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THE REPUBLIC OF THE SUDAN
MINISTRY OF AGRICULTURE

ROSEIRES SOIL SURVEY

REPORT No. 15

THE NILE FROM KHARTOUM TO KAREIMA SEMI-DETAILED SOIL SURVEY AND LAND CLASSIFICATION OF SELECTED AREAS

HUNTING TECHNICAL SERVICES LTD.
LAND USE & AGRICULTURAL CONSULTANTS
6 ELSTREE WAY
BOREHAM WOOD
HERTS.

SIR M. MACDONALD & PARTNERS
CONSULTING ENGINEERS
HANOVER HOUSE
73 HIGH HOLBORN
LONDON .. W.C.1

FEBRUARY 1967

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Date 28th February,
1967

Your Ref _____ Our Ref _____
H.E. The Minister of Agriculture,
Ministry of Agriculture,
KHARTOUM,
REPUBLIC OF THE SUDAN.

Your Excellency,

ROSEIRES SOIL SURVEY REPORT No.15
THE NILE FROM KHARTOUM TO KAREIMA

We have pleasure in submitting our Report No.15 for the Roseires Soil Survey Project, the study of which was entrusted to us by the Contract for Soil Survey of Irrigable Lands in the Sudan, dated September, 1962.

The report, which includes index sheets, and is accompanied by an album of maps, contains the results of the semi-detailed soil and land classification survey of selected areas along both banks of the Nile between Khartoum and El Bauga and along the lower Atbara river near its junction with the Nile.

The area surveyed covered 194,810 feddans located in eight main basins and 69,940 feddans were found to be in the arable land Classes 1, 2 or 3. We believe a further 17,950 feddans of Class 4 land is potentially arable subject to special limitations. Class 5 land, 90,330 feddans is at present considered non-arable, but the Consultants consider that because of the shortage of good land north of Khartoum a further study should be made to determine whether the salts could be leached from the lighter textured Class 5 land and hence reduce the exchangeable sodium content to a safe level. Experimental work or experimental farms and pilot projects to investigate this type of reclamation should be initiated. Only 10%, 16,590 feddans have been graded Class 6.

Roseires Report No.15 completes the survey of the Nile lands between Khartoum and the Third Cataract, referred to as Area 4 in the Contract. Earlier surveys of parts of these lands are described in the following Soil Survey Reports:-

- No.3 The Nile from Kareima to the Third Cataract, Soils and Engineering Reconnaissance.
- No.5 The Nile from Khartoum to Kareima, Soils and Engineering Reconnaissance.
- No.8 The Nile from Kareima to the Third Cataract, Semi-Detailed Soil Survey and Land Classification of Selected Areas.

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Because of this great shortage of arable land we wish to mention again the 67,200 feddans of somewhat difficult lands on the higher terraces in the Shendi and Atbara areas, recommended for further study in our Report No.5 but not included in the semi-detailed surveys. We consider that where these lands lie adjacent to proposed new pump projects they should be regarded as possible extensions to such projects if shown to be suitable.

The necessary soils studies were undertaken on our behalf by Messrs. Hunting Technical Services Ltd. of London. The agricultural development possibilities of these lands are at present being investigated under the Pre-Investment Survey of Pump Projects.

We are, Excellency,

Your obedient servants,

ISC Mathew

SIR M. MACDONALD & PARTNERS.

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ACKNOWLEDGEMENTS

The compilation of a report of this kind cannot be complete without reference to many organisations and individuals, both in Sudan and the United Kingdom, who have assisted us by providing information, advice or facilities. Among the many who have assisted us in this way are the following, to whom our thanks are due.

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The members of the Ministry of Irrigation and Hydro-Electric Power including the Permanent Under Secretary of Irrigation and the Assistant Under Secretary (Development) with their staff, for their help.

The members of the Survey Department, the Geological Survey Department, the Department of Meteorology and members of the Agricultural Bank for technical assistance.

The officers of local administration and police, for practical help during the actual survey.

- Ful mawri - The thick bean; Vicia faba.
- Gari - Terrace areas on river banks cultivated as exposed by receding flood water.
- Haboob - A strong wind usually accompanied by thick dust.
- Hafir - A pool usually excavated to collect and store water.
- Halba - Grown for its seeds (Trigonella Foeniculum L.)
- Hummos - Chick Pea; Cicer arietinum L.
- Kharif - Rainy season; June to October.
- Khor - Water courses - usually dry.

GLOSSARY

- Ardeb - A volume measure of agricultural produce equalling 198 litres.
- Neem - 1 ardeb of dura = 150 kg
- Sagiya - 1 " " groundnuts = 72 kg
- Self - 1 " " wheat = 162 kg
- Baladi - Arabic = native or local.
- Berseem-Lucerne - (Medicago sativa Linn).
- Buda - The root parasite of sorghum species (Striga hermonthica (Del.) Benth.).
- Cummin - Cuminum cyminum L.
- Damira - Crops of the darat.
- Darat - Autumn season when Nile is in flood.
- Dukhn - Bullrush millet (a food grain) (Pennisetum typhoideum (Burm) Stapf & Hubbard).
- Dura - The great millet (Sorghum vulgare Pers.).
- Fasulia - The haricot bean; Phaseolus vulgaris.
- Feidan - Land forming natural, annually flood basins along the Nile.
- Feterita - Variety of dura; resistant to drought.
- Ful masri - The thick bean; Vicia faba.
- Gerf - Terrace areas on river banks cultivated as exposed by receding flood water.
- Haboob - A strong wind usually accompanied by thick dust.
- Hafir - A pool usually excavated to collect and store water.
- Helba - Grown for its seeds (Trigonella Foenum-graccum L.)
- Hummos - Chick Pea: Cicer arietinum L.
- Kharif - Rainy season; June to October.
- Khor - Water course - usually dry.

- Kirkadey - Crop plant, yielding vitamin-rich calix (Hibiscus sabdariffa L.).
- Lubia ANDREW, G. (19) The bean (Dolichos lablab Linn.). dan, Ch. VI in
- Neem - Valuable shade tree of villages; (Azadirachta indica).
Oxford University Press.
- Sagiya - An ox-driven water wheel for irrigation purposes.
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- Seif - The summer season.
in the Sudan. Edited by J. D. Tothill.
- Seifi - Crops associated with the seif. ity Press.
- Seluka ANDREWS, F.W. A digging stick with foot rest. Plants of the Sudan.
- Shaduf - A hand operated counterbalanced water lifting
device for watering vegetable plots.
ARKELL, A.J. (1) ground of Sudan
- Shita - The cool winter season.
Agriculture. Ch. II in Agriculture in the
- Shitwi - Winter grown crops.
Sudan, ed. Tothill, Oxford University
- Terus - A small earth bund for impounding rainwater
for raingrown dura.
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- 1.1 The semi-detailed survey of Area 4b, Khartoum to Kareima covers a total area of some 194,810 feddans. These lands were selected for semi-detailed soil and land classification survey following the soils and engineering reconnaissance survey of nearly one million feddans between Khartoum and Kareima, carried out from November 1963 to February 1964. As a result of this study the Consultants recommended the carrying out of a detailed soil and land classification survey of a total area of 271,000 feddans, of which 67,000 feddans are comparatively more difficult to gate. (See Boscires Soil Survey Report No. 5). After due consideration the Client decided to include only the more favourable lands, totalling about 200,000 feddans, in the semi-detailed soil and land classification survey described in this report.
- 1.2 The survey lands form a narrow and discontinuous strip of flood plain and terrace material on both banks of the Main Nile between Sabaloka Gorge and El Banga, between latitudes $16^{\circ} 33'N$ and $18^{\circ} 34'N$. Also included is a strip of land on both banks of the River Atbara near Kineidra.
- 1.3 The soil parent material is mainly Nile Alluvium, but the age of the deposits varies from very recent flood plain to pre-Palaeolithic upper terrace. Small areas of piedmont deposits also occur within the survey area.
- 1.4 The climate of 4b is arid, divisible into four climatic seasons, namely 'ahita', 'zeif', 'kharif' and 'damarat'. Rainfall is very low, varying from 164 mm at Khartoum to 72 mm at Atbara, and falling mainly in the months of July and August. Temperatures show a wide range in mean maximum and minimum daily and annual values, which is characteristic of a desert climate.

CHAPTER 1

1.5 Within the survey area, much of the vegetation is riverine and not representative of the vegetation of Northern Province. Of the riverine vegetation, *Hyphaene thebaica* (especially along the river

Atbara), *Acacia albida* and *Acacia seyal* are the main trees and scrub species. Grasses and sedges like *Cynodon dactylon* and *Cyperus* spp. provide grazing for sheep and goats. Outside riverine influence the main species are *Macraea crassifolia* desert

1.1 The semi-detailed survey of Area 4b, Khartoum to Kareima covers a total area of some 194,810 feddans.

These lands were selected for semi-detailed soil and land classification survey following the soils and engineering reconnaissance survey of nearly one million feddans between Khartoum and Kareima, carried out from November 1963 to February 1964. As a result of this study the Consultants recommended the carrying out of semi-detailed soil and land classification surveys of a total area of 271,000 feddans, of which 67,000 feddans lay at a higher level and would be comparatively more difficult to irrigate. (See Roseires Soil Survey Report No.5). After due consideration the Client decided to include only the more favourable lands, totalling about 200,000 feddans, in the semi-detailed soil and land classification survey described in this report.

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(ii) 'Sagiya' irrigation of small units producing wheat, berseem,

1.3 The soil parent material is mainly Nile Alluvium, but the age of the deposits varies from very recent flood plain to pre-Palaeolithic upper terrace. Small areas of piedmont deposits also occur within the survey area.

(ii) land dependant on the river floods. The area cultivated varies with the height of the floods. Heavy textured soils

1.4 The climate of 4b is arid, divisible into four climatic seasons, namely 'shita', 'seif', 'kharif' and 'damarat'. Rainfall is very low, varying from 164 mm at Khartoum to 72 mm at Atbara, and falling mainly in the months of July and August. Temperatures show a wide range in mean maximum and minimum daily and annual values, which is characteristic of a desert climate.

Year 1. Damira and some seifi crops.

Year 2. Shitwi crops.

Year 3. Fallow; some vegetables.

1.5 Within the survey area, much of the vegetation is riverine and not representative of the vegetation of Northern Province. Of the riverine vegetation, Hyphaene thebaica (especially along the river Atbara), Acacia albida and Acacia seyal are the main tree and scrub species. Grasses and sedges like Cynodon dactylon and Cyperus spp. provide grazing for sheep and goats. Outside riverine influence the main species occur in the Acacia tortilis. Maerua crassifolia desert scrub zone of Harrison and Jackson (1958). Capparis decidua, Cadaba rotundifolia and Ziziphus spina-christi occur on heavy textured soils and Acacia ehrenbergiana and Salvadora persica on sandy sites.

1.6 The population of the region between Sabaloka and Abu Hamid is 493,300 and is mainly Arab. The influx of labour to the main towns has given rise to a rather more mixed population in these centres.

1.7 Two main land use divisions are recognisable, non-riverine and riverine. The former is mainly given over to poor quality grazing. On rare occasions, after unusually heavy rains, rain-fed dura can be grown on favoured sites.

Within the riverine land use division, four main types of land use occur:-

- (i) 'Gerf' cultivation of dura and some dukhn on flood moistured riverside soils.
- (ii) 'Sagiya' irrigation of small units producing wheat, berseem, lubia, ful masri and fasulia during the shitwi season and dura, lubia and maize during the damira along with some vegetables and groundnuts.
- (iii) 'Feidan' land dependant on the river floods. The area cultivated varies with the height of the floods. Heavy textured soils predominate. Wheat, fasulia, ful masri, lubia and hummus are the main crops grown.
- (iv) Pump schemes, both private and government owned. A three course rotation is used:
 - Year 1. Damira and some seifi crops.
 - Year 2. Shitwi crops.
 - Year 3. Fallow; some vegetables.

1.10 Land classification follows the principles stated in the U.S.D.A.
1.8 The semi-detailed soil and land classification survey was carried out according to the specifications of the agreement of 27th September 1962. The minimum density of observations was one site per 250 feddans. One site in 20 was a 2 metre pit with additional auger observations to 3 metres in every second pit.

The areas of the various land classes are as follows:-
1.9 The soil classification is based on the U.S. Department of Agriculture Seventh Approximation (1960). Three main orders are represented in the survey area, Vertisols, Entisols and Aridisols. Vertisols occur only on the heavy clays of the central part of the flood basins. Entisols are found on the other recent flood plain materials and on areas of recent aeolian deposits. Surrounding the clay basins are areas of heavy textured soils which are regarded as Vertisol-Entisol intergrades. Aridisols occur on the older parent material of the higher Nile terraces and bordering the piedmont areas. On the lowest of the older Nile terraces, soils have developed which seem to represent a stage in development between Entisols and Aridisols. These have been regarded as Aridisol-Entisol intergrades within the Entisol order. The sub-groups within the three orders recognised are:-

VERTISOLS

Typic Grumusterts

Entic Grumusterts

ENTISOLS

Typic Haplorthents

Typic Quartzipsamments

Grumustertic Haplorthents

Natrargidic Haplorthents

ARIDISOLS

Typic Natrargids

Typic Calciorthids.

In some cases, soils of the Entisol order on recent aeolian deposits overlay soils of the Aridisol order on older deposits. Two series have been defined within each sub-group of the Aridisol order on the basis of whether the clay content is greater or less than 30 per cent in the top 45 cm. The typic Haplorthents and Natrargidic Haplorthents of the Entisol order have also been divided into series on this basis. For Grumustertic Haplorthents and Typic Quartzipsamments of the Entisol order and all soils of the Vertisol order, series have been defined on whether the exchangeable sodium percentage is greater or less than 15 in the top 45 cm.

1.10 Land classification follows the principles stated in the U.S.D.A. Bureau of Reclamation Manual, with criteria adapted to suit local conditions. Land classes range from 1 to 6. In this survey, class 5 has been used to denote lands requiring special research over a wide range of subjects. Areas which are liable to be inundated during the Nile flood are delimited on the land class maps.

The areas of the various land classes are as follows:-

Land Class	Area in Feddans
1	6,210
2	14,360
3	49,370
4	17,950
5	90,330
6	16,590
Total:	194,810

1.11 The preliminary recommendation for the arable lands is that the present agricultural system should be modified and expanded. The increased use of fertilisers, mechanisation and the production of locally adapted crop varieties would increase the economic viability of the area. The high cost of irrigation water may limit the development of lands which are marginally economic on other criteria.

Improvement in communication facilities, especially by road, is necessary to help realise the potential of the area.

Social requirements may necessitate the development of lands which could not be recommended on purely economic grounds.

These deposits are regarded as Cretaceous. North of the Sabaloka Gorge to near Ed Damer, they are of widespread occurrence, but north of Ed Damer most of the sandstone has been eroded and removed. The sandstone persists in only relatively small local areas, north-east of Atbara and on either side of the Nile at El Bauga. This Nubian sandstone is the main source material for much of the non-alluvial soils within the project area.

Local outcrop of later rocks are confined to Hudi chert of Tertiary and early Quaternary age and volcanic basalts of the Pliocene.

These later rocks do not outcrop within the boundaries of the project area. Over large stretches of the valley the sandstone occurs as flat-topped hills bordering the Nile trough.

CHAPTER 2

THE ENVIRONMENT

2.1 Location

The area covered by the semi-detailed soil survey comprises 150,810 feddans in narrow strips on both sides of the Nile from the northern end of the Sabaloka gorge in the south to El Bauga in the north, between latitudes $16^{\circ}33'N$ and $18^{\circ}34'N$.

A further area of 40,000 feddans is located on either bank of the River Atbara near Kineidra, some 60 km upstream from the confluence with the Nile. The reasons for and the manner of selection of these areas is given in 1.1.

Much of the area consists of flood basin and lower terrace material, associated with the Nile, and is usually limited on the landward side by higher terrace material or rock. The survey area reaches a maximum width of 6 km in the Kelli basin, but elsewhere is considerably narrower than this. In a few places rock borders the river.

2.2 Geology and Geomorphology

2.2.1 Geology

The platform on which the Nubian Series was deposited is of folded, more or less altered sediments and bedded volcanic rocks. These were altered, folded, and intruded by igneous rocks, elevated to form a land surface, and then denuded to form the sub-Nubian peneplain on which the deposits of the Nubian series were subsequently laid down.

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2.2.2 Geomorphology

Within the project area, the main deposits are of alluvial origin. Only along the inland edges do piedmont deposits occur. A larger area of piedmont deposits occurs in the area south of the River Atbara, opposite the village of Kineidra.

The project areas along the Main Nile consist of a series of more or less discontinuous basins, separated from each other by piedmont material or rock outcrops.

The basins contain deposits which vary considerably in age and nature. It seems likely that these basins are the remains of former courses or subsidiary channels of the Nile, the lowest level of the basins indicating the former river course. The present surface deposits in the lowest part of the basin have a high clay content. This clay is of variable depth, and is usually underlain by coarse textured deposits ranging from loam to nearly pure sand. The sand fraction tends to become coarser with depth.

These coarser sands may indicate a period of continuous and reasonably fast water flow. With progressive down cutting of the river bed, perhaps associated with some lateral movement of the river, the channel could have become cut off from the main river channel at low flood. This would have given rise to seasonal lagoonal conditions for short periods at low Nile, with definite water movement during the flood. As the main river channel was lowered, the basins would have been inundated for shorter periods and only at higher flood levels, with resulting deposition of finer textured material in suspension rather than coarser material carried by the force of the river flow. Associated with the deposition of clay and silt in the basins, is the formation of levees of rather coarser material along the main channel banks, and recent, low level terraces immediately above the bottom of the basin.

Under present conditions the basins are inundated only at very high flood levels, and this with the help of artificially deepened inlet channels. In some cases the basins are flooded from the downstream end due to the presence of high sand bars across the mouth

of the basins. Any material deposited is likely to be very fine sediment carried in suspension. Many of the basins seem to have had a simple one cycle depositional history with deposits gradually becoming finer from the bottom upwards. In some cases, the deposition shows evidence of a more cyclical history with alternating bands of coarse and fine material in the lower horizons. In all cases the upper deposit is fine textured and shows little evidence of banding but this may have been destroyed by the swelling and shrinking of the clays.

On the landward side of these recent basins there are two higher terraces associated with a former high level Nile system. Generally these show some degree of erosion due to the infrequent rain storms which cause sudden run-off to the lower terrace levels. These higher terraces have a moderately high silt plus clay content and occasionally have gravelly surfaces. The gravel is probably derived from higher ground beyond the terraces and is not a constituent of the terrace material.

In a few localities, gravelly high ridges border the old terraces. These may be piedmont outwash material derived from the flanking adjacent Nubian sandstone. These eroded, gently sloping piedmont plains are best seen within the project area on the south side of the river Atbara. The content of gravel in the profiles is usually less than would be expected from the surface, where it is concentrated through erosion of the finer material by wind and water. Very recent material is derived from the numerous wadis which flow off the comparatively high erosion plain on to the terraces. Occasional large wadis may reach the river, but in most cases they stop on the flat terraces or in the basins. After exceptionally large storms, water flows in these wadis and carries coarse sandy material on to the terraces and basins, producing a series of small alluvial fans.

Aeolian erosion and deposition are important throughout the area as a whole, but are particularly important in the Kelli basin and in the areas on both sides of the Atbara. In the Kelli basin, a line of high, rather unstable dunes extends the length of the basin. In places these abut into the clay basin itself. The dunes are partly vegetated, but the cover is not sufficiently dense to prevent movement of the sand in high winds. Between the high dunes and the piedmont platform is a belt of low undulating sandy aeolian material. These aeolian deposits are derived from desert erosion peneplain and from the sandy bottoms of the numerous wadis.

On the north side of the river Atbara, aeolian deposition occurs in a somewhat different form. The material is of very fine sand loam to silt loam texture, and seems to be of fairly local derivation, possibly originating from the older silt terraces of the Atbara. The material collects in mounds around vegetation like Calotropis procera, Cadaba rotundifolia, Salvadora persica and Hyphaene thebaica. The height of the mounds is very variable, generally around 2-3 metres, but in a few cases large mounds may exceed 12 metres. "Coppice mound" is a term used in America to describe this sort of vegetation trapped wind blown material. South of the river the aeolian material is much coarser and tends to form ridges rather than discrete mounds. The material may be derived from the large sand banks in the river bed which are exposed at low water level, during the season of strong northerly winds.

The various elements described above are shown in the accompanying sketch map. Fig. 2.1.

2.2.3 An unusual feature of the clay basins

Within the flood basins of the Nile there occurs an unusual and complex system of shallow channels. The channels are U-shaped and seldom more than 2 metres in width and 50 cm in depth. They are very clearly visible on aerial photographs and from these it is obvious that they form different patterns in different areas. They have developed to a greater or lesser degree in all the basin areas which are subject to seasonal inundation.

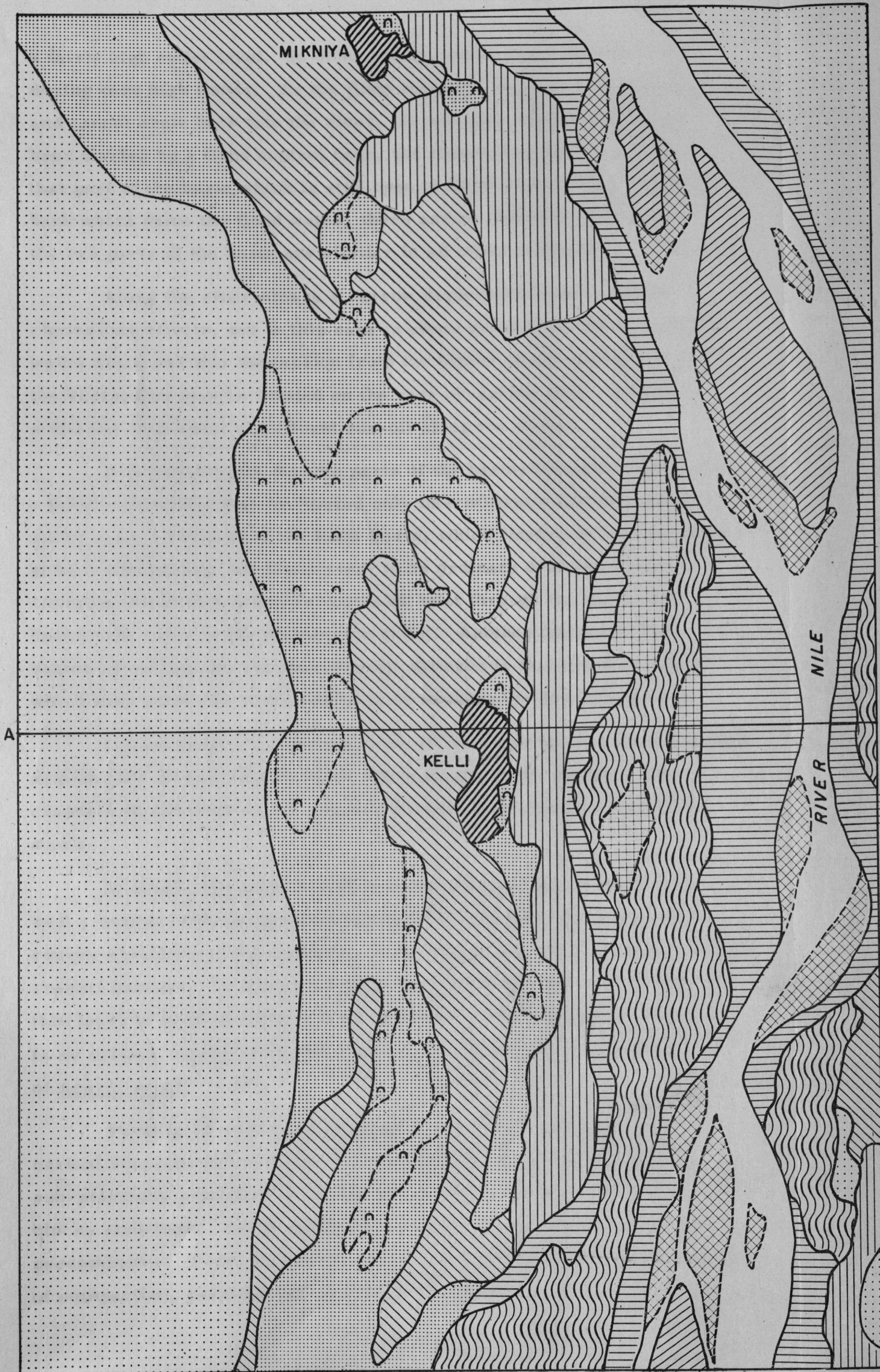
The channels occur in three basic patterns, trellised, dendritic and reticulate. The latter is the most commonly occurring pattern. The first two forms are nearly always associated with the better developed channels close to flood inlet points. On examination of the aerial photographs, it seems that the complete channel system helps to distribute flood water from the main inlets throughout the basin as a whole.

