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REPUBLIC OF KENYA

MINISTRY OF AGRICULTURE—NATIONAL AGRICULTURAL LABORATORIES

KENYA SOIL SURVEY

SOILS OF THE VALLEY BOTTOMS OF KABETE VETERINARY LABORATORIES - NAIROBI

A preliminary assessment for irrigation suitability

by

D.O. Michieka

SITE EVALUATION REPORT

number 36-December, 1977

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Kenya Soil Survey
S 479/AW/DOM

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1. INTRODUCTION

A request was received from the authorities of the Veterinary Laboratories Kabete, through the Scientific Research Division of the Ministry of Agriculture for a site evaluation of the conditions of the soils and waters of the Valley Bottoms of Kabete Veterinary Laboratories. The aim was to find out whether the soils and the waters of the valleys can be used for irrigation of napier, lucern and alfefa. A site evaluation of a bont 61 ha was carried out on 23rd and 24th October, 1977.

2. ENVIRONMENT CONDITIONS

2.1 Location and Communications

The area is located in the Valley Bottoms of the Kabete Veterinary Laboratories Nairobi at an elevation of about 1940 metres. One of the Valleys starts just in front of the main offices and is joined by another one about 2kms east of the Laboratories and both drain through the Loresho ridge in the north, and Kangemi trading centre in the South to join the Nairobi river. The area is seasonally waterlogged and as such, the accessability is only possible during the dry seasons.

2.2 Geology and general landscape features

The area is covered by alluvium/colluvium deposits derived from Limuru trachytes and quartz trachyte of upper Trachyte Division of Pleistocene age (Saggerson, in press). These rocks overlie the Kirichwa Valley Tuffs and Nairobi Tigoni trachyte. The trachytes, which are grey-green, are considered to have been a result of a narrow lava flow erupted from the Muguga-Limuru areas.

The valley bottoms are flat; the surrounding areas consist of steep valleys which are subject to erosion if left barren. Within the steep valleys shallow soils occur; deep, red and brown soils are found in the ridges and interfluves; here also shallow depressions (which are not shown in the soil map) occassionally occur. During the rains water drain from the surrounding ridges towards the depressions and the valley bottoms, making the areas seasonally waterlogged.

2.3. Climate and Vegetation:

The area in the elevation of 1940 metres falls with zone II according to National Atlas of Kenya (1970) but which falls under zone III according to Braun (1977). The weather is cool in the months of June, July and August and warm in the months of November, December and January. Mean annual rainfall, recorded over 45 years up to 1960 for the Veterinary Laboratories, is 990mm. Table I gives the rainfall distribution recorded for the same place over the last 11 years. The rains appear well distributed with April, May, October, November and December being the wettest months. January, February, June and July appear to be the driest months.

TABLE I: Mean Monthly Rainfall (mms) for the Veterinary Laboratories 1959 - 1969.

Year / Months	1950 1	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
January	24.9	41.1	1.5	200.7	87.4	46.7	74.9	149.6	0	0	82.4
February	160.3	6.6	11.7	42.2	55.1	1126.7	7.9	51.6	8.9	123.2	86.2
March	35.8	247.7	77.2	39.6	103.4	55.9	23.4	20.6	24.1	209.5	103.7
April	141.5	192.3	176.0	184.7	402.1	451.1	324.9	223.0	290.1	40.1	237.0
May	346.5	108.5	151.9	296.9	454.4	134.4	79.8	113.5	496.3	184.5	119.2
June	44.2	33.3	29.0	58.4	38.5	17.0	18.3	41.4	37.0	48.0	3.4
July	92.7	6.6	32.3	3.8	2.0	27.9	14.2	4.1	26.9	5.8	6.0
August	0.5	9.7	37.6	40.1	64.5	70.4	10.2	64.8	51.1	6.4	39.3
September	7.6	32.8	47.8	9.4	18.8	11.4	6.9	19.6	44.2	5.8	8.6
October	10.2	78.7	177.3	25.6	12.4	29.5	88.6	46.5	113.0	51.7	32.4
November	54.6	75.7	547.9	117.6	171.2	78.2	142.5	167.9	125.7	110.5	285.1
December	54.6	35.0	369.8	126.2	332.5	93.7	162.8	48.8	39.6	14.3	163.3
Total	973.4	866.0	1660.0	1205.2	1737.3	1142.9	984.4	951.4	1257.0	779.8	1166.8

The whole of the survey area was under bushland vegetation until 1975 when the authorities of the Veterinary Laboratories decided to clear and drain it for napier grass growing. At present the bushland vegetation is concentrated within unit VIg, which receives seepage influence from the valley sides of the ridges. The central parts of the area Unit VId and VIg2 have grassland vegetation. The southern valley bottoms near the Veterinary Laboratories have until now napier grass. Also there is tall and healthy Hyoarrhenia Hirta grass.

