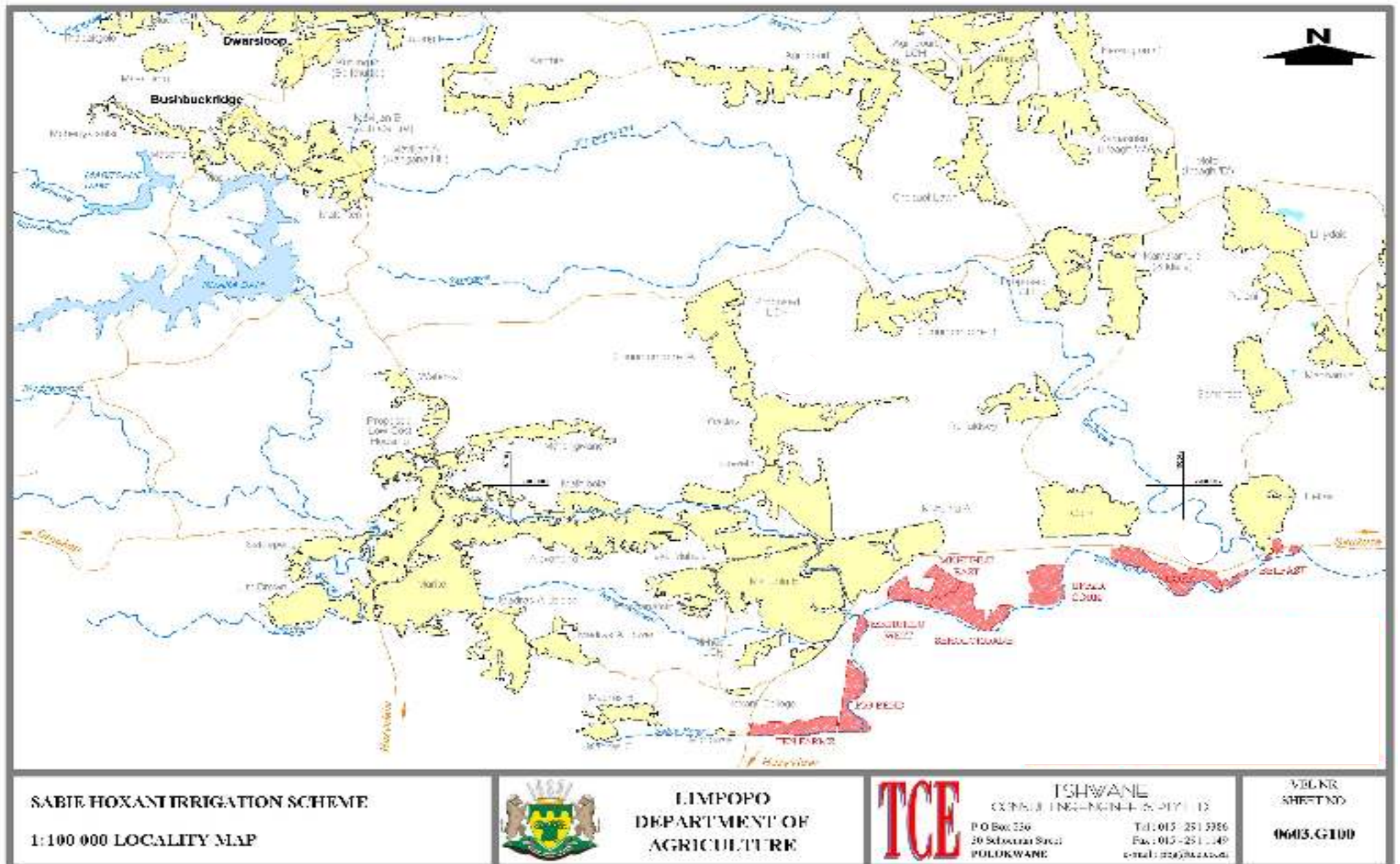


FIGURE 1: Locality map of the surveyed area at Sabie Hoxantie.

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.

