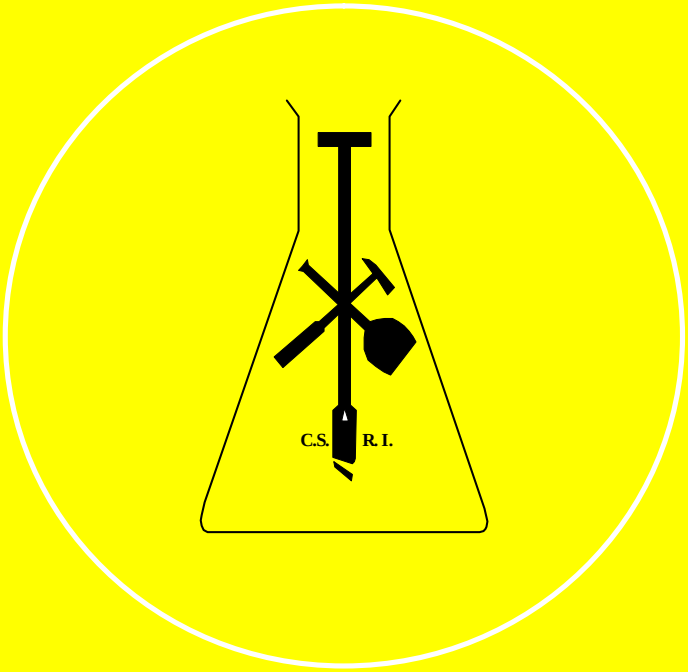
Reference No. 1787 FS/3/3/105

ZIMBABWE



Chemistry and Soil Research Institute

Soils Report No: A 682

SOILS OF THE PROPOSED

MUTAWATAWA/CHIKONO DAM IRRIGATION PROJECT

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Oct - Nov 2005

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SUMMARY

A soil survey was conducted at the proposed Mutawatawa irrigation project in Maramba Communal Lands, Mashonaland East Province to assess the suitability of soils for irrigation.

Irrigability classes were assigned as outlined in Appendix 2. The proportions of irrigability classes in terms of hectarage are shown in table 1 below.

Table 1: Size and irrigability classes of different soil categories

Category	Irrigability Class	Approximate Area (hectares)	Limitations/Remarks	Recommended Use
G1	B	2.2	Slope, light surface textures, structure	Most crops
G2	C	5.5	Slope, light surface textures	Horticultural
G3	S	4.2	Light textures	Tobacco
E1	B/C	7.0	Depth, surface stones and boulders	Most crops
E2	C/D	8.0	Depth, stones and boulders	Vegetable, citrus, sorghum, cotton
E3	C/D	7.2	Depth, sodicity	Millet, grazing
GE1	D	14.8	Depth, surface stones	Grazing

Shallow soil depth, light textures, surface stoniness, boulders, slope, structure and sodicity are the major limiting factors for irrigation development.

1.0 INTRODUCTION

The Department of Irrigation, Ministry of Water and Infrastructure Development, requested Chemistry and Soil Research Institute to conduct a detailed soil survey in October - November 2005 in areas earmarked for irrigation development in Mutawatawa, Maramba Communal Lands, in Mashonaland East Province.

An area covering approximately 100 hectares was surveyed by four pedologists over a period of 14 days. A 1:6 250 aerial photograph (Mutoko photo number 241flown in 1985) was used as base material to delineate soil boundaries in the field. A total of 35 auger holes were made in the area using the free survey method. Soils of similar morphological properties such as texture, drainage, surface stoniness were demarcated. For each soil category a pit was dug, fully described and sampled for laboratory analysis. A total of 7 soil pits were dug. Auger holes, pits and soil boundaries were marked on the base material. Soil profile description and analytical results are shown in Appendix 6.1.

Map number 682 to accompany this report was then prepared from 1:6 250 aerial photo enlargements used during the survey.

2.0 GENERAL DESCRIPTION OF AREA

2.1 Introduction

The proposed Mutawatawa Irrigation Scheme is located near Mutawatawa Growth Point, Maramba Communal Lands of Uzumba Maramba Pfungwe District in Mashonaland East Province. It is situated 158km north east of Harare and about 72km N of Murewa Centre, along Murewa/Mutawatawa Road to the south of Chikono Dam. Mutiwawora Mountain Range marks the eastern boundary. Matedza and Chin'unu mountains mark the southern and eastern boundaries of the survey area respectively.

The survey area is found in Natural Region IV at an altitude range of 940m to 960m. Data from Mutawatawa meteorological station (local) indicates that the area receives erratic rainfall ranging from 450 to 900mm annually with January recording the highest rainfall. Maximum temperatures are recorded in summer and minimum temperatures are recorded during winter.

2.2 Geology and Landform

Two main types of geologies are dominant in the survey area. These include the younger granitic rocks of the medium to coarse-grained adamellite group and doleritic intrusions.

Guvira River, on which Chikono Dam was constructed, mainly drains through the survey area. The main river (Guvira), together with its tributaries forms a dendritic drainage pattern.

The survey area is mainly a pediment and pediplain in some areas. Topography is gently undulating with slopes of 3-6%.

2.3 Soils

The soils are derived mainly in situ from granite and dolerite. Dolerite derived soils are heavy textured and red. The soils are shallow to moderately shallow on middle and upslope positions.

Those soils derived from granite are light to medium textured and pale. They exhibit a catenal variation (toposequence) although all major soils are found on upper and middleslope positions due to the convex nature of the slope. These soils are moderately shallow to deep and they are moderately weathered and highly leached

Soils derived from intergrades are light to medium textured. These soils are characterized by many doleritic and granitic small surface stones in most places with occasional to few surface stones. The soils are extremely shallow, found mostly on middle to upperslope positions.