2.4. Hydrology and Water Resources

The only permanent source of water for irrigation is by trapping the rain water by dams during the rains. The "old dam", although is at present rather neglected, still contains water. This dam could be expanded or reconstructed by using the expertise of the Soil Conservation service section of the Ministry of Agriculture. The water from this point could be easily pumped to the next valley.

Areas with very gently undulating topography could also benefit from this dam. The construction of another dam in the Valley bottom at the far east of the survey area, could involve a lot of earth scooping which may be uneconomical. It may also reduce quite a lot of land which could be used for growing crops. However, this advise may be best received from the Land Management Division of the Ministry of Agriculture. During the site evaluation the two Valley Bottoms were almost dry. There was no any water running out of the Dam of Wellcome Laboratories. There was some water coming out of the old Dam.

At present water for irrigation has been tested from three points; from Old Vet. Lab. Dam; from the eastern Valley Bottoms, near pit no. 2; (see soil map); and from the Dam of Wellcome Laboratories. Table no. 2 gives the results. According to Richards/ed 1961 these waters are free from salinity and alkalinity hazard. There also seems to be no any other limitation in the water as far as the other soluble element are concerned. The water is therefore safe for irrigation.

3. THE SOILS

The soil map attached is on a scale of 1:10.000, and was compiled from enlarged aerial photographs (scale 1:50,000). Three soil units occur in the area namely, units VId - chromic Vertisols; VIg1 - humic Gleysols and VIg2 -vertic gleyic phaeozems. From the analytical data of few soil samples taken from the areaand analysed at National Agricultural Laboratories; it is apparent that all the soils are moderately acid and are poor in available phosphorus and sufficient in other available nutrients. (see tables 3-5).

TABLE 2: Water analysis

1. Vet. Dam
2. Vet. Farm near pit no. 2
3. Wellcome Dam

Ref.	1	2	3
Lab. No. /77	8233	8234	8335
pH	7.8	7.4	8.2
EC micro mhos/cm	460	380	450
Na m.e.1l	2.37	2.78	2.50
K "	1.69	0.97	1.89
Ca "	1.76	0.76	1.36
Mg "	0.44	0.32	0.58
HCO_3"	3.76	1.10	2.90
CO_3 "	Nil	Nil	Traces
Cl "	2.60	3.40	2.68
SO_3	0.10	0.30	0.10
S.A.R (Sodium adsorption ratio)	2.26	3.78	2.54

Analysis carried out at National Agricultural Laboratories

3.1 Uplands

Soils developed on Limuru trachyte

Mapping Unit UIr

Full details on these well drained, very deep, dark reddish brown to dark red, friable clayey soils may be received from the surveys of Nyandat N.N./Michieka D.O. (1970) and D'Costa V. and Nyandat N.N.(1968). These soils cover the largest portion of the Veterinary Laboratories area.

3.2 Valley Bottoms

Soils developed on alluvium/colluvium from Limuru trachyte

Mapping Unit VId;

Total area 10.2 ha: soil classification chronic Vertisol.
These are imperfectly drained, very deep, very dark grey, cracking clay soils, lacking distinct horizons in their profile. This is related to the process of churning due to their capacity to expand and contract with changes in moisture content. The clay minerals are of the Montmorillonite type. The first 0-55cm of the profile is very dark greyish brown (10YR 3/2). The structure is angular blocky breaking to prismatic structure. Many slickensides occur. The field pH is 5.1 to 5.5. Few fine mottles are present. From 55 to 130cm+ the soils are very dark grey (10YR 3/1) with angular blocky to prismatic structure. The pH ranges from 5.5 to 5.7. Common cracks of 10-15mm wide and 50cm deep occur through-out the profile. The macrorelief in general is flat. Few gilgai features occur and cracks of more than 30cm deep and 5cm wide are common on the surface.