Apart from the main channels described above, very small 'tributary' channels run into the main channels at right angles.


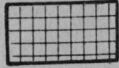
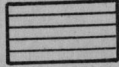



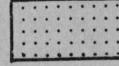
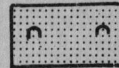
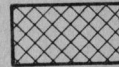
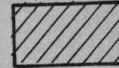
The channels only develop on soils of over 45 per cent clay content and in the lowest parts of those clay basins which appear to have

PHYSIOGRAPHICAL SKETCH MAP OF KELLI BASIN

SCALE 1:50,000



LEGEND

-  Clay Basin
-  Low Channelled Clay Basin
-  Low Terrace
-  Intermediate Terrace
-  High Terrace
-  Level Sandy Material mainly aeolian
-  Desert Piedmont
-  High sand dunes
-  Low Ephemeral Islands
-  High Islands

a fairly high outlet level. In other words, water can only enter them during very high floods. As the flood recedes, the water is trapped and cannot drain back into the river. In one case where a basin has been divided by a flood control bank, the channelling only occurs in that part of the basin which is still open to flood water. Beyond the bank which dams the flood water, there are no channels, although the two parts of the basin are similar in all other respects.

Along the river Atbara a narrow depression shows similar channelling effects, but in this case is above river flood level. Several wadis drain into this depression from the higher desert peneplain, and the depression may be flooded on the rare occasions when rainfall is sufficient to produce significant run-off along the wadis.

It is conceivable that the parts of the basins along the Nile which exhibit channelling may be flooded only intermittently and not regularly every year. One part of the Kelli Basin, which floods every year, does exhibit channelling, but these seem to be ordinary drainage channels carrying floodwater from the upstream inlet through the basin and back to the river at the downstream outlet. Another feature of the basins containing the complex channel patterns is that any flood-water which does enter the basin seems to do so from the downstream end.

Occasionally the channels seem to be connected to a wadi drainage system, but do not seem to be an integral part of the system. The channels do not form on the coarser alluvial fans associated with the wadis.

In detail, the soils on which these channels have formed are well cracked, with the greatest intensity of cracking occurring on the convex shoulders of the channels. Cracking is also well developed in the channel bottoms. In many cases the channels were seen to contain a thin layer of sand which may have come from wadi drainage. There is no surface vegetation in these areas, except for scattered clumps of Acacia seyal.

Profiles of soils associated with this channel pattern show the normal characteristics of the Vertisol order. They have a coarse sub-prismatic structure in the top 40 cm with associated rather coarse blocky structure. Below this depth a well developed wedge structure predominates. From the nature of their structure and their high degree of compaction, permeability is probably very low.

2.3 The majority of sites sampled in these channelled soils showed low E.C. values, seldom greater than 3 mmhos per cm. at any point in the profile. Exchangeable sodium percentages were in the great majority of cases less than 15 in the top 45 cm and generally less than 15 in the 45-90 cm zone. There is little secondary calcium carbonate and gypsum was not observed in any profile.

Quite commonly a sandy substrate is present within 2 metres the sand showing some evidence of bedding.

From the point of view of land utilisation, these channels are of considerable importance, since in any irrigation scheme preliminary levelling would be required. Further, an understanding of their mode of formation would indicate whether they would be likely to reform, even in subdued form, under irrigation.

2.3 Climate

2.3.1 General

The climate of area 4b is arid. The year is divisible into four seasons. During the dry, relatively cool winter or "shita" (November to March) north and north-easterly winds prevail, bringing hot air heated during its passage over the northern deserts. The ensuing "seif" is characterised by steadily rising temperatures and the increasing occurrence of dust storms or "haboobs". By late June the wind veers to the south due to the approach of the inter-tropical convergence: rainfall is slight and variable. This "kharif", or rainy season, ceases with the southward retreat of the inter-tropical convergence in September, the short transitional period before the drying northerly winds recommence is known as the "darat".

Climatological data for this report have been obtained from the 1931-1960 climatological Normals for the following stations, which are situated at varying latitudes around the area:-

First Class Stations:	Atbara	17°42' N	33°58' E
	Khartoum	15°36' N	32°33' E
Second Class Station:	Shendi	16°42' N	33°26' E

All times quoted are local times, G.M.T. plus two hours.

2.3.2 Climatic Data

The following discussion and figures serve to summarise the climatic features of the area.

The alternation between the wet and dry seasons is illustrated by figures 2.2 and 2.3 which contain temperature and rainfall data for the three stations. The relatively cool winter period is an important feature of the Northern Province climate. When considering development of this area temperature is probably more important than rainfall. Although the latter may enable the cultivation of some non-riverine land, the agriculture of the region is almost completely reliant upon the Nile for water requirements. Temperature, however, is fundamental to the choice of crops and the times at which they are grown.

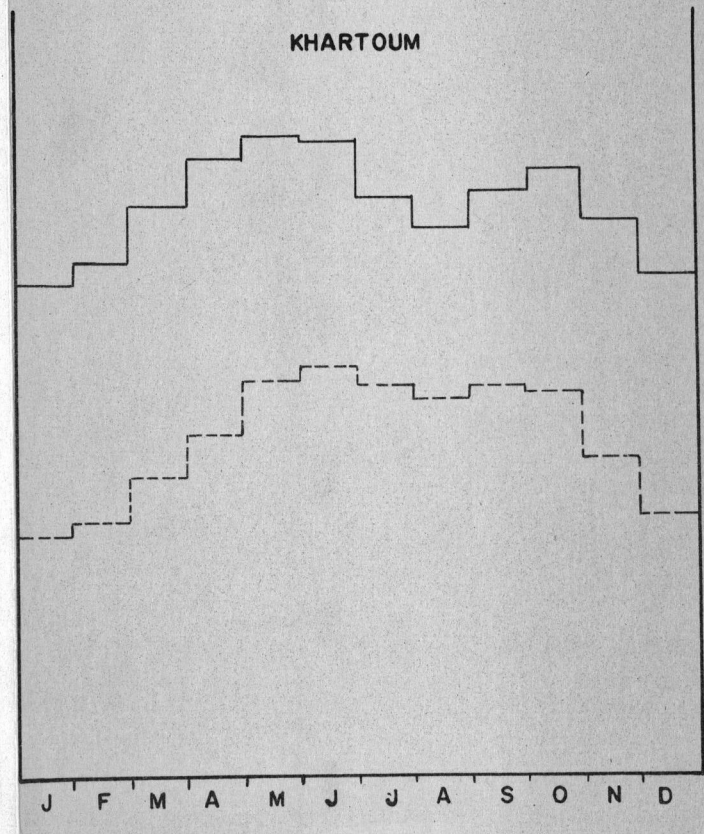
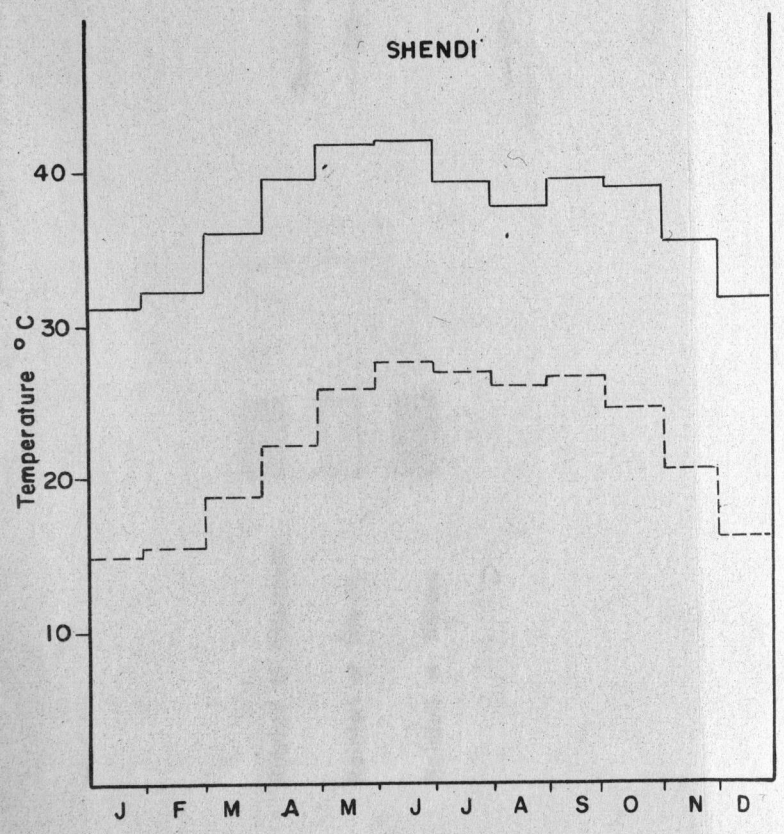
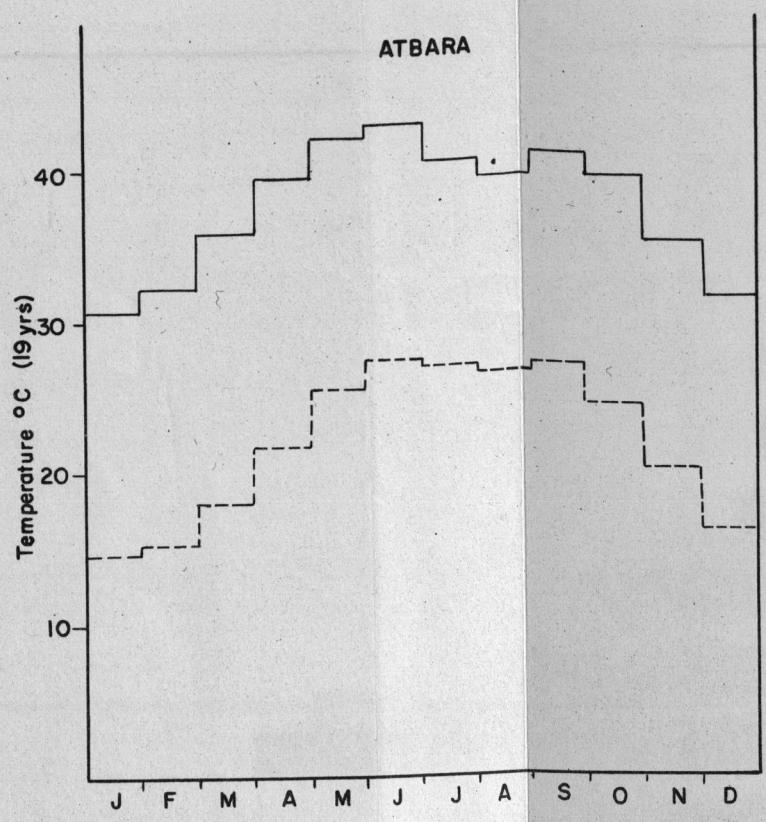
Most of the precipitation occurs in July and August, although variable amounts of rain fall during May, June and September. Rainfall rapidly decreases northwards, as illustrated in Table 2.1. Despite the deficiency of rain, heavy storms have been recorded. The average rainfall per rainy day varies with each station.

TABLE 2.1 Averaged Annual Rainfall Data (1931-1960)

Station	Total Rainfall mm	Max. in one day mm	No. of rainy days (over 1 mm rain)	Average Rainfall per rainy day mm
Atbara	72	98.1	9.9	8.0
Shendi	136	85.0	10.9	12.5
Khartoum	164	79.9	19.7	8.3

Associated with the rainfall is the cloud cover: Table 2.2 contrasts the cloudiness of the June-September period with that of the winter months. Shendi appears to be particularly cloud-free.

MEAN DAILY TEMPERATURE. MONTHLY MEANS



— Mean Daily Maximum Temperature
- - - Mean Daily Minimum Temperature

MEAN MONTHLY RAINFALL 1931 - 1960

KHARTOUM(30yrs), SHENDI(19 yrs) AND ATBARA(30 yrs)

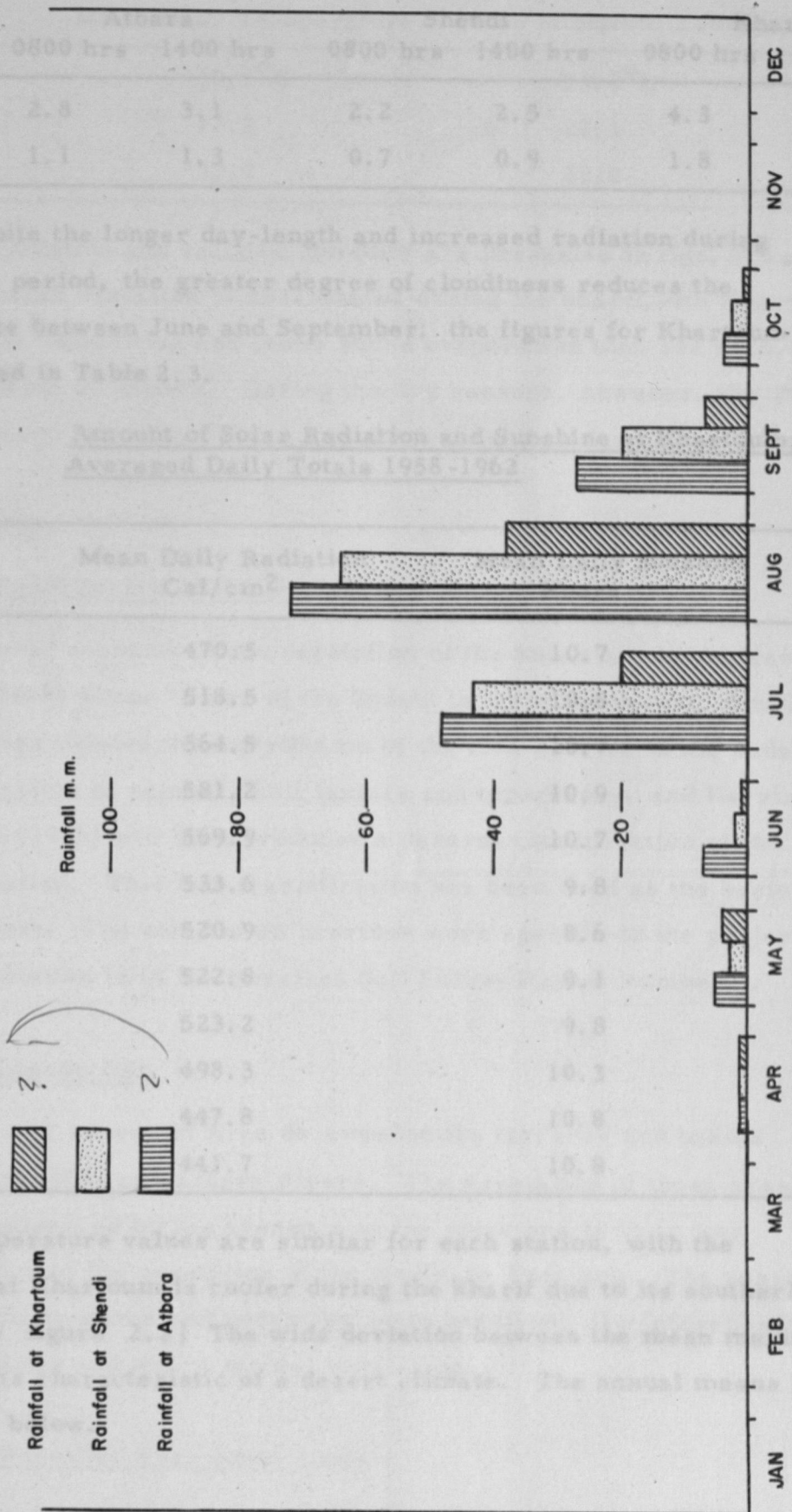


TABLE 2.3 Mean daily Cloud Amount Data (0-8) : Atbara (30 yrs), Shendi (19 yrs) and Khartoum (30 yrs).

	Atbara		Shendi		Khartoum	
	0800 hrs	1400 hrs	0800 hrs	1400 hrs	0800 hrs	1400 hrs
June-Sept.	2.8	3.1	2.2	2.5	4.3	6.2
Sept-May	1.1	1.3	0.7	0.9	1.8	1.9

Despite the longer day-length and increased radiation during the summer period, the greater degree of cloudiness reduces the sunshine rate between June and September; the figures for Khartoum are presented in Table 2.3.

TABLE 2.4 Amount of Solar Radiation and Sunshine Averaged Daily Totals 1958-1962

Month	Atbara	Shendi	Khartoum
January	479.5	479.5	479.5
February	516.5	516.5	516.5
March	564.9	564.9	564.9
April	581.2	581.2	581.2
May	567.5	567.5	567.5
June	533.8	533.8	533.8
July	520.9	520.9	520.9
August	522.6	522.6	522.6
September	523.2	523.2	523.2
October	498.3	498.3	498.3
November	447.8	447.8	447.8
December	411.7	411.7	411.7

Temperature values are similar for each station, with the exception that Atbara is cooler during the winter due to its southerly position. The wide deviation between the mean rainfall and sunshine of a desert climate. The annual mean rainfall is

TABLE 2.2 Mean daily Cloud Amount Data (0-8) : Atbara (30 yrs), Shendi (19 yrs) and Khartoum (30 yrs).

Station	Atbara		Shendi		Khartoum	
	0800 hrs	1400 hrs	0800 hrs	1400 hrs	0800 hrs	1400 hrs
June-Sept.	2.8	3.1	2.2	2.5	4.3	4.2
Sept-May	1.1	1.3	0.7	0.9	1.8	1.9

Despite the longer day-length and increased radiation during the summer period, the greater degree of cloudiness reduces the sunshine rate between June and September; the figures for Khartoum are presented in Table 2.3.

TABLE 2.3 Amount of Solar Radiation and Sunshine at Khartoum. Averaged Daily Totals 1958-1962

Month	Mean Daily Radiation Cal/cm ²	Mean Daily Sunshine Hours
January	470.5	10.7
February	518.5	10.8
March	564.5	10.7
April	581.2	10.9
May	569.9	10.7
June	533.6	9.8
July	520.9	8.6
August	522.8	9.1
September	523.2	9.8
October	498.3	10.3
November	447.8	10.8
December	441.7	10.8

Temperature values are similar for each station, with the exception that Khartoum is cooler during the kharif due to its southerly position (see figure 2.2) The wide deviation between the mean maxima and minima is characteristic of a desert climate. The annual means are summarised below.

2.4.3 Classified Vegetation Zones

a) Desert

In Harrison and Jackson's classification the southern limit of the desert region is taken as latitude 18° north which passes through

No. 13 - Years

ATBARA

TABLE 2.4

Mean Daily Temperatures, Atbara, Shendi and Khartoum

Station	Mean Max. Temperature	Mean Minimum Temperature
Atbara	37.6°C	22.1°C
Shendi	37.2	22.1
Khartoum	37.3	22.2

Evaporation and relative humidity are presented in figs. 2.4 and 2.5. The north-south variation is accentuated during the kharif, with Khartoum having higher humidities and lower Piche evaporation than are recorded at either Shendi or Atbara. During the dry seasons, however, the Piche evaporation and humidity curves are almost identical for each station.

2.4 Vegetation

2.4.1 Brief review of the literature

General accounts of the vegetation of the Sudan are by Andrews (in Tothill 1948) whose 'Flora of the Sudan' is the most recent; Smith (1949) who has related the distribution of the tree species in the Sudan to the interaction of rainfall, soil texture and topography, and Harrison and Jackson (1958) who have produced a general classification of the Sudan vegetation. This last classification has been used as the basis for this report. The only known previous work specific to the project area on vegetation is in the Roseires Soil Survey Report Number 5.