Three soil profile pits were dug, described and sampled in the different soil units. About 97 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), $\text{pH}_{(\text{H}_2\text{O})}$, 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 used 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 Lower Cork and Belfast

4.1.1. Irrigation potential

The irrigation potential of the soils at Belfast and Lower Cork falls into Irrigation Classes 1, 2, 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 22.45% (7.5 ha) at Belfast and 9.17% (13.2 ha) at Lower Cork. These soils have an effective depth deeper than 1 200 mm (Figure 2.4) clay content in the A horizon between 12% and 15% (Figure 2.2) and in the B horizon between 15% and 20% (Figure 2.3).

The soils of Irrigation Class 2 cover an area of 29.44% (7.5 ha) at Lower Cork. These soils have an effective depth between 600 and 900 mm (Figure 2.4) clay content in the A horizon between 20% and 25% (Figure 2.2) and in the B horizon between 30% and 40% (Figure 2.3).

The soils of Irrigation Class 3 cover an area of 26.34% (8.8 ha) at Belfast and 15.22% (21.9 ha) at Lower Cork. These soils have an effective depth of mostly shallower than 600 mm (Figure 2.4), clay content in the A horizon between 3% and 25% (Figure 2.2) and in the B/E horizon between 4% and 40% (Figure 2.3). The reason for being allocated to Irrigation Class 3 is the high coarse material content of the soils and very high or very low clay content.

The soils of Irrigation Class 4 and Irrigation Class 5 cover an area of 46.19% (66.5 ha) at Lower Cork and 51.19% (17.1 ha) at Belfast 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, 11.1 ha at Lower Cork and Belfast has an effective soil depth between 900 and 1 200 mm and deeper, 56.9 ha at has an effective soil depth between 600 mm and 900 mm, 95.9 ha has an effective soil depth between 300 mm and 600 mm and 12.4 ha has an effective soil depth between 200 mm and 300 mm.

About 67.76 % of the area has a clay content between 10% and 20% in the A horizon and in the B horizon(Fig 2.2 and Fig 2.3). The relatively high clay content is an indication of relatively low infiltration and hydraulic conductivity rates, low drainage capacity, but high water and nutrient retention.

The water holding capacity of the soils in map unit *Oa* ranges from 80 to 120 mm/m, maps unit *Hu* and *Va* ranges from 120 to 160 mm/m, map unit *Cf* ranges from 5 to 70 mm/m, map unit *Tu* ranges from 100 to 155 mm/m and map unit *Gs* ranges from 75 to 120 mm/m.

The expected infiltration rate of the soils in map unit *Oa* is 40 mm/h, map unit *Hu* 35 mm/h, map unit *Cf* 100 mm/h, map units *Va* and *Tu* 30 mm/h and map unit *Gs* 70 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 6.47 (JPN 106 – Belfast) and 8.62 (JPN 83 – Lower Cork). 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 calcium or magnesium. The dominant soluble cation is mostly sodium and the dominant soluble anion is mostly chloride.

Some of the subsoils (Profiles JPN 106 and JPN 83) 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 2.342 cmol (+) kg⁻¹ (JPN 106) to 20.638 cmol(+)kg⁻¹ (JPN 31). The relatively high CEC values of the Irrigation Potential Class 1 and 2 soils, are 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 in the topsoil from 1.07 (JPN 83) to 10.14 mg/kg (JPN 80) 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 0.026 (JPN 106) to 0.405 cmol (+) kg⁻¹ (JPN 83).

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 5**. The Oakleaf soils of map unit Oa comprise very dark grey, apedal, loamy sand topsoil underlain by a dark brown to very dark greyish brown, weakly structured, sandy loam, non-luvic B horizon. The effective depth ranges from 900 to deeper than 1200 mm. Because of the

favourable clay content as well as the deep effective depth of the soils in this map unit, it falls into Irrigation Potential Class 1.

The soils of map unit *Hu* belongs to the Hutton soil form and comprise with dark reddish brown, sandy clay loam orthic A horizons on a clay loam, dark reddish brown, structureless and non-calcareous B horizons with a duplex character, which are eutrophic and luvic. The unit has an effective depth of 600 to 900 mm. The soils of map unit *Hu* belong to irrigation class 2. Although part of the clay content range in the B horizon is higher than 35%, the majority of the soils in this map unit had a clay content below 35% and the decision was made to put it into Irrigation Potential Class 2 and not 3.