Laboratory data: (table 3)

A-horizon; the soils are rich in available Ca and Mg, sufficient in available K and Mn, poor in available P. The organic Carbon is 1.88% CEC soil is 37.0 m.e.100g soil, base saturation is more than 100% exchangeable Sodium is 8.0% and pH H20 is 5.2 and pH-KCl is 3.8

C-horizon; Organic Carbon is 0.94 decreasing to 0.15 in the C2 horizon; CEC soil ranges from 44.0 to 47.0 m.e. 100g soil; base saturation ranges from 70 to 91% and the exchangeable sodium is 8.5 to 9.0%.

Mapping Unit VIg1:
Total area 36.3 ha; soil classification: humic Gleysols. These are imperfectly drained, very deep, dark greyish brown to dark brown, Mottled, clayey soils. These are young soils which are always receiving fresh material from the valley sides. The field pH of these soils is 5.5 throughout. They have a substantial amount of organic matter in the first 0-20cm, showing a black colour (2.5YR 1/0). The lower horizon

+ Colours moist unless otherwise stated

TABLE No. 3: Soil analysis

Place: Vet. Lab farm/Nairobi

Unit : VId

Soil classification: chromic Vertisols

Date sampled : 25/10/77

Laboratory number /77	8238	8239	8240	
Field reference 148/4-1				
Depth in cm	0-15	15-55	55-130	
Texture (hydrometer)class	C	C	C	
Sand %	27	12	16	
Silt %	33	28	20	
Clay %	40	60	64	
pH.H2O (1.2½ susp.)	5.2	5.4	6.0	
pH-KCl (" ")	3.8	3.8	4.6	
EC (" ") mmhos/cm	0.25	0.30	1.05	
C %	1.88	0.94	0.15	
N %	0.22			
Cation Exchange Capacity m.e./100g	37.00	47.00	44.00	
Exchangeable Ca " "	17.60	20.00	25.00	
Mg " "	8.50	7.75	10.00	
K " "	0.88	1.05	1.51	
Na " "	2.65	3.68	4.13	
Sum	39.63	32.48	40.64	
Base saturation %	100	70	91	
E.S.P	8.0	8.5	9.0	
Hp m.e. %	0.40	-	-	
Available Ca "	9.20	10.40	10.00	
Mg "	5.20	4.60	5.80	
K "	0.50	0.42	0.60	
Na "	1.70	2.35	2.90	
Mn "	0.82	0.54	0.85	
P ppm	10	10	5	
Saturation extract			100	
pHp			6.4	
ECe in mmho's/cm			1.6	

The lower horizon 74 to 100cm is dark brown (7.5YR 3/2). Many distinct yellowish brown to dark yelowish brown mottles are present. The horizon from 100 to 130cm+ has a dark greyish brown (10YR 4/2) colour and angular blocky to prismatic structure. Many clay cutans and slickensides occur. Also present are common, distinct dark brownish mottles. The mottling is due to seepage from the valley sides. The soils are moist throughout. There are a few springs within the unit.

Laboratory data. (table 4)

Ap - A2 horizons: The soils are rich in available Mn and Mg, sufficient in available P. The organic Carbon is high 5.77 %; the CEC - soil ranges from 34.0 to 35.0 m.e./100g; base saturation ranges from 62 to 86%; exchangeable sodium ranges from 4.4 to 8.5%; pH H2O ranges from 5.6 to 5.8 and pH KCl is 4.4.

B - horizons: Organic carbon 0.43 to 0.99%; CEC soil 28.0 to 33.0 m.e./100g soil base saturation ranges from 57 to 66%; exchangeable sodium from 3.0 to 5.7% and pH H2O and pH KCl from 5.4 to 5.6 and from 4.0 to 4.4 respectively.

Mapping Unit V1g2:

Total area 14.3ha; soil classification verto-gleyic Phaeozems. These are imperfectly drained, very deep, very dark brown to very dark greyish brown, mottled clay soils with few cracks within the profile. The soils have relatively high organic matter content in the first 0 to 10cm of the profile. The colour is dark brown (7.5YR 3/2). The structure is granular and the consistence is friable. In the horizon from 10 to 120cm+ the colour changes to very dark brown(10YR 3/2). Slickensides and clay cutans are common, the structure is angular blocky to prismatic. Dark brown mottles are present throughout the profile. The field pH is 4.5 to 5.5 throughout.