2.4.2 Introduction

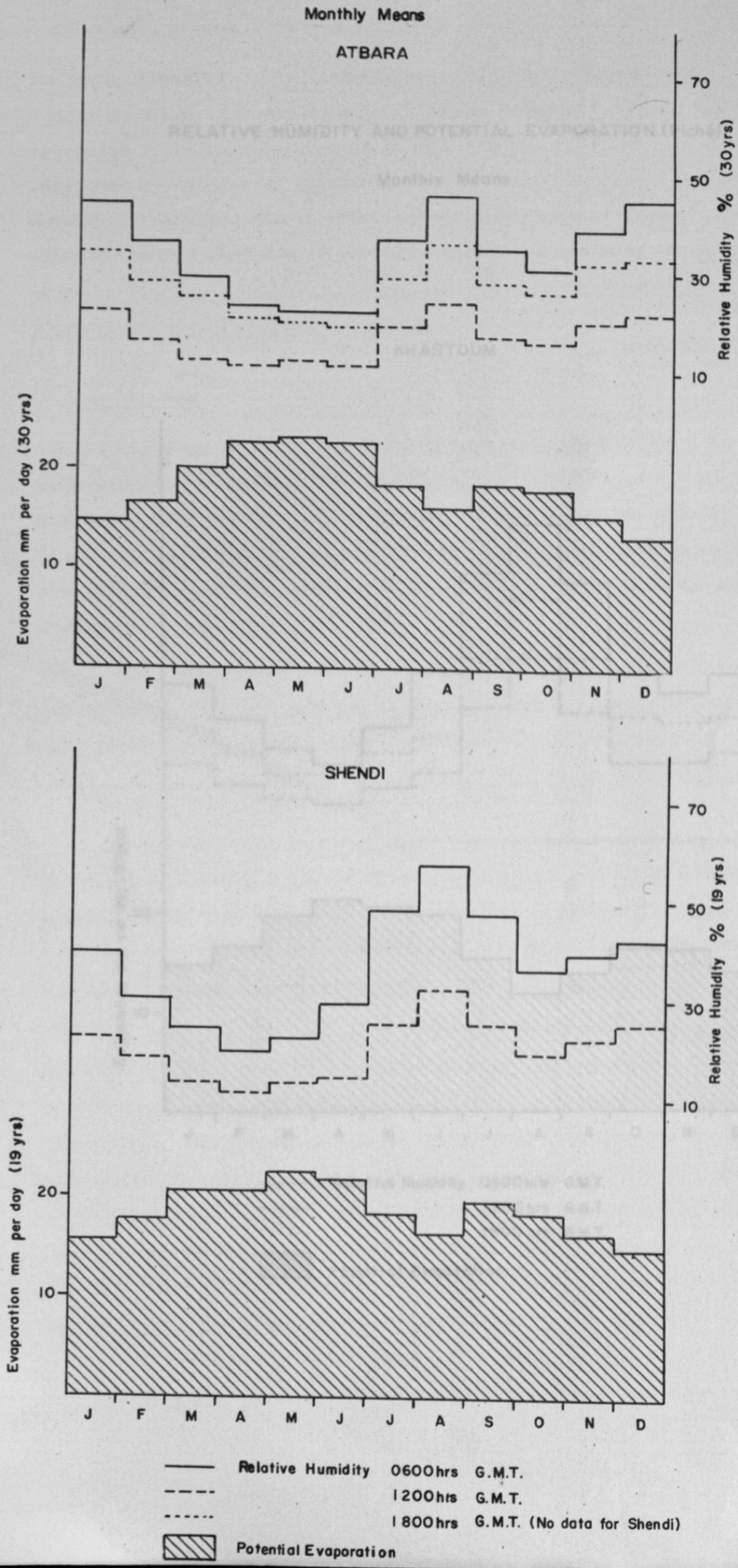
The soil survey of Area 4b covered the terraces and basins along the main Nile and Atbara Rivers. The vegetation of these areas is greatly influenced by the presence of the river and is in no way representative of the vegetation of the Northern Province. The vegetation therefore will be described under two main headings: the 'classified' vegetation zones and the 'riverine' vegetation.

2.4.3 Classified Vegetation Zones

a) Desert

In Harrison and Jackson's classification the southern limit of the desert region is taken as latitude 18° north which passes through

— Relative Humidity 0600hrs G.M.T.
 - - - - - 1200hrs G.M.T.
 ······ 1800hrs G.M.T. (No data for Shendi)
 ▨ Potential Evaporation

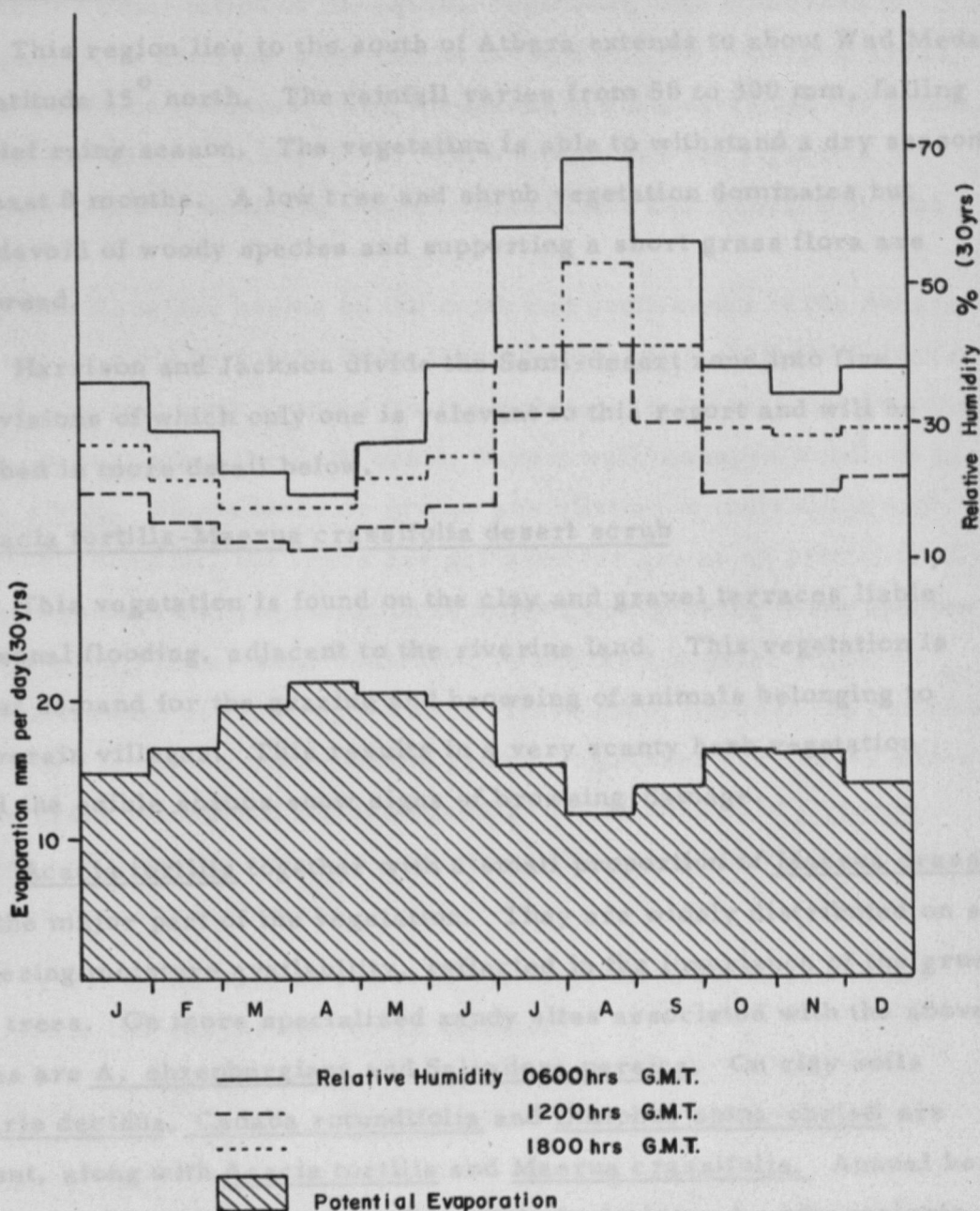


RELATIVE HUMIDITY AND POTENTIAL EVAPORATION (Piché)

Monthly Means

KHARTOUM

b) Semi-desert



the town of Berber. This includes parts of both the Nubian and Libyan deserts. The annual rainfall varies between 0-50 mm and is irregular in its distribution with occasional heavy showers which may produce ephemeral vegetation. Generally the desert is a region devoid of vegetation except within seasonal drainage channels. These channels have a deep rooted shrubby vegetation consisting of: *Acacia ehrenbergiana*, *A. tortilis* var *raddiana*, *Leptadenia pyrotechnica*, *Fagonia cretica*, *Parolium turgidum*.

This region lies to the south of Atbara extends to about Wad Medani or to latitude 15° north. The rainfall varies from 50 to 300 mm, falling in a brief rainy season. The vegetation is able to withstand a dry season of at least 8 months. A low tree and shrub vegetation dominates but some development of woody species and supporting a grass flora are widespread.

Herbaceous and Jackson Divisive vegetation is found on the clay and gravel terraces liable to seasonal flooding, adjacent to the riverine land. This vegetation is a grassland and forest consisting of animals belonging to the riverine and floodplain zone.

Acacia robusta is desert scrub vegetation is found on the clay and gravel terraces liable to seasonal flooding, adjacent to the riverine land. This vegetation is a grassland and forest consisting of animals belonging to the riverine and floodplain zone.

species are *A. alba*, *Capparis detrita*, *Leptadenia pyrotechnica*, *Schoenefeldia gracilis* was inferred from the remains of inflorescences. Small patches of woody undergrowth consisting of *Indigofera tinctoria* and *Cassia acuta* are found on sites which have been disturbed and watched.

the town of Berber. This includes parts of both the Nubian and Libyan deserts. The annual rainfall varies between 0-50 mm and is irregular in its distribution both in time and place. Rare rain storms may produce ephemeral vegetation, but normally the desert is a region devoid of vegetation except within seasonal drainage channels. These channels have a deep rooted shrubby vegetation consisting of: Acacia ehrenbergiana, A. tortilis var raddiana, Leptadenia pyrotechnica; Fagonia cretica, Panicum turgidum.

b) Semi-desert

This region lies to the south of Atbara extends to about Wad Medani or to latitude 15° north. The rainfall varies from 50 to 300 mm, falling in a brief rainy season. The vegetation is able to withstand a dry season of at least 8 months. A low tree and shrub vegetation dominates but areas devoid of woody species and supporting a short grass flora are widespread.

Harrison and Jackson divide the Semi-desert zone into five sub-divisions of which only one is relevant to this report and will be described in more detail below.

Acacia tortilis-Maerua crassifolia desert scrub

This vegetation is found on the clay and gravel terraces liable to seasonal flooding, adjacent to the riverine land. This vegetation is in great demand for the grazing and browsing of animals belonging to the riverain villages. This results in a very scanty herb vegetation and all the edible shrubs show signs of browsing damage.

Acacia tortilis together with a small proportion of Maerua crassifolia form the major part of the vegetation. They are widely distributed on sites of differing moisture availability, reflected in the luxuriance of the growth of the trees. On more specialised sandy sites associated with the above species are A. ehrenbergiana and Salvadora persica. On clay soils Capparis decidua, Cadaba rotundifolia and Ziziphus spina-christi are frequent, along with Acacia tortilis and Maerua crassifolia. Annual herbs are very rare but the presence of Aristida funiculata, A. adscensionis and Schoenefeldia gracilis was inferred from the remains of inflorescences. Small patches of woody undershrubs consisting of Indigofera oblongifolia and Cassia senna are found on sites which have been disturbed and enriched

in some way such as by cultivation or animal enclosures or storage and waste pits. Close to village sites and along livestock tracks Calotropis procera and Acacia nubica commonly occur, this is said to indicate overgrazing.

2.4.4 Riverine Vegetation

The riverine lands have varied soils. The higher moisture status resulting from the proximity of the river gives rise to a complex vegetation. The activities of cultivators and graziers have resulted in a greater exploitation of the natural vegetation than elsewhere in the Sudan. The riverine lands can be divided into the cultivated areas and the woodland reserves. The woodlands are highly valued for shade, fuel, timber and for animal feed. Each village has the right to a particular piece of woodland which is maintained and managed by that village.

The Keneidra basins on the north and south banks of the Atbara river are covered by a Dom Palm forest (Hyphaene thebaica) the leaves of which are regularly cropped for the making of palm leaf mats. Other basins, in particular the Kelli basin, have a well managed woodland of Acacia albida. Single trees or groups are allotted to individuals and these are fenced off, the fruits are gathered for use as an animal feed. The management and regeneration of other quick growing thorn species (e.g. A. seyal) is carefully controlled to ensure a regular supply of branches for fuel and fencing. On the river banks, between the cultivated areas there is often a considerable growth of grasses and sedges which remain green throughout the dry season. These consist of Cynodon dactylon and Cyperus spp. and are intensively grazed by flocks of sheep, goats and occasional donkeys.

A list of the species found on the riverine lands can be found in the check list and marked by an asterisk.

L. Moutonioides

Grasses

Aristida adscendens L.

Aristida laniculata Trin. & Rupr.

Aristida herdasica Kunth.

Aristida mutabilis Trin. & Rupr.

Check List of the Flora

Trees and Shrubs

- * *Acacia albida* Del. Mimosaceae
- Acacia ehrenbergiana* Hayne Mimosaceae
- Acacia etbaica* Schweinf. Mimosaceae
- Acacia nubica* Benth. Mimosaceae
- * *Acacia nilotica* (L.) Willd. ex Del.
 - subsp. *tomentosa* (Benth.) Brenan Mimosaceae
- * *Acacia seyal* var. *seyal* Del. Mimosaceae
- Acacia tortilis* (Forsk.) Hayne
 - subsp. *raddiana* (Savi) Brenan Mimosaceae
 - Acacia tortilis* (Forsk.) Hayne
 - subsp. *spirocarpa* (Hochst. ex A. Rich.) Brenan Mimosaceae
- * *Balanites aegyptiaca* Del. Balanitaceae
- Bergia suffruticosa* Del. Fenzl. Elatinaceae
- Cadaba rotundifolia* Forsk. Capparidaceae
- Calotropis procera* Ait. f. Asclepiadaceae
- Capparis decidua* (Forsk.) Lam. Capparidaceae
- Cassia senna* L. Caesalpinaceae
- Cassia italica* L. Caesalpinaceae
- Hyphaeae thebaica* (L.) Mart. Palmae
- Indigofera oblongifolia* Forsk. Papilionaceae
- Leptadenia pyrotechnica* (Forsk.) Decne Asclepiadaceae
- Maerua crassifolia* Forsk. Capparidaceae
- Phoenix dactylifera* L. Palmae
- Salvadora persica* L. Salvadoraceae
- * *Tamarix nilotica* (Ehrenb.) Bung. Tamaricaceae
- Ziziphus spina-christi* (L.) Willd. Rhamnaceae

Herbs

I. Monocotyledons

Gramineae

- Aristida adscensionis* L.
- Aristida funiculata* Trin. & Rupr.
- Aristida hordacea* Kunth.
- Aristida mutabilis* Trin. & Rupr.

Chrenchrus biflorus Roxb.

Chloris virgata Kunth.

Cymbopogon proximus (Hochst.) Chióv.

* *Cynodon dactylon* (L.) Pers.

Dactyloctenium aegyptium (L.) Beauv.

* *Desmostachya bipinnata* (L.) Stapf.

Dinebra retroflexa (Vahl) Panz.

* *Echinochloa colonum* (L.) Link.

Eragrostis tremula Nees

Panicum turgidum Forsk.

Schoenefeldia gracilis Kunth.

Sporobolus humifusus Var. *cordofanus* Stapf ex Massey

Tetrapogon cenchrifolius (A. Rich.) W.D. Clayton

TABLE 2.5 Population Data for Shendi-Berber Region
Cyperaceae

Cyperus spp. Census Area	Total	Percentage proportion of Ethnic Groups			
		Arab	Beja	Nubiyin	Others
2. Dicotyledons	36,298	54.4	2.1	16.2	27.2
<i>Aerva javanica</i> A. Juss.	115,216	90.0	5.2		2.8
* <i>Chrozophora plicata</i> A. Juss.	40,000				
<i>Fagonia cretica</i> L.	Z 74,522	72.5	22.0		9
* <i>Gynandropsis gynandra</i> (L) Briq.	45,000				
* <i>Ipomea blepharosepala</i> (Choisy) Hochst.	83,544	94.6	0.7		7
<i>Tephrosia apollinea</i> (Del. DC.					
<i>Trigonella hamosa</i> L.					

* **Riverine Species**
The preponderance of Arabs in the area as a whole has been modified at Atbara by the influx of labour to the railway headquarters. Similarly at Shendi the Arab proportion is only 72 per cent owing to the inclusion of both nomadic and settled elements of the Beja group.

The Ga'allyin Arabs are the principal tribe of the riverine area, living in association with occasional settled elements of the Hassaniya and Shagiya. A large nomadic population exists away from the Nile (Bayoumi, 1965), but compared with the Sudan as a whole, the nomadic proportion of the population is low. During the dry season these nomads are largely dependant upon the river for water supplies and they establish temporary camps along the fringe of the project area. The west bank nomads are Hassaniya and Shagiya, with some Fadniya around Wad Hamid: the region north of the Atbara river is occupied by Zeibediya and Bisharin, whilst elements of the Hadendowa and Hassaniya live to the south and east of this river.

2.5 Population and Present Land Use

2.5.1 Population and ethnic groups

According to the 1955/56 census, the population of the region between Sabaloka and Abu Hamid is 493,300. Except for scattered nomadic groups, the population is confined to the riverine zone of the Nile: the census figures consequently are closely applicable to the area surveyed.

There are three major towns. Atbara (36,298), Shendi (11,031) and Berber (10,977) of which the first two provide the principal markets. A few minor centres of population exist, such as Metemma, Ed Damer, Kabushiya and El Bauga, with numerous smaller villages situated alongside the Nile.

TABLE 2.5 Population Data for Shendi-Berber Region

Census Area	Total	Percentage proportion of Ethnic Groups			
		Arab	Beja	Nubiyin	Others
Atbara Town	36,298	54.4	2.1	16.2	27.2
Berber district, settled	115,216	90.0	5.2	1.1	2.8
" " nomadic	40,000				
Shendi district, settled	174,522	72.5	22.0	1.6	3.9
" " nomadic	45,000				
Ed Damer	92,264	94.6	0.7	1.0	3.7

The preponderance of Arabs in the area as a whole has been modified at Atbara by the influx of labour to the railway headquarters. Similarly at Shendi the Arab proportion is only 72 per cent owing to the inclusion of both nomadic and settled elements of the Beja group.

The Ga'aliyin Arabs are the principal tribe of the riverine area, living in association with occasional settled elements of the Hassaniya and Shagiya. A large nomadic population exists away from the Nile (Bayoumi, 1965), but compared with the Sudan as a whole, the nomadic proportion of the population is low. During the dry season these nomads are largely dependant upon the river for water supplies and they establish temporary camps along the fringe of the project area. The west bank nomads are Hassaniya and Shagiya, with some Fadniya around Wad Hamid: the region north of the Atbara river is occupied by Zeibediya and Bisharin, whilst elements of the Hadendowa and Hassaniya live to the south and east of this river.

2.5.2 Present Land Use

The land use pattern of the project areas is determined by water availability and the form of land-tenure. Several systems are recognisable.

1. Non-riverine - grazing and occasional arable.

2. Riverine

a. "Gerf" cultivation

b. "Sagiya" cultivation

c. Flood-basin cultivation

d. Pump-scheme cultivation

(Government and Private).

Subsequent to the Land Settlement and Registration Ordinance in 1925, all unregistered land is held by the Government.

2.5.2.1 Non-Riverine Land Use

The herds of cattle, goats, sheep and camels belonging to the nomadic tribes are grazed inland from the river. The construction of wells in the desert has decreased the dependence of these people upon the Nile and consequently has reduced friction with the riverine population.

Arable cultivation occasionally is encountered in remote "wadis", where "terus", or earth ridges, have been constructed to retain the run-off from the infrequent rainstorms. Feterita dura is grown, but, due to the variability of the rains, never more than 50 per cent of the crop is expected to mature. Tothill (1948) optimistically quotes an average yield of one ardeb (150 kg) per feddan.

2.5.2.2 Riverine Land Use

The population pressure upon the riverain land is severe and has been partly responsible for the migration of men-folk to seek employment in other parts of the Sudan. The remaining population tends to be elderly, lack incentive and rely heavily upon money from their migrant relatives, which decreases their incentive to work. Furthermore, under the muslim system of inheritance private land has been sub-divided to such a degree that many individual holdings have become uneconomic. Although land is so scarce, legal entanglements and the uneconomic size of holdings often result in land lying derelict. However, compared with

people in other parts of Sudan, the natives of Northern Province possess a long tradition of intensive irrigation farming.

As discussed earlier (2.3.1) the year is divisible into four main seasons namely: "kharif", "shita", "seif" and "darat". The crops which are cultivated within these seasons are termed "damira", "shitwi" and "seifi".

"Gerf" Cultivation

As the annual flood of the Nile and Atbara subsides, it exposes the moist and fertile silts of the river banks and islands. These gerf lands are hand cultivated. The main crop is shitwi dura, which is also used as fodder and a feed-grain for livestock. Dukhn is occasionally grown along the Atbara, but is subject to damage by moths of the Sesamia genus.

Name of Basin	Total	Min.	Max.					
Hugna	2,000	-	2,000	300	200			
Medisaa								
Wad Har	3,350	10,000	8,760	8,300	8,300	9,000	9,000	3,300
Salewa	5,000	7,200	4,320	5,000	5,000	5,000	5,000	1,635
Seyal	3,000	550	3,200	1,750	2,200	2,200	2,000	580
Guweir	3,000	-	9,700	480	2,300	1,000	3,000	3,000
Safra-Taiba	6,000	-	4,000	1,200	4,000	4,000	-	-
Kelli	7,000	-	13,000	300	5,500	3,000	4,400	2,500
Kimir	3,000	-	3,000	200	2,000	1,000	2,000	2,000
Basabir	5,000	-	5,000	450	3,000	2,900	3,000	5,500
Annual Totals	44,000	6,050	50,000	5,150	20,000	15,000	20,000	20,000

No information is available as to the extent or productivity of these areas.

"Sagiya" Cultivation

It has been estimated that within the Shendi-Berber area about 2,200 feddans are irrigated by sagiya. The maximum area irrigated by one sagiya is 5 feddans. Much of this irrigated land is devoted to the production of fodder crops for the oxen which operate the water wheels. The introduction of small motor-pumps would therefore increase the food producing capacity of these holdings.

After the floods have subsided the shitwi crops are irrigated.

Wheat, berseem, lubia, ful masri and fasulia are grown. With the exception of fasulia, these crops are consumed locally. During the seif, irrigation is restricted by the low Nile and temperatures limit crop growth; however, lubia and dura may be grown and cut green for fodder.

Dura, lubia and maize are the principal damira crops of sagiya holdings: vegetables and small areas of groundnuts may be included. Cultivation is done by hand using a "seluka" stick or by ox-plough.

Flooded-Basin Land or "Feidan"

Between Sabaloka and Atbara lie several natural occurring basins, adjacent to the river, and totalling some 70,000 feddans. Some of these basins have been converted to perennial irrigation schemes,

the remainder are flooded annually, the area affected depending upon the height and duration of the Nile flood. Most basins have been equipped with retaining banks, including inlet and outlet sluices. The following table emphasises the variability of cultivable feidan land, from 6,050 feddans in 1941 to 54,300 in the year of the high flood in 1946. It can be observed that the extent of flooding during the year of this survey was close to that of 1941.

TABLE 2.6 Areas of Basin Land Flooded along the Sabaloka-Berber Reach (Areas in feddans)

Name of Basin	Total	Means		Annual Figures					
		Min. 1941	Max. 1946	1960	1961	1962	1963	1964	1965
Hugna	2,000	-	2,000	-	300	200	-	-	-
Medisisa	500	-	1,000	-	3,000	2,000	-	150	-
Wad Hamid	9,000	3,350	10,000	8,760	8,300	8,300	9,000	9,000	3,300
Salewa	5,000	2,150	7,200	4,320	5,000	5,000	5,000	5,000	1,635
Seyal	3,000	550	3,200	1,750	2,200	2,200	2,000	2,000	580
Guweir	3,000	-	9,700	480	2,300	1,000	3,000	3,000	-
Safra-Taiba	6,000	-	?	94	4,000	1,200	4,000	4,000	-
Kelli	7,000	-	13,000	300	5,500	3,000	4,400	2,500	-
Kimir	3,000	-	3,000	200	2,000	1,000	2,000	2,000	-
Basabir	5,000	-	5,000	450	3,000	2,900	3,000	5,500	-
Annual Totals	44,000	6,050	54,300	19,354	32,900	25,000	32,400	35,150	6,515

Owing to the influx of silt laden flood water, the basins are aggrading as clay and silty-clay loams: this necessitates ox or tractor ploughing as opposed to hand cultivation on the lighter textured gerf lands.