2.4 Natural Vegetation and Land Use

Natural vegetation in most parts of the survey area has been cleared for cultivation and the main vegetation types were observed on field edges. The area is however predominated by *Piliostigma thonningii* and *Diospyros kirkii* re-growths found on all soil types. *Terminalia sericea* occupied all the granitic catenal points with *Parinari curatellifolia* and *Ficus capensis* dominating the mid to lower slope positions.

Syzgium guaneense were observed on lowerslope positions of the wetland. Stunted Colophospermum mopane open woodland was also observed on the lowerslope position of the doleritic derived soils.

Crop production and grazing/livestock production are the main agricultural activities in the survey area.

2.5 Water Quality for Irrigation

A composite sample of the water intended for irrigation was collected from Chikono Dam. The analytical results showed that the water is of medium salinity with a moderate chance of causing soil salinity and will tend to raise soil pH if used for irrigation. Soil samples should therefore be taken from time to time in order to check for salinity and pH levels. The water may however be used for irrigation on well drained upland soils. The analytical results are given in Appendix 6.2.

3.0 SOIL CLASSIFICATION

The soils are moderately leached and weathered. Three major soil groupings have been identified basing on parent material (granite, dolerite and intergrades) from which the soils are derived. Depth, texture, colour and surface stoniness were considered in subdividing the soil categories.

3.1 Soils derived from dolerite (E)

Soils derived from dolerite are heavy textured, dark reddish brown and well drained on middleslope and upperslope positions. They are common doleritic stones and boulders associated with these soils on both the soil surface and within the soil profile. Three soil mapping units were identified within this category.

3.1.1 Category E1

The soils in this category are shallow. They consist of well drained, dark reddish brown medium sandy clay loam and medium sandy clay overlying dark reddish brown clay. They are characterized by occasional small surface stones and boulders within the profile.

The soils are found mainly on middleslope positions on gently undulating topography of 3-4% slopes.

The natural vegetation comprises of *Bauhinia galpinii, Kirkia acuminata, Sclerocarya caffra, Diospyros kirkii and Pericopsis angolensis*.

Soil morphological properties

Depth	45 - 50cm onto stones
Texture	Medium sandy clay loam and medium sandy clay over clay
Colour	Dark reddish brown (5YR 3/4 m) over dark reddish brown (5YR 3/4 m)
Structure	Moderately developed coarse sub-angular blocky over strongly developed course angular blocky
Permeability and drainage	Good permeability and well drained

Subsoil chemical properties

CEC (m.e %)	10-20

S/C	30-40
E/C	30-50
Base saturation (%)	80-100
pH ($CaCl_2$)	5-6
Typical profile	16/XX/05

Remarks

Classification	
Zimbabwe	4E
Approximate AWC (%)	14
Irrigable value	2
Irrigability class	B/C

Surface doleritic stones and boulders typical of this category can interfere with tillage hence the soils have been downgraded to irrigability class B/C.

3.1.2 Category E2

This category is a stony variant of E1. It is characterised by many small surface stones.

The soils are found mainly on middle to upperslope positions on gently undulating topography of 3-4% slopes.

The natural vegetation comprises mainly of *Bauhinia galpinii, Piliostigma thonningii, Combretum molle, Diospyros kirkii, Combretum species, Dichrostachys cinerea, Julbernardia globiflora and Pseudolachnostylis maprouneifolia*.

Soil morphological properties

Depth	40 - 55cm onto stones/soft weathering rock
Texture	Medium sandy loam over medium sandy clay loam
Colour	Dark reddish brown (5YR 3/4 m) over dark reddish brown (5YR 3/4 m)
Structure	Strongly developed coarse sub-angular blocky

Permeability and drainage	Good permeability and well drained

Subsoil chemical properties

CEC (m.e %)	7
S/C	40
E/C	40
Base saturation (%)	100
pH ($CaCl_2$)	5.5-6.5
Typical profile	17/XX/05

Remarks

Classification	
Zimbabwe	4E
Approximate AWC (%)	12
Irrigable value	2
Irrigability class	C/D

The soils in this category have been down graded to irrigability class C/D due to surface doleritic stones and boulders.

3.1.3 Category E3

The soils in this category are very shallow. They are well drained, dark reddish brown medium sandy loam overlying dark reddish brown coarse sandy clay loam.

The soils are found on lowerslope positions on gently undulating topography of 2-3% slopes.

The natural vegetation is predominantly stunted *Colophospermum mopane*.

Soil morphological properties

Depth	40cm onto soft weathering rock
Texture	Medium sandy loam over coarse sandy clay loam

Colour	Dark reddish brown (5YR 3/3 m) over dark reddish brown (5YR 3/3 m)
Structure	Moderately developed coarse sub-angular blocky over massive
Permeability and drainage	Good to slightly restricted permeability and well drained

Subsoil chemical properties

CEC (m.e %)	12
S/C	60
E/C	60
ESP	10
Base saturation (%)	>96
pH ($CaCl_2$)	5.4-6.5
Typical profile	20/XX/05

Remarks

Classification	
Zimbabwe	8nE
Approximate AWC (%)	14
Irrigable value	3
Irrigability class	C/D

The soils in this category have been downgraded to irrigability class C/D due to depth and sodicity.

3.2 Soils derived from granite (G)

Soils derived from granites are light to medium textured, pale and moderately deep. Three mapping units were identified under this category.

3.2.1 Category G1

These soils are moderately deep, medium sand and medium loamy sand over coarse grained sandy loam and are moderately well drained. They are dark yellowish brown over strong brown.

The soils are found mainly on the upperslope positions on gently undulating topography of 4-5% slopes.