Laboratory data. (table 5)

A1 - B1 horizons: The soils are high in available Mg and Mn, sufficient in available K and Ca and poor in available P. The organic Carbon is 3.59 decreasing to 1.42 in the lower 10-65cm horizon of the profile. The CEC soil ranges from 28.65 to 35.0 m.e./100 soil;base saturation from 55 to 80%, exchangeable sodium from 3.5 to 7.4% and the pH H_2O and pH -KCl 5.2 to 5.4 and 3.8 to 4.2 respectively.

B2 - horizon: Organic carbon is 0.51%; CEC soil 34.0 m.e./100g soil; base saturation is more than 100%; exchangeable sodium is 11.7% and pH H_2O and pH KCl is 5.4 and 4.4 respectively.

TABLE No. 4 Soil analysis
Place: Vet. Lab farm/Nairobi
Unit: VIg1
Soil classification humic Gleysols
Date sampled: 25/10/77

Laboratory number /77		8241	8242	8243	8244
Field reference 148/1-2					
Depth in cm		0-10	10-74	74-100	100-130
Texture (hydrometer) class		CL	C	C	C
Sand %		24	24	32	20
Silt %		40	36	24	32
Clay %		36	40	44	48
pH.H2O (1.2½ susp.)		5.8	5.6	5.6	5.4
pH-KCl (")		4.4	4.4	4.0	4.4
EC		0.22	0.90	0.18	1.00
C %		5.77	0.85	0.99	0.42
N %		0.16			
Cation Exchange capacity	m.e./100g	34.00	35.00	28.00	33.00
Exchangeable Ca	" "	14.40	18.90	9.60	16.40
Mg	" "	4.45	8.00	4.10	3.35
K	" "	1.09	0.45	0.45	1.63
Na	" "	1.50	3.08	1.58	0.83
Sum		21.44	30.43	15.73	22.21
Base saturation %		62	86	57	66
E.S.P		4.4	8.5	5.7	3.0
Hp	m.e. %	0.3	0.2	0.5	0.6
Available Ca	"	8.8	6.8	2.4	6.8
Mg	"	5.8	4.6	3.0	4.8
K	"	0.88	0.22	0.26	0.26
Na	"	1.46	1.50	1.24	2.35
Mn	"	1.38	0.34	0.44	0.36
P	ppm	68	10	8	8
Saturation extract			94.2		103.9
pHp			6.6		7.4
ECe in mmho's/cm			2.15		2.4

TABLE No. 5 Soil analysis

Place: Vet. Lab farm/Nairobi

Unit: VIg2

Soil classification: Verto-gleyic Phaeozems

Date sampled: 25/10/77

Laboratory number/77		8245	8246	8247
Field reference 148/4-3				
Depth in cm		0-10	10-65	65-120
Texture (hydrometer) class		C	C	CL
Sand %		28	16	24
Silt %		32	24	40
Clay %		40	60	36
pH.H2O (1.2½ susp.)		5.4	5.2	5.4
pH-KCl (")		4.2	3.8	4.4
EC (")in mmho's/cm		0.12	0.40	1.95
Cation Exchange Capacity m.e./100g		28.60	35.00	34.00
Exchangeable Ca	"	10.80	17.00	22.00
Mg	"	4.75	7.70	10.05
K	"	1.40	0.76	0.60
Na	"	0.48	2.58	4.30
Sum		16.43	28.04	36.95
Base saturation %		55	80	100
E.S.P		3.5	7.4	11.7
Hp	m.e %	0.4	0.9	0.2
Available Ca	"	6.0	8.0	9.2
Mg	"	4.4	5.0	6.7
K	"	0.16	0.36	0.30
Na	"	0.44	1.85	3.60
Mn	"	1.60	0.24	0.72
P	ppm	14	4	4
Saturation extract				93.6
ECe (mmho's/cm)				4.5
pHp				7.0

4. SUITABILITY FOR IRRIGATION

From the field point of view, all the soils of valley bottoms are imperfectly drained and very deep with probably identical clay mineral constituents. They have therefore been discussed together in this section. The laboratory results indicate that both the soils and water are free of salinity and alkanity hazards. The soils are acid. In general these soils have active clay minerals (Montmorillonite) and as such they are hard to very hard when dry but plastic and sticky when wet. If cultivated when they are wet, many of them will puddle and become massive and hard. If tilled when too dry, many of them will turn up in large blocks or clods that will not shake down to a granular mass. Thus these soils can only be cultivated within a very narrow range of soil moisture.