The first crops are damira, sown at the extremities of the basins as soon as the flood subsides. When soil conditions permit, the remainder is sown with shitwi crops. These include dura, wheat, fasulia, ful masri, lubia and hummus. The latter is particularly adapted to the wetter sites. The rights to the use of the feidan land are inherited and usually attached to narrow strips of land.

The responsibility of controlling the extent of basin flooding rests with the Irrigation Department. The completion of the Roseires dam will not affect the maximum height of the flood in this reach, but the water level will

subside faster and earlier in December. Thus the duration of the basin flooding will be reduced and pumps and sagiya will lose their water supply earlier than in the past.

Pump Schemes

The pump schemes are either private or government owned. Four government schemes are sited between Shendi and Berber. Their extent is shown by the table below. Gandetto, Kitiab and El Bauga have been in operation since 1917. Aliab was established during the Second World War.

TABLE 2.7 Government pump schemes in the Shendi-Berber District

Scheme	Gross Area in Feddans		Total
	Govn't Owned	Private Land	
Gandetto	2,300	900	3,200
Kitiab	5,000	800	5,800
Aliab	4,500	-	4,500
Bauga	1,800	1,400	3,200
Totals	13,600	3,100	16,700

Although these schemes are at present unprofitable, it is difficult to see how the losses incurred could be avoided. Any economic increase in the water-rate charged to the tenants would force them off the scheme, with no alternative source of livelihood (Barbour 1961).

Since the licensing of the Zeidab scheme in 1904, over 500 concessions have been granted for the development of private pump schemes. Licenses are valid for between 10 and 15 years. Private schemes range in size from less than 50 feddans up to 30,000 in the case of the Zeidab syndicate. Roughly 60 per cent of the land is privately owned, the balance being rented from the Government. Systems of ownership similarly vary, from the small owner-cultivator to the larger co-operatives and companies which derive much of their capital from outside investors. Recently the Agricultural Bank has been active in providing credit for these developments. Approximately 25 per cent of the concessions granted have been relinquished subsequently, either through lack of funds, disagreement between partners or silting-up of the pump inlets. In some cases, however, salinity has been responsible.

Private schemes have a better record of efficiency, but prospective tenants frequently would prefer development by the Government, which provides a more secure source of income. Tenants on private schemes are entitled to 50 per cent of the profits, which provides an incentive that is lacking on government schemes. Mechanisation is limited to tractor cultivation and sowing; on smaller schemes oxen are used.

The following three course rotation is currently practised, although there is pressure to reduce the fallow proportion:

- Year 1. Damira crops; some seifi crops if water is available.
- Year 2. Shitwi crops.
- Year 3. Fallow, some vegetables.

A fairly wide range of crops are grown in the pump schemes; these are summarised below, including estimates of average yields.

- Seifi
1. Cotton - only on Zeidab Scheme - gives rather poor yields of 2 kantars per feddan. Disease, the lack of labour and high cost of production prevent the widespread cultivation of this crop.
 2. Dura - cut prematurely as fodder: being replaced by groundnuts where water is available.
 3. Maize - cut green as fodder but grown for grain in Government Schemes, where yields of 3 ardebs per feddan (450 kg) are recorded.
 4. Lubia - mostly cut as fodder.
 5. Vegetables - for local consumption.
 6. Castor beans - being introduced experimentally in Government Schemes.
- Damira
1. Dura - free of pests, yielding up to 2 ardebs (300 kg) per feddan.
 2. Maize - small areas for fodder.
 3. Groundnuts - consumed locally, but some exported, an increasing area, yields range from 20 ardebs (1400kg) per feddan north of Berber to 8.5 (600 kg) at Shendi.

1. Wheat. A native bearded variety is grown exclusively; attempts to introduce higher yielding varieties have been limited by lack

- Shitwi
1. Fasulia - the most important cash crop, harvested dry and transported as the haricot bean; yields of 800 kg per feddan are quoted.
 2. Kirkadey - less grown now since prices have fallen due to decreased trade with Egypt, low yields are obtained, around 3 ardebs per feddan.
 3. Ful masri - widely grown for local consumption and export; up to 700 kg per feddan may be expected.
 4. Lubia - principal fodder crop.
 5. Wheat - the primary food crop; $3\frac{1}{2}$ ardebs (560 kg) per feddan is given as an average yield.
 6. Onions - a valuable cash crop in the southern region, commanding a good price if drying and storing facilities are available.
 7. Vegetables - any excess of local demand are exported to the three towns, especially from the schemes in the Shendi district.
 8. Dura and Maize - small areas of fodder.

Occasional small orchards, which produce limes, oranges, grapefruit, mangoes and dates, are situated along the Shendi-Berber reach, particularly around Metemma and Shendi. Such plantations, once established, prove very profitable. The construction of a good road to Khartoum would undoubtedly stimulate the production of fruit and vegetables in N. Province. Despite the currently poor communications fruit and vegetables are sent by lorry to Khartoum from as far as El Bauga. This latter scheme is also the principal date producer in the area.

2.5.2.3 Agronomy

In co-operation with both Government and Private Schemes, the Hudeiba Research Station staff are conducting research into the agronomy of the region. The following principal crops deserve particular mention.

1. Wheat. A native bearded variety is grown exclusively; attempts to introduce higher yielding varieties have been limited by lack

of heat tolerance or greater susceptibility to bird damage.

The distribution of good seed would probably give a widespread increase in yields. Sowing is traditionally started on November 10th. Under local conditions yields are inversely related to

temperatures, thus the sowing date is critical if heading is to occur at the coldest period of the year. The harmful effect of high soil E.S.P. appears to be greater for late sown wheat.

Ammonium sulphate fertiliser is applied on most schemes at up to 50 kg per feddan.

2. Groundnuts. Considerable success has been obtained by growing this crop for confectionery, especially on the sandy soils of a

private scheme north of Berber. Continuous monocropping has increased yields. It is grown as a damira crop and it is thought that the leaching and deposition from the silt-laden irrigation water during this season may account for the increasing fertility of the soil. Light textured soils are most favourable, since they facilitate nodulation and harvesting, and the possibility of expanding the production of quality nuts in the Sabaloka-Berber reach seem promising.

3. Ful masri. Northern Province is the principal producer of this bean in Sudan. Yields are generally poor due to shedding and powdery mildew (Erysiphe umbelliferum, E. polygani and

Leveillula taurica). These latter are avoided by early sowing.

4. Lubia. As a seed crop this is sown in October, later sowing increasing its susceptibility to a mosaic disease. The seed is harvested dry.

5. Castor beans. The Government plan to introduce this crop into the schemes of Northern Province. Initial trials have been encouraging, but yields have been depressed by salinity above 0.6 mmhos per cm (Heipko et al. 1965), and this will severely limit the extent of its success. Where the population density is so high and land scarce, the introduction of a new crop must occur only at the expense of another. Castor cannot be eaten, even during a famine, nor does it provide fodder. It is possible that under sowing with lubia may obviate the latter criticism.

Initial trials on silt soils around Shendi have yielded 1300 kg per feddan as opposed to clay soils at Hudeiba and Zeidab, where 700 kg and 300 kg respectively, were recorded (Heipko, 1966).

6. Cotton. This is only grown on Zeidab scheme: disease, the lack of labour and high cost of production prevent widespread cultivation of this crop.
7. Helba and Cummin are grown around Medisisa and Wad Hamid for export to Khartoum.

2.5.2.4 Livestock

Sheep and goats are the dominant livestock. A dairy farm at Atbara produces milk for the town. Cattle are generally scarce due to the restricted grazing during the dry seasons. Occasional camels are kept for transport. The ubiquitous goats effectively remove most forms of vegetation, which increases the risk of wind and water erosion. In dry years the goat numbers greatly exceed the available grazing and their diet may even include leaves of the Calotropis procera bush.

2.5.3 Erosion

Fluvial erosion is severe. The river is continuously eroding and re-depositing silt islands, and may leave pumping stations without water. Erosion from sudden rainstorms can cause severe damage to basins and pump schemes; this can be avoided by constructing embankments along the wadis, as at Zeidab. The incursion of wind blown material causes further damage to crops.

boundaries. There was CHAPTER 3 correlation between the various patterns identified on the photographs and the various soil types recognised. SURVEY METHODS

3.1 Use of Aerial Photographs

Since only small scale and rather inaccurate topographical maps are available in this area, aerial photographs and mosaics were essential as base maps as well as for interpreting soil boundaries.

The photography of the Nile valley was flown in November 1965 at a scale of 1:25,000, and mosaics compiled at 1:50,000 by the Sudan Survey Department. In a few instances, small areas were not covered by this photography, and an older photography at the same scale flown in 1959 was used to fill the gaps. The photography of the River Atbara was taken in 1964.

The procedures followed during the survey were:-

De-lination of the area on the mosaics for the semi-detailed survey indicated by a previous reconnaissance soil survey. (Roseires Soil Survey, Report No. 5).

Study of the mosaics, in conjunction with aerial photographs, in order to obtain an overall impression of the area and to eliminate such areas as were under permanent agriculture, mainly existing pump-schemes. Areas of high dunes, whether stable or unstable were also eliminated at this time.

A sample area was chosen near the village of Kineidra on the north side of the River Atbara during the preliminary interpretation. This area was sited to include the maximum number of variable patterns that could be identified on the print and which recurred throughout the area as a whole.

Along the main Nile, the photographs showed a sequence of patterns inland from the river which were common to most of the areas to be surveyed. In this case, pits were sited to give two representative cross sections.

After completion of the field work and with the chemical data to hand, a final photo-interpretation was carried out to delineate the series

Along the Nile, the greater densities of these tree species boundaries. There was a high level of correlation between the various patterns identified on the photographs and the various soil types recognised, virtually devoid of vegetation except in sandy wadis, and this helps to give some indication of the degree of erosion of these

3.2 Aerial Photo-interpretation

The following elements have been distinguished during the photo-interpretation.

Relief

Variations in relief were much more easily detected in this area than in the clay plains. The river edge levees with their associated reverse slopes could be detected in most cases and this was important since one particular series was usually found on these levees. The low lying flood basins were easily identified as was the complicated system of 'gullies' mainly associated with the lowest part of the flood basin. The higher terraces on the inland side of the flood basins were equally easy to detect. The higher dunes whether stable or unstable could be identified by relief alone, and so distinguished from flatter sand areas which give the same pattern on the prints as far as colour, tone and vegetation are concerned.

Vegetation

In this area of low rainfall and heavy overgrazing, the only vegetation is tree and scrub species, apart from cultivated areas close to the river and in pump schemes.

The main tree species which could be identified from the prints along the main Nile are Acacia tortilis, Hyphaenae thebaica (Dom Palm) and Acacia seyal. Acacia tortilis shows up as a round black dot on the prints, while the Dom palm has a near star-shaped outline. Acacia seyal is less definitive than the former two. In the Kineidra area along the river Atbara, the main species are the Dom palm, Salvadora persica and Capparis decidua with a few scattered Acacia tortilis. Salvadora persica and Capparis decidua give a grey, stippled effect on the aerial prints.

of the basins, but rather weakly expressed. These are regarded as Vertisol - Entisol intergrades. They are characterised on the prints occur on the sandy soils, especially on stabilised or partially stabilised dunes, the main occurring species being A. tortilis. The higher terraces are virtually devoid of vegetation except in sandy wadis, and this helps to give some indication of the degree of erosion of these higher terraces. A similar pattern exists in the Kineidra survey area, except that Salvadora and Cadaba species occur mainly on higher clay content soils and not on the sand areas.

Soils

With the almost complete lack of close ground vegetation in this area, any patterns on the prints are directly related to soil surface features. Relief is sufficiently high to be detected by stereoscopic examination. This allows the higher terraces to be separated from the lower and from the flood basins. It is found that the higher terraces are mainly Aridisols, while the lower are Entisols, with Vertisols occurring in the lower flood basins.

At lower category levels, various shades of colour have been useful in allowing a fairly accurate delineation of the various soil series recognised in the survey areas along the Nile. Apart from their low level, the flood basins are easily distinguished by their dark colour on the prints. In nearly all cases, this also indicates a clay content of over 40 per cent in the soils, the higher clay contents of over 50 per cent usually showing a complicated dendritic or trellised system of shallow gullies. This phenomenon has been discussed in detail in Chapter 2. Another feature of the flood basin is a well marked inlet and outlet channel which has usually been artificially deepened and straightened.

Between the flood basins and the river is a stretch of land which is often partially cultivated by 'sagiya' irrigation. The land slopes upwards towards a narrow river edge levee which is discontinuous. Soils on the levee itself are usually Entisols with less than 30 per cent clay, but between the levee and the true flood basin, the clay percentages increase, but the soils are still Entisols. A narrow band on the edge of the clay basins is usually of fairly high clay content, averaging about 50 per cent, showing structural similarities with the Vertisols of the central part

of the basins, but rather weakly expressed. These are regarded as Vertisol - Entisol intergrades. They are characterised on the prints by the dark colour of the clay basins, but with either no gully pattern or a weakly developed one. The heavily gullied clay areas are virtually always Vertisolic in character.

On the inland side of the clay basin are the higher terraces. They are not always distinguishable one from another, but there seem to be two main terraces. In general, the soils have a high alkali and salt content. Two orders occur, Entisols and Aridisols. The Entisols are probably grading towards the Aridisols. It is not always easy to identify Aridisols and Entisols on the photographs, but those Aridisols which contain 30 per cent of clay or more have a medium grey colour, rather darker than the colours associated with the corresponding clay percentage Entisols. The Aridisols with less than 30 per cent clay are usually found only on the higher terrace or on the eroded gravel ridges which border this terrace. The colour on the print is usually light to very light grey. In many of the river basins there are areas of high dunes and other very sandy areas which are probably blown out dunes. These are easily recognised both by their very light colour on the photographs and by the relatively high density of the species growing on them. The high dunes show up in relief under the stereoscope.

Within the survey area on either side of the River Atbara, the overall pattern is somewhat different. Low alkali, low saline Entisols occur along the river on both banks. These are easily recognised on the photographs by their even medium grey colour and by the fact that there is a dense growth of Dam palm on these soils. Away from the river, a complex pattern of grey and very light grey colours, perhaps due to wind erosion, normally indicate Aridisols, mainly with clay contents of over 30 per cent. These soils support a fairly dense growth of S. persica and C. rotundifolia. Light textured Aridisols occur on low gravel covered ridges. These can be distinguished on relief alone under the stereoscope, but also by their even colour and texture and almost complete lack of vegetation, apart from trees, mainly A. tortilis, which grow in the sandy erosion channels.

Over the area as a whole, fairly accurate interpretation of the patterns visible on the prints in terms of soil types can be achieved.

Land Use

Two main land use types are obvious from the photography, non-riverine and riverine. As described in Chapter 2.5.2.1, the non-riverine land is used as poor grazing with occasional patches of rain-fed dura when the rain is sufficient. It was not possible to find evidence of these cultivation patches on the photography within the survey area.

On the riverine lands, areas of flood cultivation can be recognised on the prints. It is not always possible to distinguish between 'gerf' and 'sagiya' cultivation on the photographs, but pump scheme cultivation is usually made obvious by the straight edge canal systems.

The Keneldra sample area is described in detail in the appendix.

3.3 Soil Survey Procedure

3.3.1 Sampling requirements

The soil survey of the area was carried out between 7th February and 7th March 1966.

The sampling and inspection density required was one site for every 250 feddans; in linear terms, one site per kilometre. A one kilometre grid was used, but sites could be placed at distances other than 1 km when deemed necessary to examine any change or suspected change in the soil. Subsequent sites were adjusted to maintain the overall density of one site per 250 feddans. All bore inspection sites were sampled at fixed depth intervals of 0-45 cm, 45-90 cm and 90-150 cm.

Pits were sited to cover all soil types on the basis of photo-interpretation and field inspection. These were sampled by major horizons and also by the above fixed depth intervals. The minimum density of pits required was one pit in every twenty inspection sites. Two per cent of all inspection sites had to be examined to a depth of 3 metres and this requirement was met by sinking a one metre bore in the bottom of every second pit. The characteristics of the 2-3 metre depth were described, but no samples were taken.

Since suitable base maps at the necessary scale of 1:50,000 are not available, base maps for the area have been compiled and drawn by the consultants from the available mosaic cover. Since these mosaics

3.3.2 Sample area(s)

Initially, with the aid of aerial photo-interpretation, a sample area was chosen on the north side of the River Atbara, and some 2 km east of the village of Keneidra. This sample area of 8 sq. km contained 10 pits and 8 bores covering a maximum number of identifiable patterns on the prints.

Within the Kelli basin, two cross sections of 5 pits each were sited 4 and 2 km north and south respectively of the village of Kelli to provide data on the fairly regular pattern from the river inland which occurs in most of the clay basins.

The Keneidra sample area is described in detail in the appendix.

3.4 Chemical analyses

The analytical techniques used in the laboratory are described in Appendix 2.1. However, because of the very poor relationship between clay percentage and cation exchange capacity in the coarser textured soils of this area, it quickly became obvious that clay percentage could not always be used in routine estimations of the exchangeable sodium percentage. The clay percentage /C.E.C. relationship was very weak in virtually all cases where the clay content was less than 35 per cent. Additional C.E.C. determinations had to be carried out on routine bore site samples to overcome this difficulty, and, all samples containing less than 35 per cent clay which had E.S.P. values of between 17 and 28 when calculated on the basis of clay percentage, had C.E.C. determinations done on them, as had all sites with E.S.P. values greater than 50 and measured values for E.S.P. were obtained. Those in the range 7-28 E.S.P. were particularly important, since the critical land classification values fall within this range.

3.5 Map compilation

3.5.1 The Base Maps

Since suitable base maps at the necessary scale of 1:50,000 are not available, base maps for the area have been compiled and drawn by the consultants from the available mosaic cover. Since these mosaics

are uncontrolled, the base maps cannot be regarded as strictly accurate, but discrepancies in scale and direction are small and unlikely to be significant.

Pit and auger sites are indicated by the following numbered symbols.

- 5535 2 metre auger hole
- △ 5556 2 metre pit
- ⊙ 5588 2 metre pit + 1 metre bore.

3.5.2 The Soil Maps

Delineation of the soil boundaries was carried out by stereoscopic examination on the aerial photographs. The boundaries drawn on the prints were then transferred to the mosaics, from which overlays were made. From the overlays, the lines were then transferred to the prepared base maps.

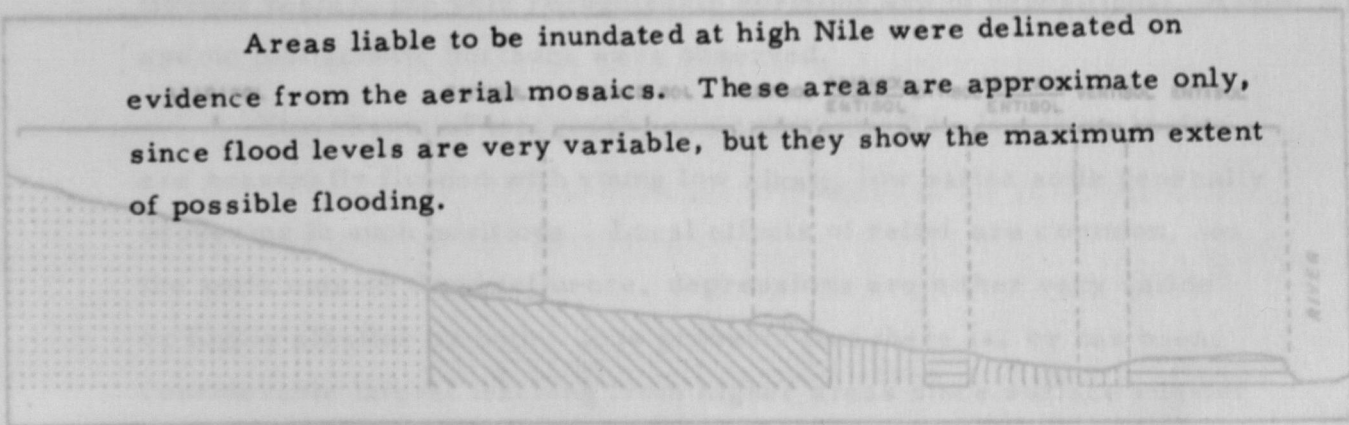
On the base maps, each soil series is represented by a specific colour; any complexes are shown by striping the colours pertaining to the series contained in the complex.

3.5.3 Land Class Maps

The boundaries of the land class units were determined in much the same way as in the case of the soil boundaries. Where there was coincidence of land class and soil class units, the boundaries previously determined stereoscopically in the soil interpretation were used to delineate the land class units.

Where no coincidence of land class and soil class occurred, the land class boundaries were interpolated from the data on the individual sites.

Areas liable to be inundated at high Nile were delineated on evidence from the aerial mosaics. These areas are approximate only, since flood levels are very variable, but they show the maximum extent of possible flooding.



See Fig. 2.1 for physiographic units.

4.2 Soil Forming Processes

CHAPTER 4

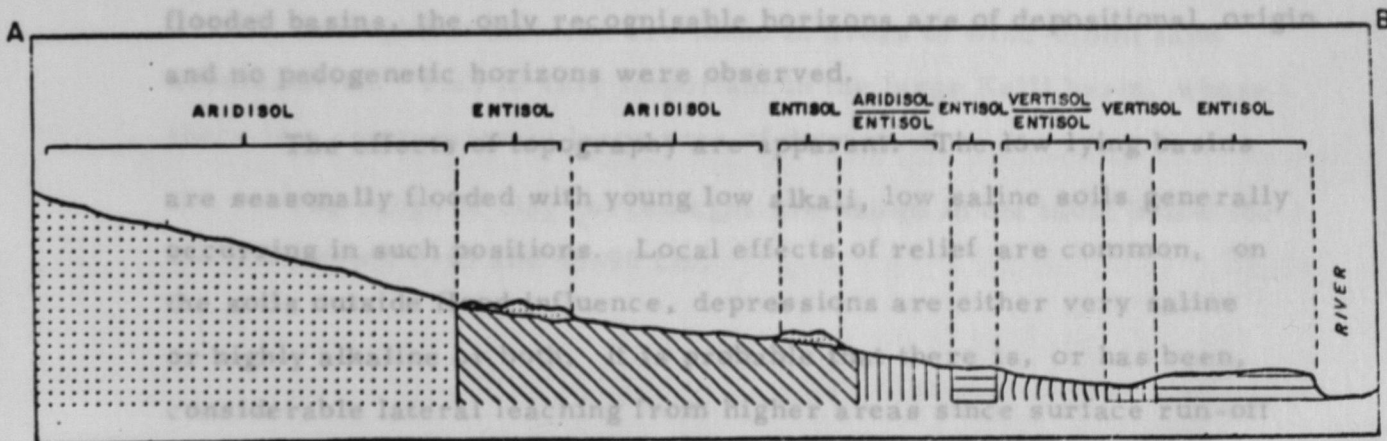
The main soil forming factors are normally considered to be: parent material, climate, organisms, topography and time. Of these,

PEDOLOGY

4.1 Parent Material

Within the project area, most of the soils are developed on material which has been deposited by the River Nile. As discussed in Chapter 2, the age of these deposits differs considerably. On a high terrace south of Atbara, palaeolithic remains have been found indicating that these higher terraces are very old. The low lying flood basins are still actively flooded, with deposition of silt and clay occurring at a very slow rate. In certain basins, aeolian deposits are important, and in some cases these deposits have been levelled, possibly due to some degree of water erosion as well as wind blow out. High dunes occur fairly frequently, especially within the Kelli basin. Many are active and there is a tendency for sand to move slowly across the basins towards the river. Much of these aeolian deposits form very young soil parent materials. Along the landward edges of many of the basins there are eroded ridges which slope upwards towards the rock outcrops which border the valley. Many of the ridges possess a fairly high gravel content and may have been formed by the coalescing of gravelly outwash fans from the higher rock areas, deposited during a period when rainfall was higher than at present.