Natural vegetation has been cleared but *Terminalia sericea, Piliostigma thonningii, Ficus capensis, Kirkia acuminata* and *Pterocarpus angolensis* are found on field edges.

Soil morphological properties

Depth	>120cm
Texture	Medium sand and medium loamy sand over coarse sandy loam.
Colour	Dark yellowish brown (10YR 4/4 m) over strong brown (7.5YR 5/8 m)
Structure	Apedal over massive
Permeability and drainage	Good permeability and moderately well drained in the sub soils.

Subsoil chemical properties

CEC (m.e %)	1-2
S/C	13-18
E/C	13-18
Base saturation (%)	100
pH ($CaCl_2$)	4.8-5.6
Typical profiles	18/XX/05

Remarks

Classification

Zimbabwe	5G
Approximate AWC (%)	10

Irrigable value	2
Irrigability class	B

3.2.2 Category G2

These soils are moderately deep, medium to coarse sands over coarse grained sandy loam and well drained. They are dark yellowish brown over strong brown.

The soils are found mainly on the upperslope positions on undulating topography of 5-6% slopes.

Natural vegetation has been cleared but *Terminalia sericea, Piliostigma thonningii, Brachystegia boehmii* and *Parinari curatelifolia* are found on field edges.

Soil morphological properties

Depth	>100cm
Texture	Medium to coarse sand over coarse sandy loam.
Colour	Dark yellowish brown (10YR 4/4) over strong brown (7.5YR 5/6)
Structure	Apedal over massive subsoils.
Permeability and drainage	Good permeability and slightly restricted permeability on the sub soils and well drained.

Subsoil chemical properties

CEC (m.e %)	2-4.5
S/C	15-34
E/C	15-34
Base saturation (%)	100
pH ($CaCl_2$)	5.5-6
Typical profiles	15/XX/05

Remarks
Classification

Zimbabwe	5G
Approximate AWC (%)	8
Irrigable value	3
Irrigability class	C

3.2.3 Category G3

These soils are moderately deep to deep, coarse sands over coarse grained loamy sands and moderately well drained. They are dark yellowish brown over light yellowish brown.

The soils are found mainly on the mid to lower slope positions on gently undulating topography of 3-4% slopes.

Natural vegetation has been cleared but *Terminalia sericea, Piliostigma thonningii, Brachystegia boehmii, Syzigium guineense, Strychnos pungens* and *Parinari curatellifolia* are found on field edges.

Soil morphological properties

Depth	>100cm
Texture	Coarse sands over coarse loamy sands.
Colour	Dark yellowish brown (10YR 3/4 m) over light yellowish brown (10YR 6/4 m).
Structure	Apedal
Permeability and drainage	Good permeability and moderately well drained.

Subsoil chemical properties

CEC (m.e %)	2
S/C	27
E/C	27
Base saturation (%)	100
pH ($CaCl_2$)	5-5.5

Typical profiles	19/XX/05

Remarks

Classification	
Zimbabwe	5G
Approximate AWC (%)	6
Irrigable value	4
Irrigability class	S

3.3 Soils derived from intergrades (GE)

These soils have influence of both dolerite and granite. They are mainly extremely shallow, medium to coarse textured, dark brown and well drained. Surface stones are also common. One category was identified and mapped.

3.3.1 Category GE1

These soils are extremely shallow, coarse loamy sands and well drained. They are dark yellowish brown soils.

The soils are found mainly on the mid to lower slope positions on gently undulating topography of 4-5% slopes.

Natural vegetation has been cleared but *Terminalia sericea, Piliostigma thonningii, Brachystegia boehmii, Syzigium guineensi, Strychnos pungens* and *Parinari curatellifolia* are found on field edges.

Top soil morphological properties

Depth	< 25cm onto soft weathering rock
Texture	Coarse loamy sand
Colour	Dark brown (7.5YR 3/4 m)
Structure	weak medium sub angular blocky structure.
Permeability and drainage	Good permeability and well drained.

Soil chemical properties

CEC (m.e %)	8
S/C	63
E/C	100
Base saturation (%)	53
pH ($CaCl_2$)	5-5.5
Typical profiles	21/XX/05

Remarks

Classification

Zimbabwe	2GE (Lithosol)
Approximate AWC (%)	8
Irrigable value	4
Irrigability class	D

The soils in this category have been downgraded to irrigability class D due to extremely shallow depth and surface stoniness.

4.0 DISCUSSION

Two main soil groups were identified based on parent material. These are mafic (dolerite derived soils) which are heavy textured and granite derived soils which are light to medium textured.

The soils derived from mafic rocks are inherently fertile with CEC values in the low to medium range (5-30 me %). These soils will give satisfactory production under irrigation. However surface stones and boulders, shallow depth and sodicity/salinity are the major limiting factors to crop production. Citrus can be grown on those areas with surface stones while shallow rooted crops like vegetables can be grown where depth is a limiting factor.

The granitic fersiallitic soils are inherently low in fertility (CEC in the range 8–12 me %) and have low available water capacity because of their low clay content and light texture. They are acidic with pH rarely exceeding 5. Adequate lime should therefore be added from time to time with other nutrients being added in the form of inorganic and organic fertilizers. Organic matter will also improve their water holding capacities and structure. The light surface textures and steep slope result in increased erodibility of the soils hence proper soil conservation practices such as tied ridging and terracing need to be employed for sustainable productivity.

Light textured soils have low AWC and low moisture retention capacities. Irrigation scheduling has to be properly adhered to improve water use efficiency. Light frequent sprinkler irrigation is recommended on soils that are on gently undulating terrain. Flood irrigation would do for flat or almost flat lands. The right irrigation scheduling would improve water use efficiency in soils with light textured surfaces. Land leveling to achieve flat terrain is not recommended where the soils are already shallow and gravelly and/ or stones are on upper horizons.