The effective use of water is more difficult on these soils than on the red or brown soils which are found around the survey area. The low infiltration rates make irrigation troublesome in many instances, while low permeabilities make the soils difficult to drain when they are too wet for satisfactory plant growth. The absence of leaching, slow drainage and strong evaporation may induce salinity. The retention of water by these soils is high but much of the water held is not available to plants. Thus, the effective utilization of water, whether from rainfall or from irrigation, meets with a number of problems. During dry season, management practice on these soils need to be directed toward maximum infiltration and storage of moisture. On the other hand, drainage is essential for these soils during the heavy rains. The infiltration rates of these soils in general are low to moderate. They can be very high initially when shrinkage cracks extend up to the surface, for water can enter such cracks in large amounts. Management of these soils can therefore be designed to maintain or improve the intake of water. Infiltration is generally highest in soils having surface layers with a granular structure. The development and maintenance of a granular structure can be encouraged by proper tillage, by crop rotations, by additions of organic matter and by proper handling of crop residues. (Dudal and Brmao 1965). The growing of grasses and legumes as is planned for this area, will probably effect these soils very favourably, partly through the influence of the roots on granulation and partly by adding organic matter (as it has been the practice in the Veterinary Lab. Farms).

The slow internal drainage and negligible lateral movement of water in these soils make subsurface drainage inefficient and practically unfeasible. Excess water must be removed by surface drainage either by ridge and furrow cultivation or by open drains.

Methods to improve water storage and irrigation practices should be devised in such a way that the soil holds water from one wetting season to another one, while maintaining free drainage.

Although soils of the survey area seem to be free of salinity and alkality hazards, these problems may develop through many years of irrigation if there is no proper soil management.

5. CONCLUSIONS AND RECOMMENDATIONS

1. The soils of the survey area are free of salinity and alkalinity hazards and as such are suitable for irrigation.

2. The soils are medium acid.

3. Problems may arise from the tillage side because of the clay minerals they contain (montmorillonite).

4. Results of analysis of a few soil samples collected from the area indicate that the soils are deficient in phosphorus but adequately supplied in the other available nutrients.

5. The waters taken from 3 points in the survey area do not show any salinity hazard.

6. Proper drainage measures should be taken to avoid salinization.

7. The only permanent source of water for irrigation is through trapping the rain water into a newly constructed dam. The methods and place of constructing this dam should be discussed with Farm and Management Division of the Ministry of Agriculture.

8. The method and the layout of the canals should be devised by the Farm and Land Management Division of the Ministry of Agriculture.

9. The staff of the Irrigation and Drainage research section of National Agricultural Laboratories should be consulted before the work starts.