In map unit *Va*, soils of the Valsrivier form were found with very dark greyish brown, weakly structured, sandy clay loam orthic A horizons over dark brown to dark greyish brown, calcareous, strongly structured, clay loam pedocutanic B horizons. The soils of this map unit with their shallow effective depth of between 300 and 350 mm, fall into Irrigation Potential Class 3.

The soils of map unit *Cf*, belong to the Cartref form with dark brown to very dark brown, apedal, sandy orthic A horizons on dark brown, apedal, sandy to loamy sand, eluvial horizons underlain by a lithocutanic subsoil. The effective depth range of this map unit is from 600 to 900mm. Because of the low clay content of below 10% this map unit falls into Irrigation Potential Class 3.

The Tukululo soils of map unit *Tu* contain very dark greyish brown to dark brown, apedal, sandy loam to sandy clay loam topsoil underlain by a dark yellowish brown to dark brown, weakly structured, sandy clay loam, luvic neocutanic B horizon on unspecified material with signs of wetness. The effective depth range is from 300 to 500mm. The occurrence of signs of wetness found between 300 and 500 mm in these soils cause it to fall into Irrigation Potential Class 4.

Map unit *Gs* with the Glenrosa soil form, consists of shallow (250-350 mm), soils and have very dark greyish brown to very dark brown, apedal, loamy sand to sandy loam topsoil and stony/gravelly lithocutanic subsoil grading into weathered rock. Rock

outcrops are also found in this map unit. Because of the rock outcrops in this map unit it falls into Irrigation Potential Class 5.

Table 2. Soil analysis results of Lower Cork JPN 80

Sample site:	JPN 80	Co-ordinates:	24° 57' 59.2" S
Soil form:	Hutton 3200	(Lat/Long)	31° 20' 07.9" E

Horizon	Depth (mm)	Particle size distribution %							Texture Class
		C Sand	M Sand	F Sand	VF Sand	C Silt	F Silt	Clay	
A	0-280	14.61	18.11	21.71	9.36	6.17	5.97	22.43	SaCILm
B	280-1100	16.60	12.32	14.26	7.13	4.43	4.43	38.49	SaCl
C	1100-1300	23.87	27.56	23.26	7.48	4.25	5.99	5.79	LmSa

Horizon	Exchangeable cations cmol(+)kg ⁻¹ (amm. acetate)						ESP %
	Na	K	Ca	Mg	S-value	CEC	
A	0.061	0.375	6.233	2.059	8.729	10.726	0.57
B	0.094	0.206	8.938	3.536	12.773	12.917	0.73
C	0.120	0.079	5.682	1.868	7.749	5.308	2.26

Horizon	Saturation extract soluble cations and anions me/l					SAR	Conductivity mS/m	P mg/kg	pH (H ₂ O)
	Ca	Mg	Na	Cl	SO ₄				
A	0.342	0.225	0.211	0.186	0.219	0.40	13	10.14	6.94
B	0.634	0.362	0.234	0.118	0.120	0.33	12	1.51	7.18
C	0.169	0.112	0.294	0.428	0.043	0.78	7	1.12	7.46



Table 3. Soil analysis results of Lower Cork JPN 83

Sample site:	JPN 83	Co-ordinates:	24° 58' 08.9" S
Soil form:	Valsrivier 1122	(Lat/Long)	31° 20' 23.9" E

Horizon	Depth (mm)	Particle size distribution %							Texture Class
		C Sand	M Sand	F Sand	VF Sand	C Silt	F Silt	Clay	
A	0-400	18.70	13.53	13.33	6.51	5.42	4.55	35.38	SaCl
B	400-650	15.13	13.39	14.21	7.57	6.13	8.03	33.23	SaClIm

Horizon	Exchangeable cations cmol(+)kg ⁻¹ (amm. acetate)						ESP %
	Na	K	Ca	Mg	S-value	CEC	
A	1.706	0.312	6.421	6.583	15.023	20.638	8.27
B	3.829	0.405	14.366	10.296	28.895	16.439	23.29

Horizon	Saturation extract soluble cations and anions me/l					SAR	Conductivity mS/m	P mg/kg	pH (H ₂ O)
	Ca	Mg	Na	Cl	SO ₄				
A	0.075	0.083	2.715	1.517	0.733	9.66	32	1.07	7.56
B	0.499	0.657	13.840	13.933	1.827	18.21	156	0.59	8.82