A greater part of the soils in the survey area are in wetland (vleis). These soils are subject to periodical/seasonal excessive wetness. Because of their fertility, cereals or root crops can be grown in the wet season and vegetables can be cultivated in the dry season. In the wet season, crops are grown on ridges, which provide aerated zones for roots. The soils can also be used for the cultivation of rice, *Cleus esculentus* (tsenza), cucurbits, cocoyams and for grazing.

5.0 BIBLIOGRAPHY

Bennet, J.G. (1985). A Field Guide to Soil and Site description in Zimbabwe. Zimbabwe Agricultural Journal, Technical Handbook No. 6.

Mharapara, M. (1995). A Fundamental Approach to Dambo Utilization. In Owen R., Verbeek K., jachson J. and Steenhuis T. (Ed): *Dambo Farming in Zimbabwe: Water Management, Cropping and Soil Potentials for Smallholder Farming in the Wetlands.* University of Zimbabwe Publications.

Munsell Soil Colour Charts (1990). Revised edition.

Muzezewa, J., Gotosa, J. and Nyamwanza, B. (2003) Characterisation of a sodic soil catena for reclamation and improvement strategies. Geoderma **113**. Elsevier Science B.V.

Nyamapfene, K. (1991). Soils of Zimbabwe. Nehanda Publishers.

Stidolph, P.A. (1977). The Geology of the Country around Shamva. Rhodesia Geological Survey Bulletin No. 78.

Thompson, J.G. and Purves, W.D. (1978). A Guide to the Soils of Rhodesia. Zimbabwe Agricultural Journal, Technical Handbook No. 3

6.0 APPENDICES

6.1 Profile Description and Analytical Results

COORDINATES	: 17º07.492′S 31º57.502′E
PROFILE NUMBER	: **15/XX/05**
AUTHOR	: MUTAWARIRA DATE: 21-11-05
LOCATION	: MUTAWATAWA
ELEVATION	: 962 m
RAINFALL	: 500-600 mm
LANDSCAPE (FORM)	: Pediment
LANDSCAPE (SHAPE)	: Gently undulating
SLOPE (POSITION)	: Middleslope
SLOPE (%)	: 4%
LANDUSE	: Cleared not planted
EFFECTIVE DEPTH	: 109cm
SLOPE (ASPECT)	: 180degrees
PRINCIPAL SPECIES	: Terminalia sericea, Julbernardia globiflora, Brachystergia spiciformis, Bauhinia galpinii, Brachystegia bohemii Parinari curatellifolia
NATURAL REGION	: IV
PARENT MATERIAL (A)	: Granite
CLASSIFICATION	

GROUP: Fersiallitic
FAMILY: 5G – Granite

DESCRIPTION :

0 - 12 cms	Yellowish brown (10YR 5/4 m) medium grained sand; dry soft, moist loose, non plastic, non sticky consistence; apedal structure; good permeability and well drained; fairly numerous very fine roots; gradual smooth transition to:
12 - 33 cms	Yellowish brown (10YR 5/4 m) coarse grained sand; dry soft, moist loose, non plastic, non sticky consistence; weakly developed fine subangular blocky; good permeability and well drained; few very fine roots; clear smooth transition to:
33 - 64 cms	Brownish yellow (10YR 6/6 m) coarse grained sandy loam; dry slightly hard, moist friable, slightly plastic, slightly sticky consistence; massive structure; slightly restricted permeability and well drained; occasional fine roots; gradual smooth transition to:
64 - 109 cms	Strong brown (7.5YR 5/8 m) coarse grained sandy loam; dry slightly hard, moist friable, slightly plastic, slightly sticky consistence; massive structure; slightly restricted permeability and well drained; occasional medium roots.

Comments

The third and fourth horizons were compact with massive structure which breaks to medium subangular blocky/moderate structure.
One face of the pit had a boulder at 90cm.
Densely packed stones from 109cm.

ANALYSIS : PROFILE 15/XX/05

****

REFERENCE	S1	S2	S3	S4
DEPTH (cm)	0 -12	12 -33	33 -64	64 -109
LAB NO	O 531	O 532	O 533	O 534
DM %	100.0	99.7	100.0	99.6
TEXTURE	mS	cS	cSaL	cSaL
CLAY %	2	3	13	13
SILT %	5	5	4	4
FINE SAND %	31	28	20	21
MEDIUM SAND %	41	41	40	38
COARSE SAND %	22	23	24	23
pH (CaCl2)	4.3	4.3	5.5	5.9
EX Ca (me %)	6.6	2.2	1.9	2.3
EX Mg (me %)	4.7	1.3	0.9	1.4
EX Na (me %)	0.04	0.09	0.04	0.23
EX K (me %)	0.48	0.13	0.19	1.81
TEB (me %)	5.5	1.6	1.9	4.5
CEC (me %)	5.5	1.6	1.9	4.5
BASE SAT %	100	100	100	100
E/C	319.6	51.7	15.5	34.0
S/C	319.6	51.7	15.5	34.0
ESP	0.7	6.0	2.0	5.0
EKP	8.7	8.0	10.0	40.0
ORG. CARB. %	0.15			

COORDINATES : 17º07.724′S 31º57.645′E
PROFILE NUMBER : **16/XX/05**
AUTHOR : CHIMANIKIRE DATE: 21-11-05
LOCATION : MUTAWATAWA
ELEVATION : 951 m
RAINFALL : 500-600 mm
LANDSCAPE (FORM) : Pediment
LANDSCAPE (SHAPE) : Flat or almost flat
SLOPE (POSITION) : Middleslope
SLOPE (%) : 4%
LANDUSE : Maize
EFFECTIVE DEPTH : 60cm
SLOPE (ASPECT) : 0 degrees
PRINCIPAL SPECIES : Bauhinia galpinii, Kirkia acuminata
Sclerocarya caffra
NATURAL REGION : IV
PARENT MATERIAL (A) : Dolerite
CLASSIFICATION