From the foregoing, it can be seen that recent parent materials occur in the flood basins, along the riverside and in aeolian deposits, whilst older parent materials occur on the higher terraces and ridges. The following diagrammatic cross-section shows the relationship between soils and the main physiographical units (Kelli Basin).



See Fig. 2.1 for physiographic units.

4.2 Soil Forming Processes

The main soil forming factors are normally considered to be: parent material, climate, organisms, topography and time. Of these, the main variables within the project area are parent material, topography and time. The climate is reasonably uniform and there is no evidence that organisms play any significant role in the soil forming processes in this area.

Area 4b is arid and the mean annual precipitation varies from 72 mm at Atbara to 136 mm at Shendi. Nearly all of this rainfall occurs in the months of July, August and September. Temperatures during the rains are high and potential evaporation also remains at a comparatively high level. The rainfall is cyclonic and uneven in distribution.

From these climatic features it is obvious that under present day conditions climate plays a negligible role as a soil forming factor. However, there is sufficient evidence to suggest that there have been periods of higher rainfall than obtain at the present, and it is possible that many of the profile characteristics of the soils on the older parent materials owe their origin to more humid periods. There is some evidence to suggest that there may have been some degree of leaching of clay, and that secondary accumulation of calcium carbonate may have occurred. Horizons of high calcium carbonate content are common throughout the area, but it is not always easy to distinguish between secondary and primary depositional carbonate.

Parent material is variable. The soils on the older parent materials show definite horizon differentiation, and have been mainly classed as Aridisols. The various horizons diagnostic of Aridisols are usually present, and indicate some degree of leaching over a long period. Within the younger materials of the river banks and the seasonally flooded basins, the only recognisable horizons are of depositional origin and no pedogenetic horizons were observed.

The effects of topography are apparent. The low lying basins are seasonally flooded with young low alkali, low saline soils generally occurring in such positions. Local effects of relief are common, on the soils outside flood influence, depressions are either very saline or highly alkaline or both. It is probable that there is, or has been, considerable lateral leaching from higher areas since surface run-off

is high, especially from the higher ground which borders the Nile valley. Most of the soils other than the very sandy ones have surface crusts and comparatively low permeabilities, so that much of the rainfall from the cyclonic storms is lost on these areas where there are significant slopes. Vertical leaching through the profiles is very limited under present day conditions.

Depth range	No. of sites	Percentage of total sites	No. of sites	Percentage of total
0 - 5	15	1.8		
5 - 10	56	6.6		
10 - 15	57	6.9		
15 - 20	71	8.5		
20 - 25				
25 - 30				
30 - 35				
35 - 40				
40 - 45				
45 - 50				
50 - 55				
55 - 60				
60 - 65				
65 - 70				
70 - 75				
75 - 80				
80 - 85				
85 - 90				
90 - 95				
95 - 100				

4.3 Physical Characteristics of the Soils

4.3.1 Texture

A wide variety of textures are found throughout the area, ranging from soils with over 60 per cent clay in the flooded basins to nearly pure sand on the high dunes. Great though the range of textures is, it does fall into a reasonably well defined pattern.

Virtually all soils with over 45 per cent clay occur either in, or on the margins of, seasonally flooded basins. Soils with lower clay but higher silt contents are found along the river banks. These are also recent deposits.

The older river terraces have variable clay contents, but generally they are over 30 per cent, with moderately high silt contents of around 25-30 per cent. However, in certain areas, especially along the Atbara, a wind-blown surface deposit of low clay percentage (i. e. less than 30 per cent) occurs. This varies in depth from 10-80 cm, but is usually around 30 cm. This is most commonly found on the older terraces.

4.3.2 Soil Colour

Above this level, the bordering gravelly ridges and the desert erosion piedmont usually have clay percentages of less than 30 per cent. The low, very gently rolling piedmont type of land surface is best seen south of the river Atbara.

The lightest textures are found in areas of wind-blown sand accumulation. This is very important in the large Kelli basin, where there is a comparatively large area of dune sand.

The range of clay percentages are shown in the table below for the fixed depth 0-45 and 45-90 cm.

On the higher ridges, especially those which have a significant gravel content, textures are generally coarse, and colours are light, often of 10YR 4/3 in Munsell notation.

TABLE 4.1 Percentage of total sites within each clay percentage range for fixed depths

Depth	0 - 45 cm		45 - 90 cm	
	Percentage range	No. of sites	Percentage of total	No. of sites
5 - 10	18	2.1	15	1.8
10 - 15	56	6.6	57	6.9
15 - 20	82	9.7	71	8.5
20 - 25	101	11.9	89	10.7
25 - 30	105	12.4	87	10.5
30 - 35	120	14.2	93	11.2
35 - 40	104	12.3	84	10.1
40 - 45	86	10.2	90	10.8
45 - 50	55	6.5	101	12.1
50 - 55	47	5.5	62	7.5
55 - 60	36	4.2	45	5.4
60 - 65	14	1.6	20	2.4
65 - 70	9	1.0	10	1.2
70 - 75	5	0.5	4	0.4
75 - 80	4	0.4	2	0.2
TOTAL:	842	99.1	830	99.7

4.3.2 Soil Colour

As will be obvious from table 4.2 there is a very considerable range in colour occurring throughout the project area. This is, to some extent, a reflection of the variable textures, colour being affected by the proportion of sand in the soil. The higher the percentage of sand, the lighter the colour tends to be.

The darker colours 10YR 3/2, 3/3, are usually associated with the clays of the seasonally flooded basins. The silt soils of the river banks are lighter in colour, although their sand percentage may be no higher. In this case, the high silt contents seem to give rise to lighter coloured soils.

On the higher ridges, especially those which have a significant gravel content, textures are generally coarse, and colours are light, often of 10YR 4/3 in Munsell notation.

The wind blown deposits provide the lightest colours in the area. Their colour is very difficult to estimate even by Munsell notation because of the very high sand content and the differing colours of the individual sand grains. However, the composite colours are usually in the 10YR 4/3 to 10YR 5/3 range.

TABLE 4.2 Analysis of Soil Colour Distribution in the top horizon

Colour	Number of sites	% of Total
10YR 3/2	74	8.43
10YR 3/3	126	14.86
10YR 3.5/2	47	5.54
10YR 3/2.5	36	4.25
10YR 3.5/2.5	21	2.48
10YR 3.5/3	41	4.83
10YR 3/4	32	3.77
10YR 4/2	76	8.96
10YR 4/2.5	48	5.66
10YR 4/3	117	13.80
10YR 4/3.5	21	2.48
10YR 4.5/2.5	19	2.24
10YR 4.5/3	33	3.89
10YR 5/3	17	2.00
10YR 3.5/3.5	11	1.30
10YR 3.5/4	9	1.06
50 Other colours (1% of total)	110	12.97
7.5YR 4/4	10	1.18
TOTAL:	848	100

4.3.3 Structure

Since there is a wide range of soil types throughout area 4b, structure will be discussed for each of the three orders which are represented, Vertisols, Entisols and Aridisols. Certain soils have been recognised which cannot be easily fitted into any one order. To accommodate such soils a Vertisol/Entisol intergrades and an Aridisol/Entisol intergrade have been named Grumustertic Haplorthents and Natrargidic Haplorthents respectively.

become weakly developed. These are the soils which have been called Gramustertic Haploorthents. The Vertisols and Gramustertic Haploorthents together make up about 15.5 per cent of the total area.

VERTISOLS

Within the flood basins of the Nile, there are soils of high clay content, the clay percentage exceeding 60 in several instances. The cation exchange capacities are also high being of the same magnitude as the clay percentage. Although no mineralogical analysis has been carried out on these clays to date, it is likely that they contain a fairly high proportion of montmorillonite. These heavy textured soils have been regarded as belonging to the Vertisol order.

In general, the soils of the Entisol order are very weakly structured, but there is some correlation between structure and texture. The fine textured Entisols with clay percentages of over 30 per cent or high silt and clay content have a moderately well developed medium blocky structure in the top 20-30 cm. Below that, the profile is generally rather weakly structured. Such structure as is identifiable is usually a fine subangular blocky ped. This is particularly true of the recent river bank soils.

The structure of these soils is controlled by the swelling and shrinking properties of the clays. When the clays are wetted by the annual flooding of the basin, the clay expands. On drying out the soil contracts and a network of vertical cracks opens up. These cracks can reach 15 cm in width but are normally less than this, the average being between 5 and 8 cm. The main cracks may extend to a depth of 80 cm, but more normally do not extend beyond 45-50 cm. Within the zone of maximum cracking, there is normally a quite well defined prismatic structure with a subsidiary weakly to moderately well developed rather coarse angular blocky structural component. This is generally a zone of rather coarse peds. Towards the bottom of this horizon a wedge shaped ped becomes apparent which reaches its maximum development in the underlying horizon immediately below the horizon of maximum cracking. Although the outline of the individual peds are obvious in the profile, they are very difficult to separate one from another, especially when the horizon has dried out. This particular structural form may be due to the high pressures built up within the soil body by the swelling of the clay, especially since fresh material is added to the soil body by infilling of the cracks.

ARIDISOLS

With depth, the soil becomes progressively more massive, although wedge shaped peds are usually still fairly obvious. In certain cases, the bottom of the two metre profile is very coarse textured, and in such cases there is an abrupt change, the sandy horizon possessing a very weak angular blocky structure which breaks down very easily to single grain.

The well defined Vertisols are found only in the bottom of the flood basins. As the land rises very gently from the lowest levels, the clay content of the soil drops and the above mentioned structural characteristics

become weakly developed. These are the soils which have been called Grumustertic Haplorthents. The Vertisols and Grumustertic Haplorthents together make up about 15.5 per cent of the total area.

ENTISOLS

Soils of the Entisol order occupy nearly 56 per cent of the total area. Of this 50 per cent, 19 per cent is due to soils which have been regarded as Aridisol/Entisol intergrades at sub Group level, and called Natrargidic Haplorthents.

In general, the soils of the Entisol order are very weakly structured, but there is some correlation between structure and texture. The fine textured Entisols with clay percentages of over 30 per cent or high silt and clay content have a moderately well developed medium blocky structure in the top 20-30 cm. Below that, the profile is generally rather weakly structured. Such structure as is identifiable is usually a fine subangular blocky ped. This is particularly true of the recent river bank soils.

At slightly higher levels than the clay basins, soils with very little horizon differentiation within one metre of the surface are found. These seem to be associated with silt terraces immediately above the present high flood level. They possess high E.C. or exchangeable sodium values or, more commonly, both. However, these chemical characteristics are not reflected in the profile morphology to any degree and they do not possess either calcic or gypsic horizons, although some gypsum crystals and calcium carbonate concretions are usually present. These soils are very poorly structured apart from a rather weakly developed coarse angular blocky structure in the top 20 cm or so, and could be regarded as massive.

ARIDISOLS

Structure is generally weak in soils of the Aridisol order. Some variability does occur due to differences in texture, and, locally, variations in salinity and alkali content can have marked effects on structure. The two main great groups recognised are Calciorthids and Natrargids, with Natrargids being the dominant group.

The Natrargids are found on a wide range of textures, from sandy loams to sandy clays. The presence of argillic horizons has not been

definitely proved, but many of the pits show a horizon of maximum clay content which also shows very high E.S.P. values. For the purposes of classification, these are regarded as natric horizons. These horizons possess a reasonably well developed prismatic structure, although horizons above and below are often massive.

In a few pits, fairly narrow horizons with E.C. values of over 20 have a very strongly developed granular structure. In one bore site, this structure was so strongly developed in a horizon of clay loam texture that the soil material flowed laterally into the bore hole like sand. This high degree of structural development is comparatively uncommon. In some areas, particularly in the Kineidra area, wind blown material overlies and buries the Aridisol profile. The depth of this deposit is seldom more than 20 cm but has been recorded as deep as 80 cm. These deposits have a definite platy structure, partly due to the planes of deposition and partly due to the burying of successive thin abrasion crusts.

Virtually structureless soils are found in the sandy dune areas, especially in the Kelli basin. In some cases, slight cementation, perhaps by calcium carbonate, imparts a weak angular blocky structure.

4.3.4 Soil Consistency

The soils of the terraces above the level of inundation and on the piedmont plains are generally dry throughout the profile, and consistency is limited to degrees of hardness. The soils of the piedmont plains are usually extremely hard, except in the few sites where strongly granular structured horizons occur. These are soft and rather loose, although the small, individual peds are themselves extremely hard.

On the terraces, the profile is still very compact, but, on the whole, rather less so than on the higher piedmont. In a few local depressions, horizons occur which are slightly moist and very firm. This often coincides with the horizons which have been regarded as natric horizons. The very light textured soils of the dune areas are mainly soft or loose, but locally hard due to cementation in the older, lower part of the profile. Certain sites have horizons which contain a high proportion of gravel. The consistency of these varies from loose to very hard depending on the degree of cementation and the content of calcium carbonate. Nearly all these gravelly horizons are also calcic horizons, and the cementation may be partly due to calcium carbonate itself.

The riverside silty terraces are mainly dry, since they are flooded only rarely during very high flood levels. They are soft to slightly hard throughout the profile, but locally are hard to very hard in the top 30-40 cm. These occasional hard horizons are probably due to higher than average clay contents.

In the seasonally inundated basins occur the clay soils. These are mainly dry in the top 80-90 cm and slightly moist to moist below. The dry upper part of the profile is very hard to extremely hard due to the high clay content and perhaps also partly due to the dominance of wedge structure in these high clay soils as described in the previous section. The moist horizons are firm to very firm.

4.3.5 Visible Mineral Accumulations

Minerals visible in field inspection of the profiles are calcium carbonate, calcium sulphate (gypsum) and salt efflorescences.

The soils developed on the recent riverside terraces contain very few mineral aggregates of any kind. Occasionally, small scattered rather hard calcium carbonate concretions occur in the lower part of the profile. The same is true for the soils of the flood basins.

The older soils of the higher terraces and piedmont plains contain a considerable amount of mineral aggregates. The commonest form is calcium carbonate. In most cases, this is at least partly a secondary accumulation, but occasionally these deposits are difficult to classify.

Basically, the accumulation is in two forms, concretionary and non-concretionary. The main concretionary form is a large slightly hard, easily fragmented aggregate. In some cases, the content may be so high that a solid calcium carbonate horizon results. In these cases, the carbonate has a definite platy structure, especially in the upper few centimetres. Less commonly, the aggregates are sub-rounded, very hard and difficult to fracture. These presented a difficult problem in augering since it proved impossible to penetrate any calcic horizon in which these aggregates were the dominant calcium carbonate form.

The diffuse forms of calcium carbonate are most common in the coarse textured soils, especially those with a high gravel content.

In this latter case, the carbonate occurs as an infill between the stones. It commonly acts as a cementing agent. In sandy soils, the calcium carbonate is disseminated through the sandy matrix and again often cements the horizon in which it occurs. In a few cases, this degree of cementation was sufficient to produce a petrocalcic horizon. Occasionally in a wide range of textures, the calcium carbonate is arranged in a series of vertical streaks through the profile. In the coarser soils, mycelia of finely divided carbonate occur. This may be an infilling of old root channels.

Gypsum crystals are found in most of the aridisol profiles and quite commonly in sufficient concentration to form a gypsic horizon. The main concentration is normally in the upper part of the profile, but smaller amounts occur throughout the profile. The gypsum is (almost) certainly a secondary deposit.

Salt efflorescences are much less common in the profiles than is gypsum, but local concentrations do occur and, in most cases, are associated with gypsum. The salt is normally concentrated in fairly narrow horizons which often exhibit strong granular structure. They were noticed mainly in the Kineidra area, on both sides of the River Atbara.

4.4 Chemical Characteristics of the Soil

4.4.1 Methods of Analysis

The techniques and methods involved in the chemical determinations are similar to those described in Report No. 12 of the Roseires Soil Survey and are briefly described in Appendix 2.1.

4.4.2 Salinity

All routine bores and pit samples were tested for salinity and, in addition, from twenty five per cent of the sites the 90-150 cm samples were also tested. The results are expressed as electrical conductivities of the saturation extract (E.C.) in mmhos per cm at 25°C. The series analyses showed a good linear relationship between E.C. and total soluble cations.

Table 4.3 demonstrates the preponderance of soils in which the upper horizons are non saline. However, a significant proportion of sites are saline and the E.C. of the two standard horizons has been an important criterion in the land classification.

TABLE 4.3 Percentage Frequency Distribution of E.C. by Fixed Depths

Soil Sub-group	Depth cm	E.C. Range mmhos/cm				
		0-4	4-8	8-12	12-20	> 20
A 11)	0-45	72.3	9.5	4.9	6.6	6.7
A 12)	45-90	52.2	15.6	8.9	13.5	9.8
A 21)						
C11)						
Typic Haploorthent						

An apparent trend of increasing salt content with depth, is not substantiated by the pit analyses. The E.C. values for genetic horizons are extremely variable, especially within the Aridisol sub-group, reflecting the diversity of parent materials within any one profile.

Table 4.4 shows the degree of salinity of the different soil sub-groups based upon the E.C. of the 0-45 cm layer. Variations in salinity are attributable to the age or form of parent materials in which the soils have developed.

The non saline soils occur on the recent deposits within the basins whilst the soils with high salinities are confined to the older terraces. The Vertisols, Typic Haploorthents and Grumustertic Haploorthents, which have developed in recent sediments and have been subjected to leaching during the annual floods, are rarely saline and generally increase in salinity with depth.

The Natrargidic Haploorthents and Typic Natrargids, however, have developed upon the older terrace materials and are usually highly saline, with E.C. values which may exceed 100 mmhos per cm. These soils are not subject to flooding, receive only sparse rainfall and therefore remain unleached. The vertical movement of salts by capillary action is probably responsible for the fine inflorescence of salt within the upper horizon of some soils. These accumulations were rarely detectable from the E.C. data, presumably due to the dilution effect of bulk sampling the whole horizon and the existence of surface deposits of sand. A slight increase in salinity is detectable in the surface horizon of Calciorthids, but this sub-group is generally less saline than the Natrargids and is

is less than one and calcium and magnesium become important.

assumed to have undergone some degree of leaching. The low E.C. values of the Quartzipsamments are attributable to their highly leached and coarse textured parent materials.

TABLE 4.4 0-45 cm Salinity of Soil Sub-groups (expressed as per cent frequency distribution)

Soil Sub-group	Total Sites	Salinity classes mmhos per cm.				
		0-4	4-8	8-12	12-20	> 20
A 11)						
A 12) Grumustert	43	98	2	-	-	-
A 21)						
C11 Typic Haplorthent	286	95	3	1	0.5	0.5
C12 Grumustertic Haplorthent	88	95	2	2	-	1
C21 Natrardigic Haplorthent	151	44	15	9	16	16
C22 Quartzi Psammustent	30	100	-	-	-	-
D11 Typic Natrargid	185	32	22	12	16	18
D12 Calciorthid	40	95	2	1	2	-

4.4.3 Composition of the Soluble Salts

There is a wide range in soil salinity and a corresponding range in the types of soluble salts present.

In soils of low salinity the bicarbonate ion dominates the soil solution but, in the absence of soluble carbonate, never exceeds 5 milliequivalents per litre. Carbonate is occasionally present and under these conditions the bicarbonate concentration exceeds 5 me/l.

As the salinity increases initially sulphate dominates the anions then sulphate and chloride are approximately equal. Finally at very high salinity levels chloride is dominant.

Sodium is generally the dominant cation except when the E.C. is less than one and calcium and magnesium become important.

TABLE 4.5 Range in Cation Exchange Capacities within Soil Sub-groups

Therefore the main salts present are generally sodium sulphate or sodium chloride and occasionally sodium carbonate.

The presence of soluble carbonate is shown by the increase in soil pH paste values and by the very low values for soluble calcium and magnesium. Soluble carbonate cannot exist in the presence of soluble calcium and magnesium as reaction occurs and the insoluble carbonates of calcium and magnesium are precipitated. Gypsum cannot be present for the same reason.

The soluble calcium concentration nearly always exceeds that of magnesium.

Soluble potassium is always present in small quantities only.

4.4.4 Cation Exchange Capacity

Unlike the montmorillonite dominated soils of the clay plains, the soils of area 4b are thought to possess a wider variety of clay minerals, related to the age and origin of the parent materials.

A comparison was made between the cation exchange capacity and the clay content of the different soil groups. In many cases 100 g of clay appears to possess more than 100 me of exchange capacity which suggests that a more reactive clay mineral, such as vermiculite, may be occurring in combination with montmorillonite.

The cation exchange capacity (CEC) was measured on all pit samples and the range of CEC values obtained for each soil suborder are summarised in Table 4.5.

Some seemingly impossible values in excess of 200 me per 100 g clay were obtained for Natrargids. This suggests that the clay fraction does not account for all the exchange capacity. A more plausible explanation, as reported in other parts of the world (Tedrow, 1966), is that a considerable proportion of the exchange capacity is associated with silt-sized clay aggregates. These aggregates may have resisted dispersion prior to mechanical analysis and resulted in an underestimation of the clay fraction.

Since exchangeable sodium values are fundamental to the soil and land classification, it was apparent that the clay: C. E. C. relationship could not be used in the calculation of E. S. P. values from all routine samples. Consequently all samples with clay percentages below 35 were re-investigated. Those soil samples in which the E. S. P.'s were

TABLE 4.5 Range in Cation Exchange Capacities within Soil Sub-groups

Soil Group and Sub-Group	C.E.C. Range me per 100 g soil	
	Minimum	Maximum
Vertisols		
All. A12	37	62
Entisols		
C11	10	45
C12	25	56
C21	10	64
C22	-	-
Aridisols		
D11	14	58
D12	10	40

4.4.4.1 Relationship between clay percentage and C.E.C.

In earlier soil surveys in the clay plains, the strong 1:1 correlation between clay content and C.E.C. justified the substitution of clay percentages for C.E.C. values in the calculation of the exchangeable sodium percentage (E.S.P.), which is required for both soil and land classification. This method was applied with success in area 4a of Northern Province. However, the soil parent materials of area 4b are not homogeneous and the clays appear to be of variable composition. Attempts to establish the same linear relationship between C.E.C. and clay, as for the soils of the clay plains, did not succeed. Although a positive correlation existed the standard deviation was in excess of the permissible limits.