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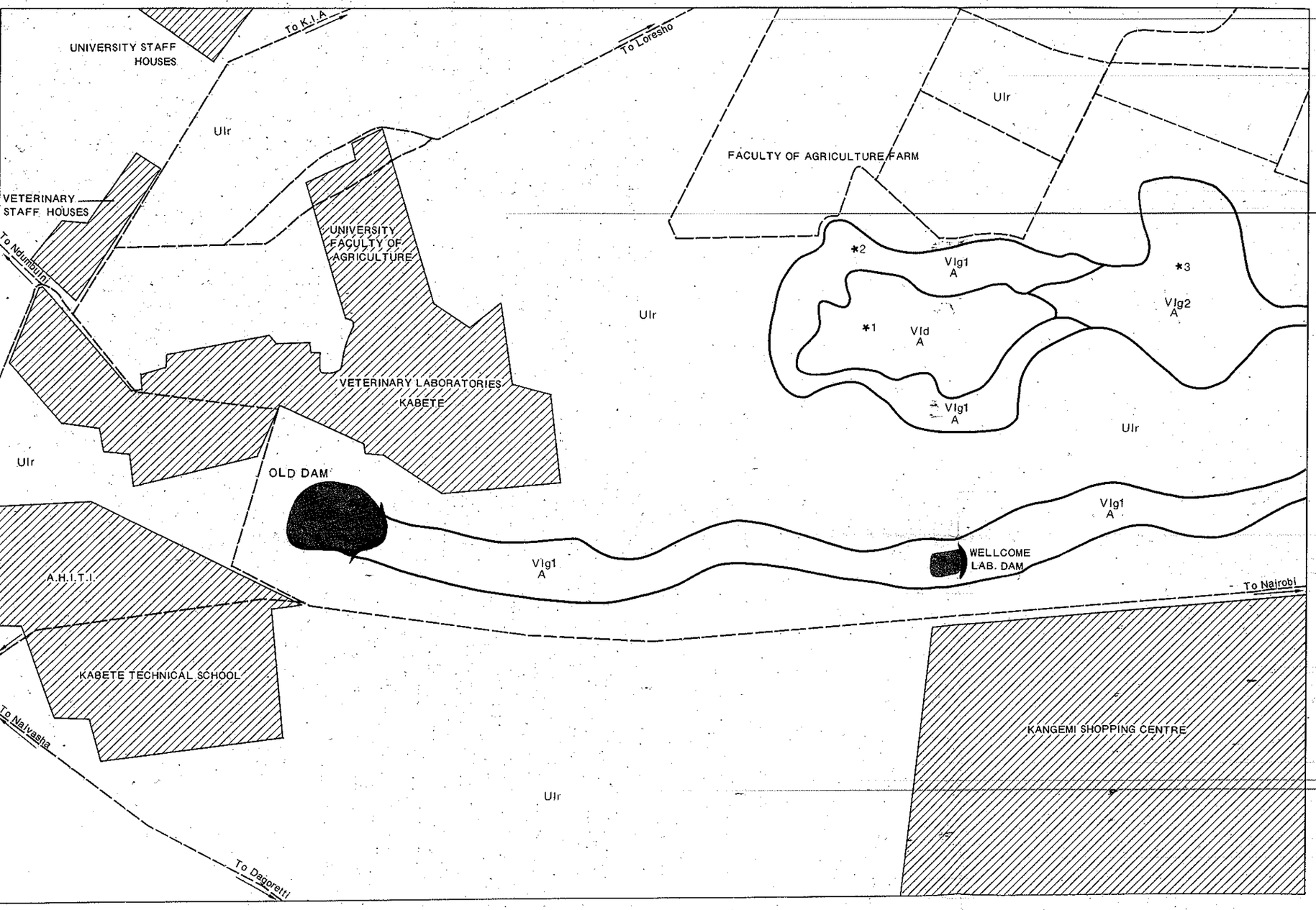
SOILS OF THE VALLEY BOTTOMS OF KABETE VETERINARY LABORATORIES



SCALE 1:10,000

m1000 750 500 250 0 1km

LEGEND

*U UPLANDS

UI **Soils developed on Limuru trachyte**

Ulr well drained, very deep, dark reddish brown to dark red, friable clay with acid humic topsoil **(humic Nitosols)**

V VALLEY BOTTOMS

VI **Soils developed on alluvium/colluvium from Limuru trachy**

Vld imperfectly drained, very deep, very dark grey, very firm , cracking clay **(chromic Vertisols)**

Vlg1 imperfectly drained, very deep, dark greyish brown to dark brown, mottled, firm clay with acid humic topsoil **(humic Gleysols)**

Vlg2 imperfectly drained, very deep, very dark brown to very dark greyish brown, mottled, firm clay **(verto*-gleyic Phaeozems)**

KEY

road

built up area

dam

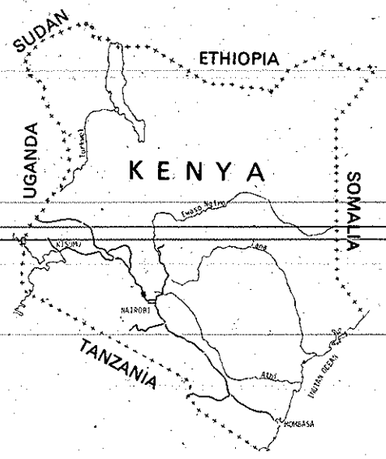
soil boundary

Vld soil mapping symbol

A slope class symbol

* profile pit

* For full description and reporting, see the soil survey report of Nyandat, N.N.and Michieka, D.O. "Soils of Kirima Kimwe Faculty of Agriculture Farm" Soil Survey Unit, N.A.L. 1970, and D'Costa,V. and Nyandat,N.N. "Soils of University College Farm" Soil Survey Unit, 1968, N.A.L.



■ Location of the survey area

Prepared and drawn by Kenya Soil Survey, November 1977

Drawing No. 7708

Appendix to site evaluation No 36