GROUP: Siallitic
FAMILY: 4E – Dolerite

DESCRIPTION:

0 - 20 cms	Dark red (2.5YR 3/6 m) medium grained sandy clay loam; dry extremely hard, moist friable,plastic, sticky consistence; moderately developed, coarse grained subangular blocky structure; good permeability and well drained; occasional very fine roots; clear smooth transition to:
20 - 50 cms	Dark red (2.5YR 3/6 m) medium sandy clay; dry very hard, moist friable,plastic, sticky consistence; strongly developed coarse grained angular blocky structure; good permeability and well drained; occasional fine roots; occasional sub-rounded large boulders; clear smooth transition to:
50 - 60 cms	Good permeability and well drained; occasional fine roots; few angular small and sub-angular large doleritic stones; gradual smooth transition to:
60 - 82 cms	Dark red (2.5YR 3/6 m) clay; dry extremely hard, moist friable, plastic, sticky consistence;strongly developed medium grained angular blocky structure; slightly restricted permeability and well drained; common fine iron/manganese concretions; clear irregular transition to:
82 - 108 cms	Soft weathering rock.

Comments

Many surface small doleritic boulders.
First horizon has doleritic boulders.
One face of the pit had a boulder at 90cm.

ANALYSIS : PROFILE 16/XX/05

****

REFERENCE	S1	S2	S4	S5
DEPTH(cm)	0 -20	20 -50	60 -82	82 -108
LAB NO	O 535	O 536	O 538	O 539
DM %	96.4	93.7	93.8	
TEXTURE	mSaCL	mSaC	C	N
CLAY %	24	38	45	
SILT %	15	14	11	O
FINE SAND %	34	24	23	
MEDIUM SAND %	20	15	14	T
COARSE SAND %	8	8	7	
pH (CaCl2)	5.3	5.7	5.9	S
EX Ca (me %)	6.4	8.5	10.8	
EX Mg (me %)	4.2	5.6	6.2	A
EX Na (me %)	0.04	0.20	0.15	
EX K (me %)	0.04	1.62	0.04	M
TEB (me %)	9.4	12.1	17.2	
CEC (me %)	9.4	12.1	21.2	P
BASE SAT %	100	100	81	
E/C	39.8	31.8	47.0	L
S/C	39.8	31.8	38.2	
ESP	0.4	1.7	0.7	E
EKP	0.4	13.3	0.2	
ORG. CARB. %	0.40			D

COORDINATES : 17º07.598′S 31º57.883′E
PROFILE NUMBER : **17/XX/05**
AUTHOR : MUTAWARIRA DATE: 21-11-05
LOCATION : MUTAWATAWA
ELEVATION : 954 m
RAINFALL : 500-600 mm
LANDSCAPE (FORM) : Pediment
LANDSCAPE (SHAPE) : Gently undulating
SLOPE (POSITION) : Middleslope
SLOPE (%) : 3-4%
LANDUSE : Cleared not planted
EFFECTIVE DEPTH : 51cm
SLOPE (ASPECT) : 180degrees
PRINCIPAL SPECIES : Brachystegia bohemii, Terminalia sericea, Diospyros kirkii
NATURAL REGION : IV
PARENT MATERIAL (A) : Dolerite
CLASSIFICATION

GROUP: Siallitic
FAMILY: 4E – Dolerite

DESCRIPTION :

0 - 14 cms	Yellowish brown (5YR 3/4 m) fine grained sandy clay loam; dry slightly hard, moist friable, plastic, sticky consistence; strongly developed coarse subangular blocky structure;good permeability and well drained; occasional very fine roots; clear smooth transition to:
14 - 51 cms	Yellowish brown (5YR 3/4 m) clay; dry slightly hard, moist friable, plastic, sticky consistence; strongly developed coarse subangular blocky structure; good permeability and well drained; few medium roots; clear smooth transition to:
51 - 89 cms	Stone line; good permeability and well drained; occasional very fine roots; common sub-rounded small quartz and parent material stones; clear smooth transition to:
89 - 120 cms	Soft weathering rock.

Comments

Fine surface cracks.
Many surface small stones and occasional doleritic boulders.
One face of the pit had soft weathering rock at 55cm.

ANALYSIS : PROFILE 17/XX/05

****

REFERENCE	S1	S2	S4
DEPTH(cm)	0 -14	14 -51	89 -120
LAB NO	O 540	O 541	O 543
DM %	97.9	94.3	
TEXTURE	fSaL	mSaL	N
CLAY %	10	19	
SILT %	8	13	O
FINE SAND %	50	33	
MEDIUM SAND %	20	24	T
COARSE SAND %	12	10	
pH (CaCl2)	5.5	6.1	S
EX Ca (me %)	5.2	9.9	
EX Mg (me %)	3.9	5.0	A
EX Na (me %)	0.03	0.20	
EX K (me %)	0.37	0.37	M
TEB (me %)	9.1	7.4	
CEC (me %)	9.1	7.4	P
BASE SAT %	100	100	
E/C	87.9	38.9	L
S/C	87.9	38.9	
ESP	0.3	2.7	E
EKP	4.0	5.0	
ORG. CARB. %	0.23		D