By plotting the deviation of C.E.C. values from the ideal 1:1 clay to C.E.C. ratio, against the clay percentage values, it appeared that those soils with less than 35 per cent clay were principally responsible for this inconsistency.

Since exchangeable sodium values are fundamental to the soil and land classification, it was apparent that the clay: C.E.C. relationship could not be used in the calculation of E.S.P. values from all routine samples. Consequently all samples with clay percentages below 35 were re-investigated. Those soil samples in which the E.S.P.'s were

critical and likely to effect the classification (E.S.P. 7-27), and those with E.S.P.'s in excess of 50 were tested for C.E.C. by laboratory measurement. Since the calculation of exchangeable sodium using clay had produced some excessively high values, it was decided to include within the latter group all samples with E.S.P.'s in excess of 50, regardless of clay content. Further, since highly saline soils are unlikely to be considered for development, samples with E.C. values in excess of 10 mmhos per cm were excluded from the C.E.C. determinations.

A total of 367 samples were selected for C.E.C. determination. The remaining 730 samples, with less than 35 per cent clay, constituted two groups: those with less than 7 per cent exchangeable sodium and those with E.S.P.'s between 27 and 50.; these samples were ignored, since their re-determination using C.E.C. would be unlikely to affect their classification. This is true for soils with less than 7 per cent exchangeable sodium. However, a change was made in the land classification after the C.E.C. determinations were completed, involving the use of E.S.P. 25 and 50 as critical values for classes 3, 4, 5 and 6, in addition to the original value of E.S.P. 15. Consequently, land of these classes may have been unnecessarily downgraded, due to over-estimation of E.S.P. values.

A total of 308 sites were affected by the recalculation of exchangeable sodium, in less than 10 per cent of these sites was the land class altered, with similar numbers being upgraded as downgraded. The recalculation of E.S.P. altered the soil series in 19 cases, but did improve the classification of the Aridisol group, where previously high E.S.P.'s in the Typic Natrargids were inconsistent with the U.S.D.A. classification.

In the cases of the Calciorthiss, the Vertisols and Vertisolic intergrades it appears to be safe to equate clay percentage with C.E.C. for the purpose of calculating E.S.P. However, for the other soils the use of this C.E.C. to clay relationship, in the absence of adequate clay analysis data, will give rise to inaccuracies in the estimation of exchangeable sodium, especially in the case of Natrargids, some of which reached impossible values of up to 350 per cent.

4.4.5 Exchangeable Cations

The exchangeable cations were measured by shaking the soil with normal ammonium acetate adjusted to a pH of 8.4 using ammonium hydroxide. A correction was made for the soluble salt content and the solution of calcium and magnesium carbonate was suppressed by using an extractant at a pH of 8.4.

Exchangeable Calcium and Magnesium

Calcium is normally the dominant exchangeable cation except in soils with a high E.S.P. when sodium dominates the exchangeable cations.

Exchangeable Potassium

The exchangeable potassium constitutes between one and two per cent of the exchangeable cations. This fraction, although small, is the primary source of potassium for plants.

Exchangeable sodium

Sodium is the exchangeable cation most liable to cause deleterious physical effects in the soil. Should the proportion of sodium to divalent ions adsorbed on the exchange complex become excessive, the clay will tend to deflocculate. This will be accompanied by the breakdown of structure and a decrease in soil aeration. In addition, the excessive quantities of exchangeable sodium present in some soils of area 4b are liable to be toxic to crops. Consequently, the proportion of exchangeable sodium on the exchange complex, expressed as the exchangeable sodium percentage, is a prominent criterion of the soil and land classification. Exchangeable sodium, as milliequivalents per 100 g of soil, was determined on both samples from all routine bores and all horizons of pit sites.

A consistent increase in the E.S.P.'s down to at least 150 cm, is apparent from the pit analyses, and the same trend is evident within the soil sub-groups (See Table 4.6), with the exception of the Natrargidic Haplorthents which have some anomalous surface horizons. The greatest exchangeable sodium percentages were recorded within the Typic Natrargids and the lower horizons of the Natrargidic Haplorthents, some of which reached impossible values of up to 350 per cent.

As reported in the previous section, considerable inaccuracies are liable to arise from the calculation of E.S.P. from the clay percentage. Recalculation, using measured C.E.C. values of all samples with E.S.P.'s greater than 50 produced more realistic values, although some still remained excessively high. If it is assumed that all the exchange capacity had been measured, then some other factor must be operating.

Recent investigations on similar soils in California by Shultz, Overstreet and Barshad (1964) have produced comparable E.S.P. values in excess of 100. Furthermore, healthy rice crops appeared to grow on soils containing up to 75 per cent exchangeable sodium. These authors suggest that "fixed" sodium ions occur on the exchange complex, which are only fully removed by leaching with Na^{22} , partly removed by normal monovalent ions and only slowly removed by divalent ions. Shultz et al. attributed this fixation to an amorphous mineral, analcime, and suggest that this form of exchangeable sodium is unavailable to plants. Consequently, a more realistic indication of exchangeable sodium in soils, as related to plant growth, would be obtained by extracting with calcium salts and not ammonium acetate, as is the normal procedure. It is possible that "fixed" sodium may be responsible for the excessive E.S.P. values in area 4b. Therefore the consultants recommend that further research should be conducted into the exchangeable sodium relationships of these soils and also into the origin and values of the exchange capacities from which the E.S.P.'s are calculated.

All the soils tested were alkaline in reaction and encompassed a wider range than previously encountered in the clay plains. The changes in pH were related to the exchangeable sodium percentage and the type and quantity of soluble salts present.

A discussion on the effect of E.S.P. and E.C. on soil pH has been given previously in soil survey report No. 12.

Briefly high salinities depress the soil pH, high E.S.P.'s increase the soil pH.

The soil pH paste values range from 7.5 to 9.7. In spite of high E.S.P. values the pH of the saturated soil paste will not exceed 9.0 unless there is soluble carbonate present in the saturation extract. Site No. 4488 (Appendix 2) is a typical example.

TABLE 4.6 Exchangeable Sodium Percentage of Soil Sub-groups
(Expressed as Percentage frequency distribution by
fixed depths

Sub-group Name	Depth cm	E.S.P. Classes						
		0-15	15-30	30-45	45-60	60-75	75-90	90+
Vertisols								
A11, A12*	0-45	96	4	-	-	-	-	-
	45-90	50	43	7	-	-	-	-
Entisols								
C11	0-45	93	4	3	-	-	-	-
	45-90	78	14	8	-	-	-	-
C12	0-45	82	18	-	-	-	-	-
	45-90	59	27	9	4	1	-	-
C21	0-45	-	-	22	44	22	12	-
	45-90	-	14	5	33	14	19	15
C22	0-45	Not available						
	45-90	The value ranged from 4 to 25 per cent but most samples						
Aridisols								
D11	0-45	13	35	10	15	11	10	6
	45-90	-	2	8	18	28	34	10
D12*	0-45	92	8	-	-	-	-	-
	45-90	53	25	16	6	-	-	-

* E.S.P.'s from clay per cent.

4.4.8.1 Total Phosphorus

4.4.6 pH

All the soils tested were alkaline in reaction and encompassed a wider range than previously encountered in the clay plains. The changes in pH were related to the exchangeable sodium percentage and the type and quantity of soluble salts present.

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Briefly high salinities depress the soil pH, high E.S.P.'s increase the soil pH.

The soil pH paste values range from 7.5 to 9.7. In spite of high E.S.P. values the pH of the saturated soil paste will not exceed 9.0 unless there is soluble carbonate present in the saturation extract. Site No. 4488 (Appendix 2) is a typical example.

Soils developed upon the more recent sediments tend to have lower pH values than those found on the older terraces, and surface horizon pH's rarely exceed 8.0. The greatest alkalinities are recorded for Natrargids, the surface horizons of which range between 7.2 and 9.3. The Calciorthids and Natrargidic Haplorthents have pH paste values varying between 7.6 and 8.5.

The pH values of the 1:5 suspension are consistently higher than those for the paste, normally differing by at least one pH unit in the majority of horizons. This difference is similar to those which previously have been reported in Northern Province (Report No. 8 R.S.S.). Differences of up to 1.5 were found in soils with high exchangeable sodium percentages, especially those situated on the older terraces.

4.4.7 Calcium Carbonate

The distribution of visible calcium carbonate has been described in Section 4.3.5.

The values ranged from 4 to 25 per cent but most samples contained between 5 and 10 per cent.

4.4.8 Total Phosphorus and Potassium

Phosphorus and potassium was extracted by boiling the soil with concentrated hydrochloric acid.

4.4.8.1 Total Phosphorus

The values obtained are extremely variable and range from 14 to 130 mg. per 100 g. soil. These results reflect the heterogeneous nature of the soil parent material. The lowest values generally occur in the deeper soil horizons probably in the zone of weathering rock but also in the surface horizons of the very sandy soils. The heavier clayey soils (Vertisols) possess adequate quantities of phosphorus for normal plant growth.

4.4.8.2 Total Potassium

There is a wide range in total potassium varying from 70 to 490 mg. per 100 g. soil. In general there is a good correlation between total potassium and the silt content. Soils with high silt contents have the highest values for potassium and vice versa.

The silt fraction usually contains the readily weatherable soil minerals and in this case probably contains a high proportion of potassium bearing micas which have been digested in the boiling acid.

There has been some slight leaching of clay in the profile, but not enough to affect the soil classification in any order other than the Entisol order.

4.4.9 Nitrogen
Nevertheless, it is felt that they may represent a stage in soil development between the Entisol and Aridisol orders. These soils have been called Natrargidic Haploorthents.

The analytical method used gave values which represent the organic plus ammonium nitrogen in the soils.

Nitrogen decreases with depth in most soils. The values obtained are low (60-870 ppm) and a great response to nitrogenous fertilisers is expected.

4.4.10 Organic Carbon

The organic carbon values are low (0.06 to 0.77 per cent) and, in general decrease down the profile. In such hot arid conditions these low values are expected.

The ratio of organic carbon to nitrogen varied from 6 to 15 and the average ratio was 8.

The quantities involved are very small and since there is a rather definite ratio the amount of organic carbon, and hence organic matter, which can be maintained in the soil is largely determined by the amount of nitrogen per cent. The nitrogen values are low therefore the organic carbon values are low.

4.5 Soil Classification

4.5.1 Definitions

Table 4.7 shows all the soil classification units used in this area, and their frequency distribution is shown in Table 4.8.
The classification of the soils is based on the "Soil Classification, A Comprehensive System, 7th Approximation", U.S. Department of Agriculture 1960, and the supplement to this classification of June 1964. Two new soil groups have been named to accommodate soils which could not be fitted into the classification. The first of these includes soils which intergrade between the Vertisol and Entisol Orders. Such soils have been regarded as Entisols, but because they possess some structural properties which are diagnostic of the Grumustert great-group of the Vertisol order, they have been called Grumustertic Haploorthents. Such Vertisolic structural properties that they do exhibit are very weakly expressed.

The second group includes soils which have high exchangeable sodium percentage and electrical conductivity values without possessing the diagnostic calcic or gypsic horizons. It is suspected that there may have been some slight leaching of clay in the profile, but not enough to allow their inclusion in any order other than the Entisol order. Nevertheless, it is felt that they may represent a stage in soil development between the Entisol and Aridisol orders. These soils have been called Natrargidic Haploorthents.

Two series have been defined within each sub-group on the basis of whether the clay content is greater or less than 30 per cent for all soils in the Aridisol order. The Typic Haploorthents of the Entisol Order have also been divided into series on the above basis. For Typic Quartzipsamments and Grumustertic Haploorthents of the Entisol Order and all soils of the Vertisol Order, series have been defined on whether the exchangeable sodium percentage is greater or less than 15 in the top 45 cm.

A few profiles occur which are composed of recent wind blown material overlying an older soil profile. The underlying profile is always an Aridisol while the overlying material is Entisolic. These have been considered to be two layered profiles when the surface deposit is thicker than 30 cm and had been stabilised by vegetation.

In a few cases, complexes containing two series have been mapped when there is insufficient evidence to indicate the relative proportions of the constituents involved within the unit.

Table 4.7 shows all the soil classification units used in this area, and their frequency distribution is shown in Table 4.8.

TABLE 4.7 Soil classification units

ORDER	SUB-ORDER	GREAT GROUP
VERTISOL	USTERT	GRUMUSTERTIC
		CLAY
		Clay percentage
ENTISOL	HAPLOORTHENT	QUARTZIPSAMMENT
		PSAMMENT
		ARGID
ARIDISOL	ORTHENT	NATRARGIDIC
		CALCIORTHENT

TABLE 4.7 Soil classification units

ORDER	SUB-ORDER	GREAT GROUP	SUB-GROUP	SERIES	SERIES SYMBOL
VERTISOL	USTERT	GRUMUSTERT	Typic Grumustert	E. S. P. < 15 0-45 cm	A 111
				E. S. P. > 15 0-45 cm	A 112
	USTERT	GRUMUSTERT	Entic Grumustert	E. S. P. < 15 0-45 cm	A 121
				E. S. P. > 15 0-45 cm	not represented
ENTISOL	HAPLORTHENT	HAPLORTHENT	Typic Haplothent	Clay < 30% 0-45 cm	C 111
				* Clay > 30% 0-45 cm	C 112
				E. S. P. < 15 0-45 cm	C 121
				E. S. P. > 15 0-45 cm	C 122
	QUARTZIPSAMMENT	QUARTZIPSAMMENT	Typic Quartzipsamment	Clay < 30% 0-45 cm	C 211
				Clay > 30% 0-45 cm	C 212
				E. S. P. < 15 0-45 cm	C 221
				E. S. P. > 15 0-45 cm	C 222
	NATRARGID	NATRARGID	Typic Natrargid	Clay < 30% 0-45 cm	D 111
				Clay > 30% 0-45 cm	D 112
				Clay < 30% 0-45 cm	D 121
				Clay > 30% 0-45 cm	D 122

Handwritten notes: 1. 2. 3. 4. 5. and a signature.

TABLE 4.8 Soil Classes

Soil Class	Total numbers	Total percentages
A 111	25	2.9%
A 112	2	0.2
A 121	19	2.2
C 111	151	17.5
C 111 D 112	8	0.9
C 111 D 111	11	1.3
C 112	132	15.3
C 112a	2	0.2
C 112 D 111	1	0.1
C 112 D 112	6	0.7
C 121	75	8.7
C 122	13	1.5
C 211	68	7.9
C 212	93	10.7
C 221	24	2.8
C 221 D 111	1	0.1
C 222	86	10.0
D 111	87	10.0
D 112	102	11.8
D 121	26	3.0
D 122	14	1.6
TOTAL:	866	100.0%

Classes 2 to 6 are mapped with their subclasses but class 1 is not subdivided.

Areas subject to river flood have been delineated and indicated by the symbol F on the land class maps but because the floods vary from year to year it was particularly difficult to assess definite flood level boundaries. Aerial photographs taken at the end of the flood period provided a reasonable estimate of the amount of flooding to be expected in one particular year.

Much of the land within the basins, which could be developed, is

CHAPTER 5

LAND CLASSIFICATION

5.1 Specifications

The objective of the survey was to produce a soil map and land class map delineating areas suitable for irrigation development.

The specifications were based on the U.S. Bureau of Reclamation standards for defining land classes. The U.S.B.R. criteria were modified, where necessary, to suit Sudanese conditions. The land classification maps, at scale 1:50,000, show land classes 1 to 6. It was decided to include class 5 due to the special conditions in the Northern Province. This deviates from the U.S.B.R. practice, where this class is used only in detailed surveys. However, in this survey, class 5 has been used to denote lands requiring special research and investigations over a wide range of subjects, including soils, agriculture, economics and engineering, before being considered for development.

5.2 Land Class Studies

The following is an outline of the U.S.B.R. definitions for each class and a discussion of the criteria used in class limitations. The specifications for each class are summarised in Table 5.2.

Classes 1, 2 and 3 are considered arable with progressively increasing limitations on their use and/or with increasing costs of reclamation and management. Class 4 includes lands which would be suited for special uses provided that further economic and engineering studies show them to be arable. Class 5 will require further detailed investigation, but this class has been introduced due to the extreme population pressure and the demonstrably irrigable nature of the land. Classes 2 to 6 are mapped with their subclasses but class 1 is not subdivided.

Areas subject to river flood have been delineated and indicated by the symbol F on the land class maps but because the floods vary from year to year it was particularly difficult to assess definite flood level boundaries. Aerial photographs taken at the end of the flood period provided a reasonable estimate of the amount of flooding to be expected in one particular year.

Much of the land within the basins, which could be developed, is

at present inundated during the flood period. In order to bring this land under controlled irrigation, additional engineering works will be required to exclude the flood waters. Where flood prevention proves to be impossible, the present land classes may require downgrading.

Class 1

Class 3 occurs mainly in the flood basins but occasionally along the levees. These lands are highly suitable for irrigation; they have deep open structured soils and are capable of producing sustained and relatively high yields of a wide range of climatically adapted crops. They are limited to lighter and medium textured soils from which, it is believed, any existing salinity will be easily removed by normal irrigation, without special treatment. For this reason a moderate degree of salinity is acceptable; apart from this the soils have no serious restrictive properties. Potentially, these lands have a relatively high repayment capacity. Generally, Class 1 land is situated on the levees of the basins and covers a total of 6,210 feddans. Most of this land is already under small private scheme irrigation.

Class 2

These are lands of moderate suitability for irrigation farming, being measurably lower than Class 1 in productive capacity, adapted to a somewhat narrower range of crops and are slightly more expensive to prepare for irrigation (especially as far as the Northern Province of the Sudan is concerned). These lands may have slightly restricted soil depths, they may be slightly saline, and either slightly coarser or finer textured than Class 1. They may possess slight accumulations of sand in the surface and a slight degree of surface irregularity. These lands occur within the basins behind the levees and are liable to flooding during High Nile. Further engineering studies are required for the additional embankments that will be necessary to prevent inundation. The Class 2 lands have an intermediate repayment capacity.

Class 3

The U.S.B.R. Manual considers Class 3 lands as suitable for irrigation development but approaching marginality. They are of distinctly restricted suitability because of more extreme deficiencies in the soil than described for Class 2 lands.

Class 3 lands may have uneven topography, moderate to high concentration of salines or restricted drainage. These limitations may be susceptible to correction but only at relatively high cost. The lands produce a yield level for normal fruit crops. These soils mainly occur along the River Atbara and in the Kelli Basin.

may have a sandy surface layer of less than 20 cm, which could be mixed with the profile by deep ploughing. In fact, this might improve the drainage capacity of the finer textured soils of this land class.

Class 3 occurs mainly in the flood basins but occasionally along the fringes of the area. Structure is particularly limiting in this latter location. Most Class 3 lands which are suitable for development are situated near the river. There are small isolated areas on the higher terraces, normally enclosed by large areas of land classes 5 and 6, which are not considered to be worth developing. The risks of farming Class 3 lands is greater than with the better classes of land, but under proper management their development should be economically feasible.

Class 4

Although the consultants believe these lands to be potentially arable, special limitations to the usage must be observed and in some cases they may require special practices. They may have an excessive, specific deficiency, or deficiencies, susceptible to correction at high cost, but are suitable for irrigation because of existing or contemplated intensive cropping such as for truck and fruits; or, they may have one or more excessive, non-correctable deficiencies thereby limiting their utility to meadow, pasture, orchard or other relatively permanent crops, but are capable of supporting a farm family and meeting water charges if operated in units of adequate size or in association with better lands. The deficiency may be inadequate drainage, excessive salt content requiring extensive leaching or an unfavourable position allowing periodic flooding.

Class 4 lands may have a range in repayment capacity greater than that for the associated arable lands. These lands may have a sandy surface horizon of less than 20 cm and this is probably the maximum depth for which deep ploughing is feasible. Further engineering and economic investigations are necessary before lands of this class can be developed.

Class 4O

Two categories have been included in Class 4. In Class 4O soils have been accepted which have rather coarse textured upper horizons and a considerable degree of topographical irregularity. The consultants consider that, under sprinkler irrigation, these soils will probably produce a yield level for normal fruit crops. These soils mainly occur along the River Atbara and in the Kelli Basin.

The other category of Class 4 includes a variety of soils, which may have no textural limitations and a high degree of alkalinity and salinity, and which may be shallow. Their special use would be date palm culture. In marginal cases these soils could be used for other crops, particularly when held with better quality land with which they can be irrigated at small extra cost. Class 4 includes, among its lighter textured components, lands suited to orchard crops, which could be developed by surface irrigation, since they lack the topographical restraints of Class 4O. It is classed as arable because of the acute shortage of better quality land.

Although it is possible for Class 4 lands to exhibit a better repayment capacity than higher classes under arable, in the present case this is unlikely to happen due to the fact that Class 4 contains lands of very marginal quality. Moreover, even where such lands are used for fruit or vegetable cultivation, Classes 1, 2 and 3 are equally or more suitable.

Class 5

Class 5 lands generally consist of the loamy and clayey soils of the higher basins and terraces in which the E.S.P., pH and/or the E.C. exceed the limits of the other classes. Some of the sites are slightly saline-alkali. Because of the shortage of good land however, Class 5 lands have been separated from Class 6 lands, for the purpose of further study to determine their arable potential. Unlike the Vertisols of the clay plains south of Khartoum, the Class 5 lands of the Northern Province include soils of much lighter texture, from which the salts could be leached. It is uncertain whether the high exchangeable sodium content could also be reduced to a safe level and this would have to be demonstrated by experimental work (or experimental farms) and pilot projects.

On the other hand Class 5 includes some fine textured saline and saline alkali soils which it will be extremely difficult to reclaim. In this present condition the Class 5 land is non-arable, and its final place must be decided by trial and experiments; further, the Consultants would stress the extreme variability of the soil, and the fact that uniform success in reclamation is unlikely. We believe that soils with loamy sand and possibly loamy textures, should reclaim fairly easily, but we do not feel justified in segregating this better type, consequently, a wide range of soils are included in this class. Class 5 occurs mainly North of the Kelli basins.

A detailed survey should be made in one or more areas within this class, in order to select a site for trials. The site should include a wide range of soils.

Class 6

Since even soils with very high salinities and the extreme range of alkali levels have been included in the non-arable Class 5, the soils of Class 6 land are characterised by the non-correctable limitations of extreme coarseness of texture, topography and profile shallowness.

Class 6 lands limited by topography occur mainly in the Kelli basin, where sand-dunes are the limiting feature, while soils restricted by profile shallowness are particularly frequent in the Wad bin Naga area.

There is one further point which the Consultants would raise in connection with Class 5 lands and to a lesser extent with Class 4. The irrigation water is of good quality with a very low SAR value and, in so far as this water passes through the soils, the changes in soil reaction and exchangeable sodium percentage will be favourable. At the same time the water is of low salinity and these favourable changes will take a long time.

The recommendations of this survey have been made on the assumption that the irrigation water will derive wholly from the Nile. There are a number of indications that groundwater may be present in exploitable quantities in the region and the Consultants suggest that a study should be made of the extent of this resource. For example, proven sources of groundwater would offer possibilities of alternative development in certain areas.