Table 4. Soil analysis results of Belfast JPN 106

Sample site:	JPN 106	Co-ordinates:	24° 57' 39.4" S
Soil form:	Wasbank 1000	(Lat/Long)	31° 22' 26.8" E

Horizon	Depth (mm)	Particle size distribution %							Texture Class
		C Sand	M Sand	F Sand	VF Sand	C Silt	F Silt	Clay	
A	0-250	17.31	20.98	28.82	14.15	8.50	4.89	3.51	LmSa
E	250-830	40.95	18.61	17.00	8.55	7.24	4.88	0.70	Sa
B	830-1200	36.88	17.09	14.77	8.54	7.24	8.64	4.62	LmSa

Horizon	Exchangeable cations cmol(+)kg ⁻¹ (amm. acetate)						ESP %
	Na	K	Ca	Mg	S-value	CEC	
A	0.109	0.049	0.708	0.717	1.582	2.342	4.65
E	0.082	0.026	0.377	0.692	1.178	2.194	3.74
B	0.380	0.064	0.478	1.406	2.328	3.404	11.16

Horizon	Saturation extract soluble cations and anions me/l					SAR	Conductivity mS/m	P mg/kg	pH (H ₂ O)
	Ca	Mg	Na	Cl	SO ₄				
A	0.026	0.032	0.339	0.100	0.148	1.98	5	1.12	6.47
E	0.185	0.200	0.937	1.006	0.514	2.14	17	1.22	6.59
B	0.048	0.094	1.800	1.281	0.657	6.76	23	0.25	7.78



Table 5. Soil mapping units and irrigation classes for Lower Cork and Belfast.

SOIL LEGEND							
MAP UNIT	DOMINANT SOIL FORM	OTHER SOIL FORMS	EFFECTIVE DEPTH (mm)	TEXTURE: CLAY % PER HORIZON	DESCRIPTION OF MAPPING UNIT	IRRIGATION CLASS	AREA (HA)
Oa	Oakleaf 2110	Oakleaf 1210 Hutton 3100	900-1200+	A: 12-15 B: 15-20	Very dark grey, apedal, loamy sand topsoil on a dark brown to very dark greyish brown, weakly structured, sandy loam subsoil.	1	21
Hu	Hutton 3200	Oakleaf 1220	600-900	A: 20-25 B: 30-40	Dark reddish brown, apedal, sandy clay loam topsoil on a dark reddish brown, apedal, clay loam, subsoil with a duplex character, on rock or saprolite and sometimes unconsolidated material.	2	42
Va	Valsrivier 2122	Valsrivier 2121	300-350	A: 20-35 B: 30-40	Very dark greyish brown, weakly structured, sandy clay loam topsoil on a dark brown to dark greyish brown strongly structured, clay loam subsoil on rock, saprolite or unconsolidated material.	3	13
Cf	Cartref 2200	Fernwood 1200 Longlands 1000 Wasbank 1000	600-900	A: 3-10 E: 4-12	Dark brown to very dark brown, apedal, sandy topsoil on a dark brown, apedal, sandy to loamy sand subsoil on a lithocutanic B horizon.	3	18
Tu	Tukulu 2120	Westleigh 2000 Katspruit 1000 Dundee 1210 Bloemdal 3100	300-500	A: 15-25 B: 20-35	Very dark greyish brown to dark brown, apedal, sandy loam to sandy clay loam topsoil on a dark yellowish brown to dark brown, weakly structured sandy clay loam, subsoil on unspecified material with signs of wetness.	4	25
Gs	Glenrosa 2211	Glenrosa 1211 Mispah 2100 Rock Outcrops	250-350	A: 10-20	Very dark greyish brown to very dark brown, apedal, loamy sand to sandy loam topsoil on stony/gravelly subsoil, grading into weathered rock. Rock outcrops are also found in this map unit.	5	58

5. WATER QUALITY

If the South African Water Quality Guidelines for Agriculture (DWAF, 1993) are used, the water from the Sabie River at Phabene is Class 1 Irrigation water, because the electrical conductivity is 11 mS/m (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.