COORDINATES : 17º07.617′S 31º57.482′E
PROFILE NUMBER : **18/XX/05**
AUTHOR : MUTAWARIRA DATE: 22-11-05
LOCATION : MUTAWATAWA
ELEVATION : 956 m
RAINFALL : 500-600 mm
LANDSCAPE (FORM) : Pediment
LANDSCAPE (SHAPE) : Gently undulating
SLOPE (POSITION) : Upperslope
SLOPE (%) : 4%
LANDUSE : Cleared
EFFECTIVE DEPTH : 120cm
SLOPE (ASPECT) : 180degrees
PRINCIPAL SPECIES : Piliostigma thonningii, Terminalia sericea, Kirkia acuminata, Ficus capensis, Burkea africana, Pterocarpus angolensis
NATURAL REGION : IV
PARENT MATERIAL (A) : Granite
CLASSIFICATION

GROUP: Fersiallitic
FAMILY: 5G – Granite

DESCRIPTION:

0 - 17 cms	Dark yellowish brown (10YR 3/4 m) medium grained sand; moist loose, non plastic, non sticky consistence; weakly coherent apedal structure;good permeability and well drained; few fine roots; clear smooth transition to:
17 - 33 cms	Dark yellowish brown (10YR 3/4 m) medium grained loamy sand; moist friable, slightly plastic, slightly sticky consistence; moderately developed medium subangular blocky; good permeability and well drained; few very fine roots; clear smooth transition to:
33 - 68 cms	Strong brown (7.5YR 4/6 m) medium grained sandy loam; moist friable, plastic, sticky consistence; massive structure; good permeability and well drained; common fine iron/manganese stains; fairly numerous medium roots; gradual smooth transition to:
68 - 106 cms	Strong brown (7.5YR 5/6 m) coarse grained sandy loam; moist friable, plastic, sticky consistence;massive structure; good permeability and moderately well drained; common fine iron/manganese stains; few medium roots; gradual smooth transition to:
106 – 130 cms	Reddish yellow (7.5YR 6/6) coarse grained sandy loam; moist friable, plastic, sticky consistence; massive structure; good permeability and moderately well drained; common medium iron/manganese stains; occasional medium roots;

Comments

Third, fourth and fifth horizons have massive structure which breaks down to moderately developed fine/medium subangular blocky structure respectively.

ANALYSIS : PROFILE 18/XX/05

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REFERENCE	S1	S2	S3	S4	S5
DEPTH(cm)	0 -17	17 -33	33 -68	68 -106	106-130
LAB NO	O 544	O 545	O 546	O 547	O 548
DM %	99.6	99.7	99.0	98.7	99.5
TEXTURE	mS	mLS	mSaL	cSaL	cSaL
CLAY %	2	7	12	13	9
SILT %	4	4	6	6	7
FINE SAND %	30	32	29	26	24
MEDIUM SAND %	42	40	39	34	32
COARSE SAND %	22	17	15	21	28
pH (CaCl2)	4.6	4.3	4.8	5.4	5.6
EX Ca (me %)	1.2	0.9	2.5	3.6	2.1
EX Mg (me %)	0.5	0.5	0.8	1.2	0.8
EX Na (me %)	0.05	0.03	0.03	0.04	0.09
EX K (me %)	0.21	0.28	0.46	0.67	0.25
TEB (me %)	1.2	1.8	1.5	2.2	1.2
CEC (me %)	1.2	3.2	1.5	2.2	1.2
BASE SAT %	100	57	100	100	100
E/C	63.6	42.9	12.5	17.9	12.6
S/C	63.6	24.5	12.5	17.9	12.6
ESP	4.0	1.0	2.0	2.0	8.0
EKP	18.0	9.0	30.0	30.0	22.0

COORDINATES	: 17º07.831′S 31º57.228′E
PROFILE NUMBER	: **19/XX/05**
AUTHOR	: MUTAWARIRA DATE: 22-11-05
LOCATION	: MUTAWATAWA
ELEVATION	: 945 m
RAINFALL	: 500-600 mm
LANDSCAPE (FORM)	: Pediplain
LANDSCAPE (SHAPE)	: Gently undulating
SLOPE (POSITION)	: Middleslope
SLOPE (%)	: 3%
LANDUSE	: Maize
EFFECTIVE DEPTH	: 64cm
SLOPE (ASPECT)	: 130degrees
PRINCIPAL SPECIES	: Terminalia sericea, Piliostigma thonningii
NATURAL REGION	: IV
PARENT MATERIAL (A)	: Granite
CLASSIFICATION	

GROUP: Fersiallitic
FAMILY: 5G – Granite

DESCRIPTION:

0 - 12 cms	Dark yellowish brown (10YR 3/4 m) coarse grained sand; moist loose, non plastic, non sticky consistence; weakly coherent apedal structure; good permeability and well drained; few very fine roots; gradual smooth transition to:
12 - 34 cms	Dark grayish brown (10YR 4/2 m) coarse grained loamy sand; moist very friable, non plastic,non sticky consistence; moderately coherent apedal structure; good permeability and well drained; occasional very fine roots; clear smooth transition to:
33 - 64 cms	Light yellowish brown (10YR 6/4 m) medium grained loamy sand;moist very friable, non plastic, non sticky consistence;massive structure; good permeability and moderately well drained;few medium iron/manganese stains, abrupt irregular transition to:
64 - 114 cms	Good permeability and moderately well drained; many coarse iron/manganese concretions, few angular quartz and subangular parent material small stones.