5.3 Areas of Land Classes

The total area mapped under each land class is shown in Table 5.1.

TABLE 5.1 Areas of Land Classes mapped

Land Class	Area (Feddans)
1	6,210
2	14,360
3	49,370
4	17,950
5	90,330
6	16,590
Total:	194,810

87890

5.4 Criteria

The values of the criteria used on the classification are given in Table 5.2, and are discussed briefly below.

(a) Soil Depth

The usual limiting layer is coarse sand, in a few instances in the Wad bin Naga area across the underlying structures are rock and caliche layers. In general this criteria has not been effective in many cases since the soils are in general deeper than 90 cm to sand.

(b) pH and E.S.P.

These criteria of alkali conditions have been applied separately even when both are available since the pH (paste) was measured only on pit samples. The alkali limits for the first three classes are the same, except in the second layer (45-90 cm) of Class 3.

The upper limits of the special use Class 4 lands are fixed at approximately the same levels as are used in the clay plains. However, the presence of lighter textured soils will, in many cases, reduce the seriousness of alkali conditions, or at least facilitate their more rapid alleviation.

(c) Texture

The use of two depths is necessary only because Class 4O accommodates soils with restricted upper soil textures overlying a deeper layer of any texture except sand.

Textures of Class 1 soils are restricted to those which we believe will facilitate the passage of water through the soil. Class 2 soils include a slightly wider range of textures, and soils of Class 3 may have any texture except sand.

(d) Profile characteristics

Extreme changes of texture within the profile are considered to be a limitation; for example we should regard 45 cm of sandy loam overlying 45 cm of clay to be a condition unacceptable in Class 2. Similarly clear evidence of poorly structured and compacted or cemented layers constitute a limitation. It will be noticed that Class 4O accepts a considerable degree of profile non-uniformity under conditions of special water control.

(e) Sand on surface

In a few instances, the soils have a surface layer of windblown sand. The Consultants' general rule has been to tolerate up to 20 cm of sand, since we believe this to be the maximum depth which, by deep ploughing, may be incorporated with the heavier textured soil beneath.

(f) Topography

Topographical limitations are of several kinds and range from very minor accumulations of sand through hard mounds and hummocks to high sand dunes. They include the surface channels which are discussed in page 8. In the case of Class 40 a considerable degree of surface irregularity is accepted because these lands are expected to be irrigated by Sprinklers.

5.5 Subclasses

The land classes are divided into subclasses on the basis of their specific limitations. For example Class 3 tk indicates land which fails to enter Class 2 because it has moderate topographical limitations combined with a soil depth of less than 60 cm. Class 3 tl has a similar topographic condition but has loamy sand in one of the two layers. Class 4a is land fulfilling all the conditions for Class 3 except that either the pH is greater than 8.5 or the E.S.P. is greater than 15 in the upper layer, or greater than 25 in the lower layer. Class 5 st has E.C.'s greater than 12 and topography which is also outside the range of Class 4.

The subclasses which have been mapped are described below:-

Class 2

Subclass 2h has textures finer than Class 1, but may not exceed an 30, in clay loam.

Subclass 2e consists of lands with limitations in structure, compaction and internal drainage.

Subclass 2t has topographical limitations, in the form of very shallow gullies.

Subclass 2a has E.S.P. values between 10 and 15 in the upper 45 cm.

Subclass 2ht has limitations in topography and has finer textures than Class 1.

Subclass 2he has limitations as described under 2h and 2e.

Class 3

Subclass 3 l consists of soils with coarser textures in the top 45 cm than Class 2 soils.

Subclass 3 h includes soils with all textures finer than Class 2 in the upper horizon as well as in the subsoil.

Subclass 3 e has moderate limitations in profile uniformity.

Subclass 3 t has topographical limitations, i.e. drainage channels and/or a few sand-dunes.

Subclass 3 a has E.S.P. values between 15 and 25 in the 45-90 cm zone.

Subclass 3 ht has limitations both in topography and due to fine textured soils.

Subclass 3 ae has limitations both in soil uniformity and in higher E.S.P. values in the subsoil.

Subclass 3 ah has limitations in higher E.S.P. values in the subsoil and finer textures than Class 2.

Subclass 3 hte has limitations in topography, texture, structure, compaction and internal drainage, as described above.

Subclass 3 aht has limitations in topography, texture and alkali content, as described above.

Class 4

Subclass 4 a has E.S.P. values less than 30 and greater than 15 in the upper 45 cm but greater than 25 in the subsoil.

In the few cases where the top 45 cm has very low E.S.P. values and in the 45-90 cm horizon E.S.P. values slightly higher than 30, sites have been classified as 4 a instead of 5 a.

Subclass 4 e has marked limitations in profile uniformity, structure and internal drainage.

Subclass 4 t has more pronounced topographical limitations than Class 3.

Subclass 4 al has E.S.P. values of greater than 15, but less than 30, in the top 45, and greater than 25 and less than 30 in the subsoil. In addition it possesses marked limitations in profile uniformity.

Subclass 4 at has limitations as described above.

Class 4O

Subclass 4 Olt have textures varying between loamy sand and light sandy loam; have E.S.P. values of less than 30 in the top 45 cm and E.C.'s of less than 12. These lands are usually hummocky.

Subclass 4 Ol have no topographical limitations but soils are coarse textured. Up to 50 cm of sand and over Nile Silt is permitted.

Class 5

Subclass 5 a has E.S.P. values of more than 30 throughout the profile.

Subclass 5 e has severe limitations in profile uniformity, internal drainage, compactness and structure.

Subclass 5 al has limitations as described above.

Subclass 5 at has limitations both in high E.S.P. values and in topography.

Subclass 5 as has limitations in E.S.P. values of more than 30 throughout the profile and has E.C.'s greater than 16 in the top and/or second horizons.

Subclass 5 ase has limitations in alkalinity, salinity and in internal drainage and poor structure, as described above.

Subclass 5 ate has topographical limitations and limitations a and e, as described above.

Class 6

Subclass 6 t has severe topographical limitations.

Subclass 6 k has limitations in depth, to gravel rock, caliche layer etc.

Subclass 6 at has limitations in topography and in alkalinity.

(E.S.P. values greater than 30).

As already explained in Chapter 3.5.3 the soil boundaries have been applied to delineate the land class boundaries, where they coincide. Where no coincidence of land class and soil class occurred, the land class boundaries were interpolated from the data on the individual sites.

The subclasses listed above have been used as mapping units. To avoid fragmentation of the mapping units it has been necessary to include a number of anomalous sites. Where this has been done the individual sites carry their subclass description on the maps. Anomalous sites can therefore be easily identified.

LAND CLASSIFICATION

TABLE 5.2

	CLASS 1	CLASS 2	CLASS 3	CLASS 4	CLASS 40	CLASS 5	CLASS 6	SYMBOL
Soil Depth	>90 cms	60-90 cms	45-60 cms	>45 cms	>45 cms	>45 cms	<45 cms	k
pH	<8.5	<8.5	<8.5	8.5-9.5	>8.5	Unlimiting	Unlimiting	
E.S.P.	<10	<15	<15	<30	<30	Unlimiting	Unlimiting	a
	<15	<15	15-25	<30				
E.C.	<4	<8	<12	<16	<12	Unlimiting	Unlimiting	s
	<12	Unlimited						
Dune sand on surface (less than 10% silt + clay)	None	<10 cms	<20 cms	<20 cms	<50 cm over Nile silt	Not limiting	Not limiting	u
Profile Uniformity								
i) structure	No limitations	Slight limitations	Moderate limitations	Marked limitation	Moderate limitation	Severe limitation	Not limiting	e
ii) compaction								
iii) internal drainage	Sandy loam	Loamy sand loam	Loamy sand and silt loam	Loamy sand and above to clay	Loamy sand light loam sandy loam	Unlimited except sand	Unlimiting	1* h*
0-45 cms	loam sandy clay loam silt loam	Silt clay loam silty clay loam	clay loam silty clay loam	Loam Sandy clay Clay				
Texture	Sandy loam	Sandy loam	Sandy clay	Sandy clay	Clay			

TABLE 5.2 (Cont.)

	CLASS 1	CLASS 2	CLASS 3	CLASS 4	CLASS 40	CLASS 5	CLASS 6	SYMBOL
45-90 cms	Sandy loam loam sandy clay loam silt loam	Loamy sand loam Sandy clay loam Silt clay loam silty clay loam Sandy loam	Heavier than 0-45 cms in classes 1 & 2 i.e. clay subsoil	Heavier than sand	Heavier than sand	Unlimited except sand	Unlimited	
Topography	No restrict	Slight restriction gullyng or sand ripple	Sand hummocks channels		Generally hummocky or elevated above surrounding area		Pure sand or rocks	t

* 1 and h apply to arable classes only.

6.2 Agronomy of Recommended Crops

CHAPTER 6

Considerable experience has been gained at Hudeiba in the agronomy of the principal crops of Northern Province, together with the

RECOMMENDATIONS

6.1 Introduction

The agricultural system of Northern Province has developed over a long period and is complex compared with the agriculture of the clay plains. Irrigable land is extremely scarce and even with intense cultivation, farm incomes are low. A primary object of development therefore should be to increase the irrigable land available to each cultivator and so raise his standard of living.

Before detailed recommendations on the development of the Shendi-Berber reach can be offered, further economic and engineering studies must be conducted. This chapter therefore constitutes an interim report, complementary to the pre-investment survey scheduled for 1966/67.

It has been previously stated (Chapter 2) that the people of Northern Province are conservative in their attitude to farming and rely to a large extent upon supplementary income received from migrant relatives. However, their ability in irrigation agriculture should not be under-estimated (Thornton 1964). All cultivators have a knowledge of irrigation, the communities are settled, considerable business experience is available through returning emigrants and the people have been in receipt of government aid for many years. These factors and also the fragmented nature of the land available for development suggest that the present agricultural system should be modified and expanded, rather than replaced by a new system.

In the short term significant increases in output could be obtained by a more widespread use of fertilisers, increasing mechanisation through co-operative ownership and the dissemination of the best traditional methods throughout the area (Heipko, 1966). However, such improvements are restricted by the absence of a fully operational extension service. Initially however, the distribution of seed from selected and uniform strains of local ("balladi") varieties of crops would be a more positive step towards increasing yields per feddan. As a result of trials currently being conducted at Hudeiba Research Station it is hoped to produce crop varieties which are better adapted to local conditions.

6.2 Agronomy of Recommended Crops

Considerable experience has been gained at Hudeiba in the agronomy of the principal crops of Northern Province, together with some which have been recommended for introduction (H. R. S. Reports 1964 and 1965; Heipko 1966). These will be discussed briefly, but further reference may be made to Chapter 6 in Report No. 8 of Roseires Soil Survey (1965) in which the climatically adapted crops of northern Sudan are discussed.

6.2.1 Wheat (*Triticum vulgare*)

A native bearded variety is grown exclusively; attempts to introduce higher yielding exotic varieties so far have been foiled by a lack of heat tolerance or greater susceptibility to bird damage. Termites appear to reduce yields of wheat north of Berber. Under local conditions yields are inversely related to temperature at heading-time; to maximise yields sowing should take place in the first week of November so that heading occurs at the coolest period of the year. Photo-period considerations limit wheat to the shitwi season. Exchangeable sodium appears to be the main soil limitation for wheat, the effects of which are magnified in the late sown crops. Although United States experience shows wheat to be tolerant of salinities of up to 10 mmhos per cm (U.S.D.A., 1954), the tolerance may be lower under Sudan conditions due to the higher transpiration rates. This may be overcome by rather more frequent waterings. Market conditions are favourable to the expansion of wheat production in Northern Province (see Report No. 8, Roseires Soil Survey).

6.2.2 Groundnuts (*Arachis hypogea*)

Apart from its cultivation as a vegetable and oil crop, considerable success has been obtained by growing groundnuts for confectionery, especially on the sandy soils of the Rubatab scheme north of Berber, where it is grown as a damira crop. The effects of leaching and deposition of fertile silt from the flood irrigation water during the darat are thought to contribute to the consistently high yields in this area. It is recommended that this enterprise should be extended to similar sandy sites within the Shendi area. Light textured soils are best suited to this crop, since they facilitate nodulation and harvesting. Investigations

are currently being conducted at Hudeiba to ascertain the effects of fertiliser treatments on quality and oil content. Groundnuts are moderately tolerant to soil salinity.

6.2.3 Ful masri (Vicia faba)

Northern Province is the principal area of the Sudan for the production of ful masri and it consequently occupies a strong market position. However, despite its present extensive cultivation, yields per feddan are poor. This is chiefly due to shedding and infection with powdery mildew (Erysiphe umbeliferum, E. polygani and Leveillula taurica), which reduce the yield per stem (Heipko, 1964). Ful masri will constitute an important crop in future developments, especially if a mildew resistant strain becomes available. This crop appears to favour medium textured silty soils and is moderately tolerant to soil salinity.

6.2.4 Fasulia (Phaseolus lunatus)

At present this is the chief cash crop, but due to its poor salinity tolerance it requires the best riverside loams. The present policy is to substitute groundnuts for fasulia.

6.2.5 Fodder crops

Maize (Zea mays), dura (Sorghum vulgare), berseem (Medicago sativa) and lubia (Dolichos lablab Linn) constitute the major fodder crops and provision must be made for their inclusion in future rotations. Cultivation of fodder crops is most important during the seif, when stock feedstuffs are at a premium. The present practice of allowing the damira crop to mature is to be encouraged. Whilst lubia and maize are moderately tolerant, dura has a higher degree of resistance to salinity and alkali.

6.2.6 Vegetables

The present system of farming is admirably suited to the production of a wide range of vegetables. Most vegetables are relatively tolerant to salinities between 3 and 10 mmhos per cm. Due to poor communications, access to the lucrative fresh vegetable markets of

Khartoum and Omdurman is restricted to the schemes in the Shendi District. Particularly high returns are recorded for producing onions which when dried yield a gross return of LS. 105.000 per feddan. (Thornton 1964). The profitability is dependent upon the availability of drying and storage facilities, but if these are increased, onion production is to be recommended.

6.2.7 Fruit

The rich silt lands bordering the Nile are eminently suitable for the growth of deep rooting trees. Citrus and mango plantations are at present situated throughout the area. Dates are restricted to the more northerly areas centred around el Bauga.

The establishment of an orchard is a lengthy process, but the returns per feddan are considerably greater than for other enterprises. So long as the subsistence element of the economy is dominant it will be unwise to have too high a proportion of fruit in relation to staple food crops. Also, fruit requires water at a time of the year when it is least plentiful. Consequently, for many years the Government has restricted the planting of fruit gardens, through the control of pumping licences. However, with the prospect of developing new land the expansion of fruit gardens should be encouraged. As with vegetables, the siting of gardens will be related to communications with the main markets.

The export potential of dates should be investigated with a view to expanding date production north of Berber similar to the Merowe Scheme: particular attention should be paid to the selection of high yielding trees and good management. Date palms possess a higher degree of salt tolerance than other fruit trees.

6.2.8 The introduction of new crops

Several new crops with reasonable market prospects have been proposed for introduction to Northern Province. These include safflower (Carthamus tinctorius), castor (Ricinus communis), kenaf (Hibiscus cannabinus) and barley (Hordeum vulgare). Only castor has proved feasible, but initial trials have shown that yields are depressed significantly by moderate salinity (Heipko et al 1965) and this will severely restrict its success in Northern Province. Furthermore

Most of the land classified as 1, 2 and 3 is situated in basins south of Khartoum, Salama and Wad Hamid basins and the northern part of the Khartoum basin. It is possible that undersowing with lubia may obviate the lack of fodder. However, with the expansion of irrigable land envisaged under the Roseires Project, castor is recommended for inclusion in the rotations of the larger schemes, where mechanical hullers may be justified. The initial trials have indicated that the silty soils of the Shendi district are most suitable for castor production.

Barley has been suggested for introduction with a view to supplying the Khartoum brewery, but further investigations are required. Barley is tolerant of high salinities, which commends it for Northern Province.

6.3 Land Classification and Crop Recommendations

The system of land classification has been described in Chapter 5. As was previously emphasised the land classes have been defined according to soil features, without reference to the engineering problems presented by the annual flood. However, flooded areas are shown with the symbol F on the land class map.

Class 1 land borders the river and is considered to be suitable for any of the crops recommended in the previous section. A great part of class 1 is at present irrigated by owners of small pumps. The further development of this land will depend, therefore, upon political decisions as to whether or not the existing schemes should be rationalised into larger units.

Most of the class 2 lands are suitable for a similar range of crops as class 1, but initial levelling will be necessary in 2t land, and the cultivation of castor, ful masri and fasulia will be restricted to the non-saline soils.

Soils in class 3 are to be recommended for development, with the provision that salt and alkali tolerant crops be grown. Barley, fodder crops and vegetables are the only crops likely to tolerate the salinities expected in class 4 lands, but further investigation of these lands is required prior to development.

Most of the land classified as 1, 2 and 3 is situated in basins south of Kitiab. Salawa and Wad Hamid basins and the northern section of the Kelli basin are areas most suitable for development. Other areas of land classes 2 and 3 occur further from the river or in small units, and although they would be suitable for irrigation per se, their location, often remote from the river and within sand dunes, and their small area will probably prevent their development on economic grounds. On the land capability map these lands have been classed as unsuitable for irrigation development.

Land classes 40lt and 40l are to be considered for the establishment of orchards and vegetables crops under sprinkler irrigation.

North of Kitiab and to the west of Basabir basin, land classes 5 and 6 become more prominent. Class 6 land is not recommended for development. It is recommended that class 5 land and the isolated areas of class 4 land which surround more feasible areas should be studied in greater detail with a possible view to establishing small forests. The costs of pumping make this uneconomic but forests may be justified on social grounds. These would supply the much needed firewood and also provide shade for the livestock. The land bordering the El Bauga scheme is mostly class 5 with high salinities and alkali content. These areas of class 5 land could be considered for an extension of date plantations, since these trees are adapted to salt-affected soil conditions. Although more research is required elsewhere classes 5 and 6 lands are normally associated with Aridisols and Psamments which are probably not suited to irrigation.

6.4 Agro-economic Recommendations

Profitability depends upon the efficient utilisation of the two scarcest resources, namely water and land. Both the cost of irrigation per feddan and the marginal output produced by it are considerations involved in the efficient use of water. A large marginal output from irrigated land can only be made with intensification of cropping.

Irrigation water is expensive in Northern Province, Thornton (1964) quotes a figure of 800 m/ms per feddan in contrast to 250 m/ms in the Gezira. With such high costs per watering it is evident that the net

reserve per watering must be maintained even higher. Under given economic conditions the soil fertility will become fundamental to the level of net revenue obtained through its effect on yields and the ability of the land to support intensive cultivation. Consequently it is doubtful whether, on economic grounds, the potential of class 4 lands is sufficient to justify its development. But social as well as economic considerations may arise and small areas of Class 2 lands north of the River Atbara at Kineidra could be developed to assist the local community.

Inevitably, cropping will have to be intensive, both in area and in time. A two year rotation is envisaged by the local agricultural authorities instead of the present three year one which is generally applied. Fallow should be reduced to the minimum necessary for crop hygiene. Shitwi crops are most economic since the cost of pumping is less than in the seif and furthermore, the temperatures are lower. The rotation would include shitwi groundnuts, lubia and ful masri, with fasulia or castor on the better soils; followed by seifi fodder crops and damira vegetables with dura and maize for fodder. Shitwi wheat would predominate in the second year, with similar seifi and damira crops or fallow. Onions would constitute an important shitwi and seifi cash crops.

Haplorhents of land class 4, lying adjacent to and west of the basins south of Kelli, and only marginally suitable for development, could be devoted to fodder crops in an effort to integrate livestock into the agricultural system, provided there is available water. Present animal numbers greatly exceed the food supplies available to them.

As road communications, marketing systems and extension services improve, the output of vegetables from the Shendi district will increase. Firstly however, the future of the vegetable market should be assessed. The feasibility of an onion factory and the implications of the completion of the Atbara - Port Sudan road also should be considered. Similarly, the future of local specialised crops should be studied, such as fennugreek and cummin which are produced in the Medisissa and Wad Hamid Basins.

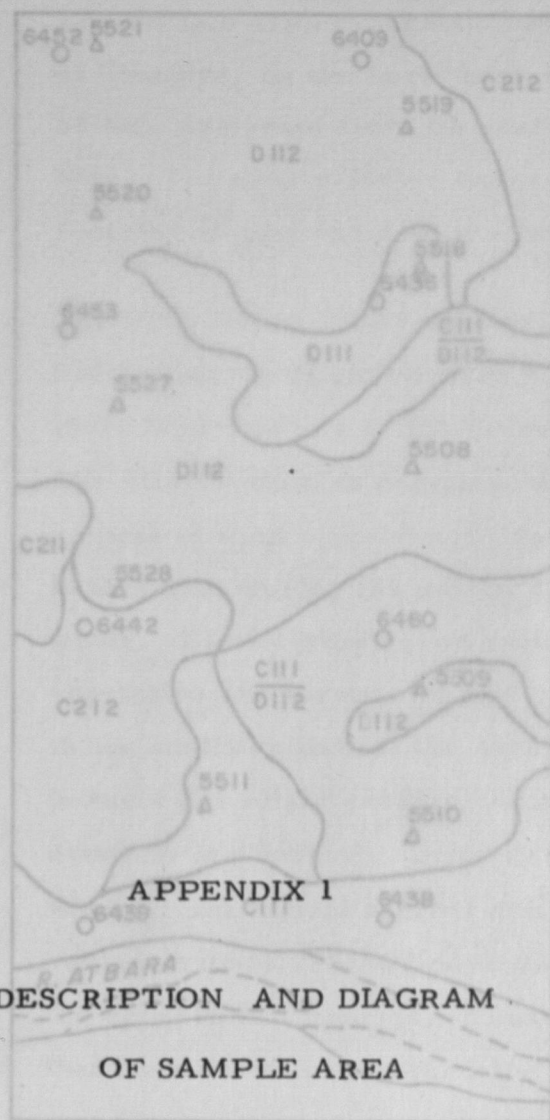
The ultimate choice of a programme of development is basically a political decision. Government schemes may not appear to be as

profitable as private companies, but a greater degree of control is afforded over development and cropping. The formation of co-operatives similar to those successfully introduced under the same conditions in the U.A.R. would unite the smaller cultivators with the minimum of family strife. Thornton (1964) does not consider that the possible resettlement of people should cause undue concern; the evacuation of people with similar attitudes from Wadi Halfa to Khashm el Girba, which constituted a far greater social upheaval, has met with reasonable success.