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 6: Irrigation potential classes for Lower Cork and Belfast.

Irrigation Potential Classes Lower Cork					Total
Class 1	Class 2	Class 3	Class 4	Class 5	
13.2 ha	42.4 ha	21.9 ha	22.6 ha	43.9 ha	144
9.17%	29.44%	15.22%	15.7 %	30.49 %	100 %
Irrigation Potential Classes Belfast					
Class 1	Class 2	Class 3	Class 4	Class 5	
7.5 ha	-	8.8 ha	2.6 ha	14.5 ha	33.4 ha
22.45%	-	26.34%	7.78%	43.41%	100%

Table 7: Water holding capacity and expected infiltration rate for Lower Cork and Belfast.

Irrigation Class	Map Unit	Effective Depth	Texture (Clay %)	Water holding capacity (mm/m)	Infiltration rate (mm/h)
1	Oa	900-1200+	A: 12-15 B: 15-20	80-120	40
2	Hu	600-900	A: 20-25 B: 30-40	120-160	35
3	Va	300-350	A: 20-35 B: 30-40	120-160	30
3	Cf	600-900	A: 3-10 E: 4-12	5-70	100
4	Tu	300-500	A: 15-25 B: 20-35	100-155	30
5	Gs	250-350	A: 10-20	75-120	70

6. SUMMARY

- The soils of Irrigation Potential Class 1 and 2 cover an area of 62.9 ha (35.45%).
- 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 30.7 ha (17.31%).
- The soils of Irrigation Potential Class 4 and 5 are not suitable for irrigation and cover an area of 83.6 ha (47.13%).
- The infiltration rate is 40 mm/h for the soils in Irrigation Potential Class 1 and 35 mm/h for soils in Irrigation Potential Class 2.

- The water holding capacity of the soils in Irrigation Potential Class 1 ranges from 80 to 120 mm/m and for soils in Irrigation Potential Class 2 from 120 to 160 mm/m.
- The low clay content of the some soils (map unit *Cf*) is problematic. With an increase in the volume-content of the sand and coarse material content, the fraction of the soil material becomes smaller and the water holding capacity decreases. The nutrient retention capacity is similarly negatively influenced. Sandy soils result in an increase in the total, as well as macro-porosity of the soil. Sandy soils are better aerated, with a rapid hydraulic conductivity compared to clayey soils. Dry, sandy soils, therefore, require less water to reach field water capacity but require more regular and lighter irrigations than clayey soils. Irrigation scheduling and fertilizer programs should thus be adjusted to these soil conditions.
- Reclamation in terms of salinity and sodicity is not required if only Irrigation Potential Class 1 and 2 are used.
- 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 are both class 1 Irrigation water. No indication of pollution was found and 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.

REFERENCES

- Bester, H.C. & Liegme, D.P.**, 1989. The evaluation of land for irrigation: A literature review. SIRI, Report No. GB/A/90/03, ISCW, Pretoria.
- Bornman, J.J., Ranwell, J.F., Venter, G.C.H. & Vosloo, L.B.**, 1989. FSSA Fertilizer Handbook. The Fertilizer Society of South Africa, Hennopsmeer.
- Dohse, T.E., Schoeman, J.L., Turner, D.P.**, 1991. Changing aspects to the assessment of land suitability for irrigation planning. Proceedings Southern African Irrigation Symposium, Durban, June 1991, SABI, Pretoria.
- Geological Survey**, 1986. 1:250 000 scale geological map 2430 Pilgrim's Rest. Department of Mineral and Energy Affairs, Pretoria.
- Green, G.C.**, 1985. Estimated irrigation requirements of crops in South Africa. Part 2. Memoirs on the Agricultural Natural resources of South Africa. ISCW, Pretoria.
- Hensley, M. & Laker, M.C.**, 1980. A proposed integrated procedure for the identification, delineation, evaluation and planning of irrigable land. Proc. 9th. National Congress, Soil Sci. Soc. S.A., Durban, Tech. Comm. No. 174, Dept. Agriculture and Fisheries, Pretoria.
- Irrigation Planning Staff**. 1980. A method of evaluating land for irrigation development. Proc. 9th National Congress, Soil, Sci..Soc. S.A., Durban, Tech. Comm. No. 174.
- Kruger, G.P.**, 1983. Terrain morphological map of Southern Africa. Institute for Soil, Climate and Water, Pretoria.
- Low, A.B. & Rebelo, A.T.** 1996. Vegetation of South Africa, Lesotho and Swaziland. Department of Environmental Affairs & Tourism, Pretoria.
- Nell, J.P.** 1991. Besproeibaarheid van gestruktureerde gronde. M.Sc. Agric. Universiteit van die Oranje Vrystaat, Bloemfontein.