Comments

Third horizon is massive structure which breaks to weakly developed subangular blocky

ANALYSIS : PROFILE 19/XX/05

****

REFERENCE	S1	S2	S3
DEPTH(cm)	0 -12	12 -34	34 -64
LAB NO	O 549	O 550	O 551
DM %	99.2	99.7	99.5
TEXTURE	cS	cLS	mLS
CLAY %	2	6	8
SILT %	4	7	7
FINE SAND %	29	29	32
MEDIUM SAND %	26	36	36
COARSE SAND %	39	22	17
pH (CaCl2)	6.3	5.5	5.3
EX Ca (me %)	2.4	2.4	1.3
EX Mg (me %)	1.4	0.8	0.9
EX Na (me %)	0.15	0.04	0.04
EX K (me %)	0.34	1.59	0.46
TEB (me %)	3.0	4.8	2.1
CEC (me %)	3.0	6.0	2.1
BASE SAT %	100	80	100
E/C	155.0	95.4	27.5
S/C	155.0	76.3	27.5
ESP	5.0	0.7	2.0
EKP	11.0	26.7	22.0
ORG. CARB. %	0.62		

COORDINATES : 17º07.868′S 31º57.425′E
PROFILE NUMBER : **20/XX/05**
AUTHOR : CHIMANIKIRE DATE: 22-11-05
LOCATION : MUTAWATAWA
ELEVATION : 939 m
RAINFALL : 500-600 mm
LANDSCAPE (FORM) : Pediplain
LANDSCAPE (SHAPE) : Gently undulating
SLOPE (POSITION) : Middleslope
SLOPE (%) : 3%
LANDUSE : Grazing
EFFECTIVE DEPTH : 40cm
SLOPE (ASPECT) : 220degrees
PRINCIPAL SPECIES : Stunted *Colophospermum mopane*
NATURAL REGION : IV
PARENT MATERIAL (A) : Dolerite (Mafic)
CLASSIFICATION

GROUP: Sodic
FAMILY: 8nE – Dolerite (Mafic)

DESCRIPTION:

0 - 7 cms	Dark reddish brown (5YR 3/3 m) medium grained sandy loam; moist friable, plastic, sticky consistence; moderately developed fine subangular blocky structure; good permeability and well drained; fairly numerous very fine roots; abrupt smooth transition to:
7 - 16 cms	Dark reddish brown (5YR 3/2 m) medium grained sandy loam; dry slightly hard, moist friable, plastic, sticky consistence; moderately developed fine subangular blocky structure;slightly restricted permeability and well drained; few fine roots; clear smooth transition to:
16 - 40 cms	Dark reddish brown (5YR 3/3 m) coarse grained sandy clay loam;dry very hard, moist friable, plastic, sticky consistence;massive structure; slightly restricted permeability and well drained; occasional few roots.

Comments

The third horizon is gravely, has occasional coarse roots and the massive structure breaks down to moderately developed medium subangular blocky. Weathering rock at 40cm depth.

ANALYSIS : PROFILE 20/XX/05

****

REFERENCE	S1	S2	S3
DEPTH(cm)	0 -7	7 -16	16 -40
LAB NO	O 553	O 554	O 555
DM %	97.1	97.5	96.3
TEXTURE	mSaL	mSaL	cSaCL
CLAY %	17	10	21
SILT %	9	14	12
FINE SAND %	37	43	24
MEDIUM SAND %	22	16	20
COARSE SAND %	15	17	23
pH (CaCl2)	5.5	5.4	6.4
EX Ca (me %)	6.3	4.1	6.7
EX Mg (me %)	4.2	3.0	3.6
EX Na (me %)	0.10	0.71	1.23
EX K (me %)	1.27	0.52	0.18
TEB (me %)	7.9	7.4	11.7
CEC (me %)	7.9	7.4	12.3
BASE SAT %	100	100	96
E/C	47.5	73.9	58.4
S/C	47.5	73.9	55.9
ESP	1.2	9.5	10.0
EKP	16.0	7.0	1.5
ORG. CARB. %	0.55		

COORDINATES : 17º07.872′S 31º57.435′E
PROFILE NUMBER : **21/XX/05**
AUTHOR : CHIMANIKIRE DATE: 23-11-05
LOCATION : MUTAWATAWA
ELEVATION : 938m
RAINFALL : 500-600 mm
LANDSCAPE (FORM) : Pediment
LANDSCAPE (SHAPE) : Gently undulating
SLOPE (POSITION) : Upperslope
SLOPE (%) : 4%
LANDUSE : Cleared not planted
EFFECTIVE DEPTH : 16cm
SLOPE (ASPECT) : 180degrees
PRINCIPAL SPECIES : Bauhinia galpinii,Diospyros kirkii, Piliostigma thonningii Brachystegia Bohemii, Acacia nilotica
NATURAL REGION : IV
PARENT MATERIAL (A) : Granite/Dolerite
CLASSIFICATION

GROUP: Lithosol
FAMILY: 2GE – Granite/Dolerite

DESCRIPTION:

0 - 16 cms	Dark brown (7.5YR 3/3 m) coarse grained loamy sand; moist very friable, slightly plastic,slightly sticky consistence; weakly developed medium subangular blocky structure; good permeability and well drained; occasional very fine roots; occasional small angular and subangular parent material stones; clear smooth transition to:
16 cms +	Good permeability and well drained.