Non-Affiliated Soil Analysis Working Committee, 1991. Methods of soil analysis. SSSSA, Pretoria.

Ratliff, L.F., Ritchie, J.T. & Cassel, D.K., 1983. Field-measured limits of soil water availability as related to laboratory-measured properties. Soil Sci. Soc. Am. J. 47: 770-775.

RHP, 2007. River Health Programme. The Sabie-Sand River System. Ecoregion 5.05. [Web: http://www.csir.co.za/rhp/state_of_rivers/state_of_crocsabieolif_01/sabie_eco_5.05.ht]

Schulze, R.E., Hutson, J.L. & Cass, A. 1985. Hydrological characteristics and properties of soils in Southern Africa 2. Soil water retention models. Water S.A., 11, 129-136.

Soil Classification Working Group, 1991. Soil classification. A taxonomic system for South Africa. Institute for Soil, Climate and Water, Pretoria.

APPENDIX 1

PROFILE DESCRIPTION



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

Occurrence 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

Occurrence 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 : 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

Occurrence 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

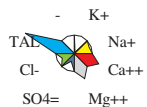
Date Described : 11/2006

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



X3H012Q01: BARCODE GRAPHS OF WATER QUALITY VARIABLES

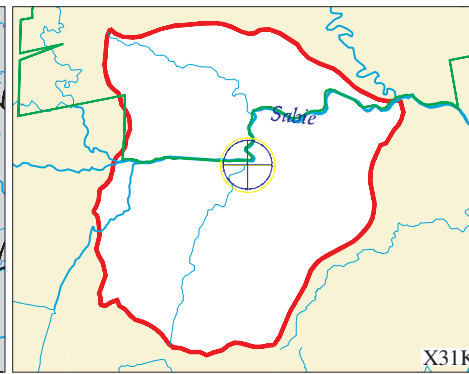
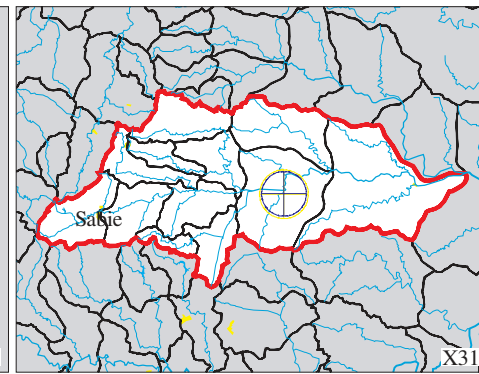
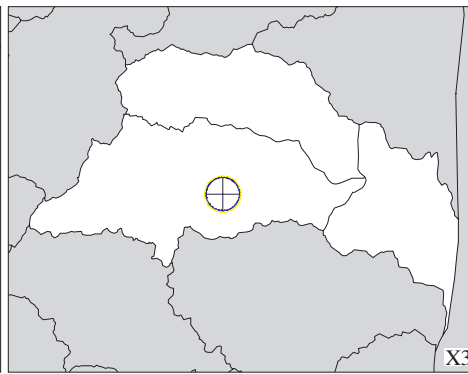
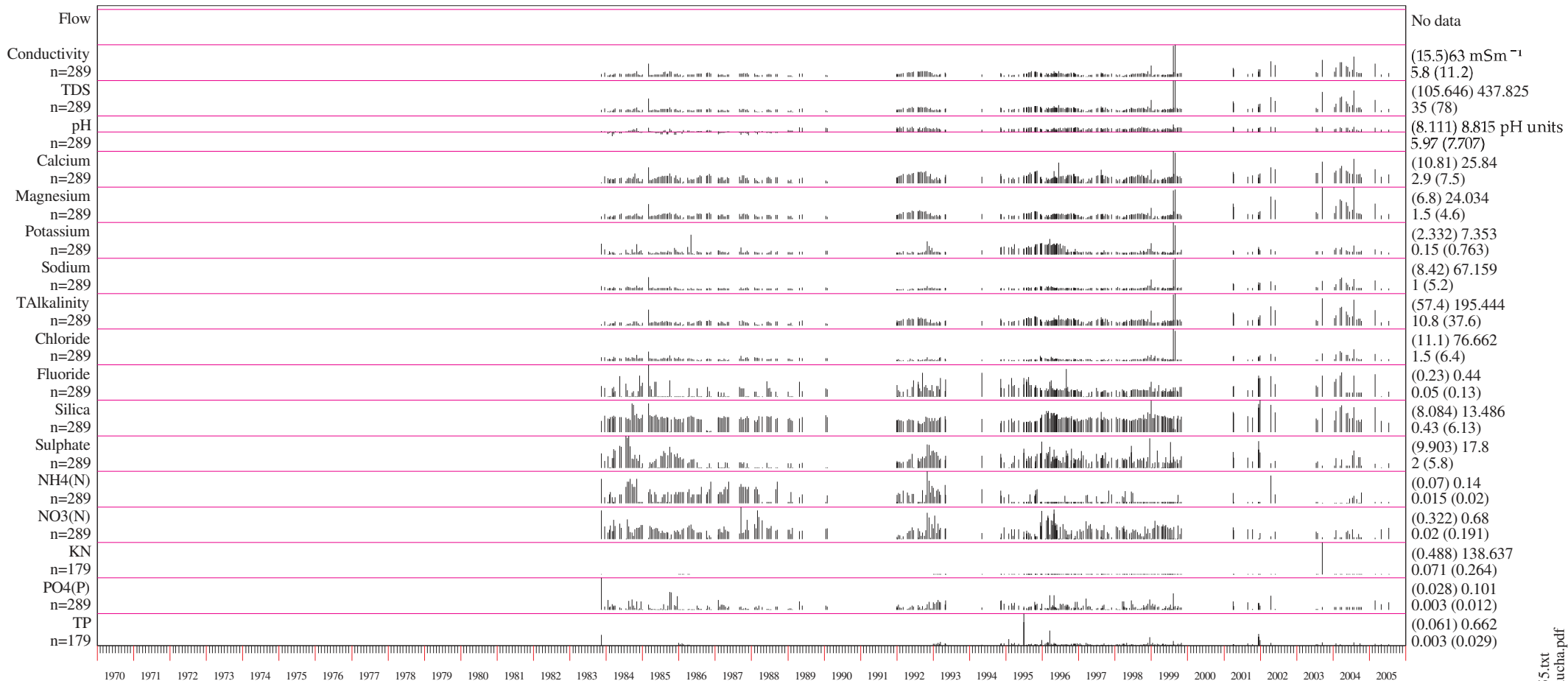
Sabie River at Phabene/Kruger National P

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.
 Tel 012 808 9605, fax 012 808 2702
 E-mail: SilberbauerM@dwaaf.gov.za
 Kun 2005-12-16 - 07:52:48 (by Michael)
 Text in /hri/db/barcode/bcmichael20051216050255.txt
 Maucha: see www.dwaaf.gov.za/iwqs/gis_apps/maucha.pdf
 /rpd2/spek/prjw8/users/michael/aml/barcode_aml v6.21

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 Ca²⁺/100g = 200.4 ppm = 5 mmol/kg = 401 kg/ha/150 mm (BD= 1333kg/m³)

1 me Mg²⁺/100g = 121.5 ppm = 5 mmol/kg = 243 kg/ha/150 mm (BD= 1333kg/m³)

1 me K⁺ 100 g = 391 ppm = 10 mmol/kg = 782 kg/ha/150 mm (BD= 1333kg/m³)

1 me Na/100g = 230 ppm

1 me Ca²⁺/l = 0.5 mmol/dm³

1 me Mg²⁺/l = 0.5 mmol/dm³

1 me Na⁺/l = 1 mmol/dm³

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 = 0.01 mS/cm =

10 μmho/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.

GLEYSOIL: 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			