Comments

16cms + is soft weathering rock

ANALYSIS : PROFILE 21/XX/05

****

REFERENCE	S1
DEPTH(cm)	0 -16
LAB NO	O 556
DM %	99.0
TEXTURE	cLS
CLAY %	7
SILT %	3
FINE SAND %	28
MEDIUM SAND %	25
COARSE SAND %	37
pH (CaCl2)	5.2
EX Ca (me %)	2.8
EX Mg (me %)	1.3
EX Na (me %)	0.08
EX K (me %)	0.12
TEB (me %)	4.3
CEC (me %)	8.1
BASE SAT %	53
E/C	118.4
S/C	63.3
ESP	1.0
EKP	1.5
ORG. CARB. %	0.34

6.2 Quality of Water in Chikono Dam

Attribute	Concentration	
Calcium (Ca^{2+})	1.70 me/L	34.00 ppm
Magnesium (Mg^{2+})	1.98 me/L	24.00 ppm
Sodium (Na^{+})	0.78 me/L	2.99 ppm
Carbonate (CO_3^{2-})	Nil	Nil
Bicarbonate (HCO_3^{-})	1.25 me/L	76.25 ppm
Chloride (Cl^{-})	0.64 me/L	22.40 ppm
Sulphate (SO_4^{2-})	-	-
Conductivity (microsiemens/cm)	338	
pH	6.9	
Sodium Adsorption Ratio	0.155	
Residual Sodium Ratio	-2.43	
Ca/Mg Ratio	0.859	
Code	C_2-S_1-R_1-X_1	

Key
C_2-Total concentration of soluble salts ranging between 250 and 750 micromhos/cm. This is an indication of medium salinity waters with moderate chances of salinity. Moderate leaching is required to wash out excess salts. Used for irrigation of plants with moderate salt tolerance.

S_1-This is a sodium hazard class indicating low sodium waters used for any soils without any chances of accumulating high amounts of sodium.

R –Factor referred to as the residual sodium carbonate, if water used to irrigate is likely to be lost through evaporation. Ca and Mg will precipitate as carbonates and bicarbonates. If there is high carbonates and bicarbonates, the excess will precipitate as sodium carbonates and bicarbonates.

R_1-Waters with less than 1.25 meq/L. The water has low residual sodium carbonate and there are no restrictions.

X –Ratio of Ca: Mg

X_1-Ratio>0.5 high Ca: Mg suitable for most crops.

6.3 Land Suitability Classification for Irrigation

The irrigability classes assigned to mapping units have been based on factors related to land characteristics, such as slope and soil properties, such as water holding capacity, permeability and levels of exchange sodium percentage.

The irrigability classes are defined as follows.

Class A: Suitable for irrigation without special precautions or practices and capable of sustained productivity.

Class B: Suitable for irrigation with special precautions or practices. Sustained productivity is attainable with good management and maximum efficiency in the use of irrigation water, but risks are greater than with class A owing to moderate soil and/or topographic limitations and special care is necessary. Corrective measures may be recommended according to the nature of limitations.

Class C: Of very restricted suitability for irrigation; confined to specific types of crops and practices owing to severe soil and/or topographic limitations.

Class D: Unsuitable for normal irrigation.

Class S: Excessively pervious sands of restricted suitability owing to inadequate water holding capacity, unavoidable high water losses and low inherent fertility.

N.B. It should be noted that these Irrigability Classes and the criteria used to asses the suitability of soils are intended for normal full-scale irrigation i.e. all-the-year- round irrigation for rotation of intensively grown crops as distinct from supplementary irrigation of summer crops grown mainly under normal rainfall. It also assumed that the water used for irrigation is of good quality.

6.4 Glossary of Technical Terms

Soil Depth

Extremely shallow	<25cm
Very shallow	25-40cm
Shallow	40-50cm
Moderately shallow	50-100cm
Moderately deep	100-150cm
Deep	>150cm

Soil Texture class

C	clay
CL	clay loam
L	loam
SiC	silty clay
SiCL	silty clay loam
Si	silt
SaC	sandy clay
SaCL	sandy clay loam
SaL	sandy loam
LS	loamy sand
Sa	sand

Texture classification-coarse(c), medium (m) and fine (f).

Express each sand fraction as a % of the total sand fraction in the sample.

- If the coarse sand is>or=25% the texture will be prefixed with a 'c'.
- If the fine sand is>or=60% the texture will be prefixed with 'f'.
- If the coarse sand, < 25% and the fine sand is <60% the texture will be prefixed with 'm'.
- If the total sand fraction is <45 there is no prefix.

Particle size grades

Coarse sand	2, 0mm (2000um)-0.5mm (500um)
Medium sand	0,5mm (500um) - 0,2mm (200um)
Fine sand	0, 2mm (200um)-0, 02(20um)
Silt	0, 02(20um) - 0,002(2um)
Clay	<0,002(2um)

Other Abbreviations

d-Dry **m**-Moist **K**-Potassium **Ca**-Calcium **Mg**-Magnesium **Fe**-Iron
CEC-Cation Exchange Capacity **TEB**-Total Exchangeable Bases
me%-Milli-equivalents percent or per 100grams of soil.
Base Saturation%-100*TEB ($cmoI_c kg^{-1}$)/CEC ($cmol_c kg^{-1}$)
ESP-Exchangeable sodium percentage **EKP**-Exchangeable potassium percentage

6.5 A Simplified Outline of the Soil Classification System of Zimbabwe

ORDER	DESCRIPTION	GROUP	TYPICAL SOIL FAMILIES
1.AMORMIC	Little or no horizon development	1.Regosol Deep sands 2.Lithosol Extremely shallow	1K(Deep sands derived from Kalahari deposits 2E(derived from mafic rocks)
CALCIMOPHIC	Unleached soils generally with large reserves of weatherable minerals: high base saturation.	3. Vertisols Very acidic clay 4.Siallitic Active clay	3B(derived from basalt) 4PE(derived from mafic gneiss)
KAOLINITIC	Moderately to strongly leached soils; appreciable amounts of free sesquioxides of iron and aluminum.	5.Fersiallitic mixed clay 6.Paraferrallitic Inert clay 7.Orthoferrallitic	5G(coarse grained sandy soils derived from granite) 6G 7G
NATRIC	Dominated by appreciable amounts of sodium as the exchangeable ion	8.Sodic Weakly sodic Strongly sodic Saline sodic	 8n 8N 8h