APPENDIX I
DESCRIPTION AND DIAGRAM
OF SAMPLE AREA

LEGEND

- 011 - Type 1 (approx. 10%)
 - 012 - Type 2 (approx. 10%)
 - 020 - Type 3 (approx. 20%)
 - 022 - Type 4 (approx. 20%)
 - 021 - Type 5 (approx. 20%)
 - 024 - Type 6 (approx. 20%)
 - 025 - Type 7 (approx. 20%)
- 030 - Type 8 (approx. 20%)
- 040 - Type 9 (approx. 20%)
- 050 - Type 10 (approx. 20%)
- 060 - Type 11 (approx. 20%)
- 070 - Type 12 (approx. 20%)



APPENDIX I
 DESCRIPTION AND DIAGRAM
 OF SAMPLE AREA

LEGEND

- CIII Typic Haploorthent : clay < 30 %
- CII2 Typic Haploorthent : clay > 30 %
- C2II Natrargidic Haploorthent : clay < 30 %
- C2I2 Natrargidic Haploorthent : clay > 30 %
- DIII Typic Natrargid : clay < 30 %
- DI2 Typic Natrargid : clay > 30 %
- CIII
DI2 Typic Haploorthent overlying Typic Natrargid

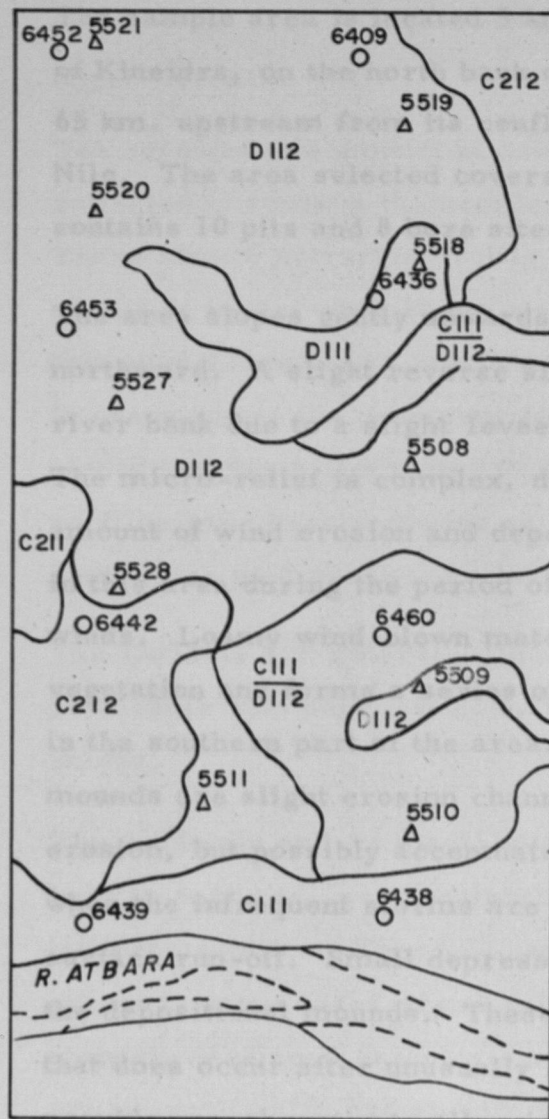
Map Compilation : Aerial Photographs

Location: Map Sheet

O 2 metre bore

Δ 2 metre pit

SCALE: Approx 1:25,000



LEGEND

- C111 Typic Haplorthent : clay < 30 %
- C112 Typic Haplorthent : clay > 30 %
- C211 Natrargidic Haplorthent : clay < 30 %
- C212 Natrargidic Haplorthent : clay > 30 %
- D111 Typic Natrargid : clay < 30 %
- D112 Typic Natrargid : clay > 30 %
- C111
D112 Typic Haplorthent overlying Typic Natrargid

Map Compilation : Aerial Photographs

Location: Map Sheet

○ 2 metre bore

△ 2 metre pit

SCALE : Approx 1:25,000

Location: The sample area is located 5 km. east of the village of Kineidra, on the north bank of the Atbara, some 65 km. upstream from its confluence with the main Nile. The area selected covers 6.6 sq.km., and contains 10 pits and 8 bore sites.

Topography The area slopes gently upwards from the river northward. A slight reverse slope occurs from the river bank due to a slight levee along the river edge. The micro-relief is complex, due to the considerable amount of wind erosion and deposition which occurs in this area during the period of prevailing northerly winds. Loamy wind-blown material is trapped by vegetation and forms a series of mounds, especially in the southern part of the area. Between these mounds are slight erosion channels due in part to wind erosion, but possibly accentuated by water erosion when the infrequent storms are large enough to allow surface run-off. Small depressions occur between the depositional mounds. These trap such little run-off that does occur after unusually large storms, and provide enough water to allow 'dura' to be grown.

Vegetation Tree and bush species are the only occurring vegetation forms in the area. On the light textured river-side soils the Dom palm (Hyphaene thebaica) predominates. Away from the river, the main occurring species are Salvadora persica, Capparis decidua and Calotropis procera, with a few scattered Acacia tortilis. These species stabilise wind-blown material to some extent.

Soils The soil pattern is fairly closely related to the physiography of the area. Light textured Entisols are found on the recent alluvial deposits along the river, with Aridisols on the older terrace material to the north. Aridisol/Entisol integrades occur on parent material which seems to be intermediate in both age and level

Plot: 5508

Location: Run B5 : Photo 155

Topography: between the recent, low river terrace and the old higher terrace.

Cultivation and Land Use: Nil

Vegetation: Capparis decidua
The considerable amount of aeolian deposition is reflected in some of the profiles on the older terrace.

Surface: Loose powdery surface; occasional gravel; few kankars.
These show a natrargid profile overlain by varying depths of recent wind-blown material. In some cases,

Profile description: this wind-blown cover reaches one metre in depth.

0-38 cm In cases where the overlying aeolian material is of significant depth and seems to be stabilised, the profiles have been regarded as bi-sequal with an Entisol top part overlying a lower Aridisol.

The Entisols are generally light textured, friable and permeable with very low E.C. values and low sodium values.

38-90 cm 10YR 4/3. Clay. Dry and hard; moderate medium sub-angular blocky; no cracks; occasional pores; moderately moisture absorbent; low permeability. They are generally poorly structured except in some cases where solid horizons possess a strongly developed granular structure. E.C. values

90-160 cm are generally high and sodium values very high. It is possible that some leaching of clay has occurred in the majority of the Aridisols.

160-200 cm moderately moisture absorbent; no roots; frequent gravel; frequent calcium carbonate concretions.

160-200 cm Moist 10YR 4/3. Sandy clay loam; dry and extremely hard; cemented; no structure; no cracks; occasional large pores; slowly moisture absorbent; no roots; common gravel; occasional calcium carbonate concretions.

Soil Classification: Typic Natrargid: Series D112

Land Classification: 5 as.

Pit:

5508

Location:

Run B5 : Photo 155

Topography:

Flat and level

Cultivation and Land Use:

Nil

Vegetation:

Capparis decidua

Surface:

Loose powdery surface; occasional gravel; few kankars.

Profile description:

0-38 cm

10YR 3/3. Clay loam to clay. Dry and hard; weak prismatic with moderate coarse angular blocky sub-structure and fine platy component; common cracks; common pores; moderately moisture absorbent; few roots; few kankars; few gravel mainly quartz; few calcium carbonate concretions; occasional quartz grains.

38-90 cm

10YR 4/3. Clay. Dry and hard; moderate medium sub-angular blocky; no cracks; occasional pores; moderately moisture absorbent; few roots; few kankars; common calcium carbonate concretions; few gravel.

90-160 cm

10YR 5/2. Sandy loam to sandy clay loam; dry and very hard, possibly cemented; no structure; no cracks; common large pores; moderately moisture absorbent; no roots; frequent gravel; frequent calcium carbonate concretions.

160-200 cm

Moist 10YR 4/3. Sandy clay loam; dry and extremely hard; cemented; no structure; no cracks; occasional large pores; slowly moisture absorbent; no roots; common gravel; occasional calcium carbonate concretions.

Soil Classification:

Typic Natrargid: Series D112

Land Classification:

5 ae.

Pit: 5509
Location: Run: 85. Photo: 155
Topography: Flat and level.
Cultivation and Land Use: Edge of formerly cultivated area, probably rain dura.
Vegetation: Hyphaene thebaica; Capparis decidua.
Surface: Soft powdery surface; few gravel and kankars; no cracks.
Profile Description:
 0- 80 cm 10YR 3/2. Silty clay loam. Dry and slightly hard; weak medium subangular blocky, with well developed platy substructure due to bedding; no cracks; occasional pores; rapidly moisture absorbent; occasional roots; frequent quartz grains; few mica flakes.
 80-120 cm 10YR 4/2. Silty clay. Moist and very firm; moderate medium angular blocky; few fine cracks; no pores; slowly moisture absorbent; no roots; few quartz grains; occasional small calcium carbonate concretions.
 120-190 cm 10YR 4/2. Clay loam. Slightly moist and firm; weak medium angular blocky; no cracks; no pores; moderately moisture absorbent; no roots; frequent quartz grains; few calcium carbonate concretions.
 190-200 cm 10YR 5/2. Gravelly sandy loam. Dry and hard, slightly cemented; no structure; some bands of clay; no cracks; occasional large pores; moderately moisture absorbent; no roots; frequent gravel, mainly quartz; frequent calcium carbonate diffuse and concretionary.
Soil Classification: Typic Haplorthent : Series C111
Soil Classification: Typic Natrargid. : Series D112
Land Classification: 5ae.

Pit: 5510

Location: Run: B5. Photo: 155

Topography: Flat and level. mounds due to trapping and wind
blown material by Dom palms.

Cultivation and
Land Use: Nil

Vegetation: Hyphaene thebaica; Capparis decidua.

Surface: Soft powdery surface; no cracks.

Profile Description: Loose powdery surface; few gravel; no cracks.

Profile Description:

0-30 cm 10YR 4/2. Silty clay loam. Dry and soft to loose;
0-20 cm very weak medium subangular blocky, with platiness
due to bedding (possibly wind deposited material);
no cracks; occasional pores; rapidly moisture
absorbent; occasional roots; frequent quartz roots;
grains. at fine quartz grains.

30-70 cm 10YR 4/2 - 4/3. Silty clay loam. Dry and slightly
hard; weak medium angular blocky; occasional
cracks; few pores; rapidly moisture absorbent; bent;
few roots; frequent quartz grains. ne quartz grains;

70-120 cm 10YR 4/2. Clay. Slightly moist and very firm;
120-200 cm few cracks; no pores; moderate coarse angular firm;
blocky; slowly moisture absorbent; no roots; few
occasional fine soft calcium carbonate concretions;
few quartz grains. rains; common fine calcium

120-165 cm 10YR 5/2. Gravelly sandy loam. Dry and hard;
Soil Classification: structureless; slightly cemented; moderately
Land Classification: moisture absorbent; no roots; abundant calcium
carbonate, both diffuse and concretionary; abundant
gypsum in surface of horizon; gravelly caliche
horizon.

165+ Red moderately fine grained sandstone rock; shows
much manganese staining.

Soil Classification: Typic Haplorthent / Typic Natrargid: C111
D112

Land Classification: 5a.

Pit: 5511

Location: Run: B5. Photo: 155

Topography: Flat and level; mounds due to trapping and wind blown material by Dom palms.

Cultivation and Land Use: Nil.

Vegetation: Hyphaene thebaica.

Surface: Loose powdery surface; few gravel; no cracks.

Profile Description:

0-20 cm	10YR 4/2 - 3/3. Clay loam. Dry and soft; weak medium angular blocky with moderate platy sub-structure; possibly wind deposited; no cracks; few pores; rapidly moisture absorbent; few roots; frequent fine quartz grains.
20-120 cm	10YR 4/2 - 7.5YR 4/2. Silty clay loam. Dry and slightly hard; weak coarse angular blocky; few cracks; common pores; rapidly moisture absorbent; few roots; common to frequent fine quartz grains; few calcium carbonate concretions.
120-200 cm	7.5YR 4/2. Clay loam. Slightly moist and very firm; moderate coarse angular blocky; no cracks; few pores; moderately moisture absorbent; few roots; common quartz grains; common fine calcium carbonate concretions.

Soil Classification: Typic Haplorthent : Series C111

Land Classification: 2h

Pit: 5518
Location: Run: B9. Photo: 203
Topography: Flat, nearly level.
Cultivation and Land Use: Nil. Near graveyard.
Vegetation: Capparis decidua; few Acacia raddiana.
Surface: Powdery surface; frequent gravel; few kankars; no cracks. mounds due to material trapped around Capparis decidua clumps.
Profile Description:
Profile Description:
0-10 cm 10YR 4/2 - 4/3. Sandy loam. Dry and loose; wind blown surface material; rapidly moisture absorbent; common roots; common gravel; frequent quartz grains.
0-16 cm
10-80 cm 10YR 4/2. Sandy loam; dry and hard; structureless; no cracks; occasional pores; rapidly moisture absorbent; occasional to common roots near surface, decreasing rapidly downwards; abundant gravel of very mixed origin, with high proportion of quartz; frequent fine quartz grains; frequent large, soft calcium carbonate concretions. occasional calcium carbonate concretions and gypsum crystals.
16-36 cm
80-115 cm 10YR 4/2. Gravelly sandy loam. Dry and very hard; structureless; slightly cemented; no cracks; common pores; moderately moisture absorbent; no roots; abundant fine gravel; common calcium carbonate concretions; abundant quartz grains. fine kankars; occasional calcium carbonate concretions; abundant gypsum; few quartz grains.
36-110 cm
115-200 cm 10YR 4/2. Sandy loam. Dry and hard; cemented; weak platy structure due to bedding; no cracks; few pores; moderately moisture absorbent; no roots; common quartz grains; common calcium carbonate, both diffuse and concretionary; few gravel. occasional patches of clay - probably evidence of former faunal activity.
Soil Classification: Typic Natrargid. Series D111
Land Classification: 401
Soil Classification: Typic Natrargid : Series D112
Land Classification: 5ae

Pit: 5520
5519

Location: Run: B9. Photo: 203

Topography: Flat and level.

Cultivation and Land Use: Nil

Vegetation: Capparis decidua.

Surface: Common kankars; powdery surface; no cracks; few gravel; mounds due to material trapped around Capparis decidua clumps.

Profile Description:

0-16 cm 10YR 4/3 - 3/4. Sandy clay loam. Dry and very hard; weak coarse prismatic with moderate coarse angular blocky substructure; common cracks; few pores; moderately moisture absorbent; rapidity; occasional kankars; gravel and quartz grains.

16-36 cm 10YR 4/2. Silty clay loam. Dry and slightly hard; 10YR 4/2. Clay loam to clay. Dry and very hard; weak to moderate coarse angular blocky; occasional fine cracks; few pores; moderately moisture absorbent; occasional roots; occasional kankars; few quartz grains; few kankars; occasional calcium carbonate concretions and gypsum crystals.

36-110 cm 10YR 4/2. Silty clay. Dry and hard; very strong medium to fine subangular blocky with weak to moderate platy component; no cracks; few pores; moderately moisture absorbent; no roots; occasional fine kankars; occasional calcium carbonate concretions; abundant gypsum; few quartz grains.

110-200 cm 10YR 4/3. Loamy sand. Dry and hard; slightly cemented; very weak coarse angular blocky; strong bedding; no cracks; frequent quartz grains; occasional patches of clay - probably evidence of former faunal activity.

Soil Classification: Typic Natrargid : Series D112

Land Classification: 5a

Soil Classification: Typic Natrargid : Series D112

Land Classification: 5ae

Pit: 5520
Location: Run: B9. Photo: 203
Topography: Flat and level.
Cultivation and Land Use: Nil.
Vegetation: Capparis decidua.
Surface: Thin soft crust on powdery surface; no cracks; occasional kankars.

Profile Description:

Profile Description:
 0-20 cm 10YR 4/2 - 3/3. Sandy clay loam. Dry and very hard; weak coarse prismatic with moderate coarse angular blocky substructure; common cracks; few pores; moderately moisture absorbent; common roots; occasional kankars; few gravel and quartz grains.
 20-55 cm 10YR 4/2. Silty clay loam. Dry and slightly hard; very strong fine subangular blocky to granular; no cracks; no pores; moderately moisture absorbent; few roots; occasional kankars; abundant gypsum; few calcium carbonate concretions.
 55-125 cm 10YR 4/2 Clay loam. Dry and very hard; moderate medium subangular blocky; no cracks - occasional pores; moderately to slowly moisture absorbent; no roots; few to occasional kankars; few calcium carbonate concretions; occasional gypsum; 5 cm caliche layer at base.
 125-200 cm 10YR 4/3. Sandy loam to loamy sand. Dry and very hard; cemented; weak coarse angular blocky; bedded; no cracks; common pores; rapidly moisture absorbent; no roots; abundant quartz grains. common diffuse calcium carbonate carbonate concretions; occasional gypsum.

Soil Classification: Typic Natrargid: Series D112

Land Classification: 5a.

Soil Classification: Typic Natrargid: Series D112

Land Classification: 3ase.

Pit: 5521

Location: Run: B9. Photo: 203

Topography: Flat and level.

Cultivation and Land Use: Nil.

Vegetation: Capparis decidua.

Surface: Thin soft crust on powdery mulch; frequent kankars; occasional shells; few gravel.

Profile Description:

0-15 cm	10YR 4/3. Clay loam. Dry and slightly hard; moderate to strong medium to fine subangular blocky; no cracks; occasional pores; rapidly moisture absorbent; few roots; occasional kankars and quartz grains.
15-30 cm	10YR 4/2 - 2.5Y 4/2. Clay. Dry and slightly hard; strong granular to fine subangular blocky; no cracks; few pores; moderately moisture absorbent; no roots; occasional kankars; common gypsum; few quartz grains.
30-90 cm	10YR 4/2 - 2.5Y 4/2. Clay. Dry and very hard; moderate coarse angular blocky with weak to moderate wedge component; occasional cracks; few pores; moderately moisture absorbent; no roots; occasional kankars; common to occasional gypsum; few calcium carbonate concretions; cleavage faces shiny.
90-165 cm	10YR 4/3. Clay to clay loam. Dry and very hard; moderate to strong coarse to medium angular blocky; no cracks; few pores; moderately moisture absorbent; no roots; occasional kankars; frequent calcium carbonate concretions; occasional gypsum.
165-200 cm	10YR 4/3. Silty clay. Dry and very hard; moderate coarse platy to moderate medium angular blocky; no cracks; few pores; moderately moisture absorbent; no roots; few kankars; frequent calcium carbonate concretions; common manganese stains along structure planes.

Soil Classification: Typic Natrargid: Series D112

Land Classification: 5ase.

Pit: 5527 . .

Location: Run: B9. Photo: 203

Topography: Flat and level, possibly depressional

Cultivation and Land Use: Nil.

Vegetation: Acacia raddiana; Hyphaene thebaica; Capparis decidua.

Surface: Loose powdery surface; occasional fine kankars; no cracks; few gravel. trapped around bushes.

Profile Description:

0-16 cm	10YR 4/2 - 4/3. Clay. Dry and soft to loose; weak to moderate platy, probably due to wind deposition; rapidly moisture absorbent; frequent roots; occasional kankars; common fine quartz grains; few gravel.
16-45 cm	10YR 4/3 - 3/3. Clay to clay loam. Dry and hard to very hard; weak to moderate medium prismatic with moderate coarse angular blocky structure; common fine cracks; few pores; moderately moisture absorbent; occasional roots; few to occasional kankars; occasional fine calcium carbonate concretions; occasional gypsum.
45-100 cm	10YR 4/3 - 10YR 5/6; very strongly mottled with 10YR 5/6 as dominant mottling colour. Sandy clay loam to sandy clay; grittiness due to calcium carbonate concretions. Dry and very hard; moderate to strong medium angular and subangular blocky; no cracks; few pores; slowly to moderately moisture absorbent; no roots; few kankars; frequent to abundant calcium carbonate concretions, both soft and hard.
100-200 cm	7.5YR 4/2; common 10YR 5/6 mottles. Sandy clay loam to sandy clay. Dry and hard; moderate to strong subangular blocky; no cracks; no pores; slowly to moderately moisture absorbent; no roots; frequent calcium carbonate concretions, both soft and hard.

Soil Classification: Typic Natrargid : Series D112

Land Classification: 5a

Soil Classification: Typic Natrargid : Series D112

Land Classification: 5 ae.

Pit: 5528

Location: Run: B9. Photo: 203

Topography: Flat, perhaps slight S.W. slope

Cultivation and Land Use: Nil.

Vegetation: Acacia ehrenbergiana; A. raddiana; Capparis decidua.

Surface: Soft powdery top; few kankars; no cracks; mounds due to wind blown material trapped around bushes.

Profile Description:

0-26 cm	10YR 4/3 - 3/3. Clay. Dry and hard; moderate coarse angular blocky with weak to moderate platy sub-structure; occasional to common cracks; few pores; moderately moisture absorbent; occasional roots; few to occasional kankars; occasional quartz grains.
26-55 cm	10YR 4/3. Loam. Dry and hard; moderate to strong medium to fine angular blocky; no cracks; few pores; moderately moisture absorbent; few roots; few kankars; common to frequent soft calcium carbonate concretions and calcium streaks; occasional gypsum.
55-115 cm	10YR 4/2. Sandy clay loam. Dry and hard; moderate medium angular blocky; no cracks; few pores; moderately moisture absorbent; no roots; few kankars; abundant calcium carbonate concretions, both soft and hard; few gypsum crystals; common manganese.
115-200 cm	10YR 4/2. Clay loam. Dry and very hard; weak coarse angular blocky to moderate granular; no cracks; no pores; moderately moisture absorbent; no roots; few kankars; abundant calcium carbonate concretions; common manganese stains.

Soil Classification: Typic Natrargid : Series D112

Land Classification: 5a

2.1 METHODS OF ANALYSIS

1. Mechanical Analysis

One hundred millilitres of five per cent sodium hexameta-phosphate solution and 100 ml of water were added to 40 grams of soil. The mixture was allowed to stand overnight then agitated for ten minutes by high speed electric stirrer. The suspension was then filtered into a one litre measuring cylinder; the residue was retained in one litre and the contents shaken by closing the cylinder and inverting several times. The density of the supernatant was measured at reading intervals of four minutes, two hours and seven hours. The temperature was recorded at the same time and cover was made for temperature and dispersing agent content.

APPENDIX 2

SERIES, DESCRIPTIONS AND ANALYSES

of silt plus clay in the soil sample and the seven hour reading gave the concentration of clay. Sand was calculated by difference.

The two hour reading was taken solely to check that the clay fraction was completely dispersed. Samples which showed a large difference in density between the two and seven hour reading were repeated using more dispersing agent.

The coarse sand fraction was measured on a separate soil sample by the wet sieving technique.

2. pH

The pH of the saturation paste or a 1:5 soil-water suspension was measured potentiometrically using a glass electrode.

3. Electrical Conductivity

The conductance of the saturation extract was measured using a conductivity bridge.

4. Total Nitrogen

A Kjeldahl digestion was followed by distillation of the freed ammonia into boric acid solution and subsequent titration against

standard acid. METHODS OF ANALYSIS carried out on the semi-micro scale.

1. Mechanical Analysis

5. Or One hundred millilitres of five per cent sodium hexameta-phosphate solution and 100 ml. of water were added to 40 grams of soil. The mixture was stirred, allowed to stand overnight then agitated for ten minutes in a high speed electric stirrer. The suspension was then transferred to a one litre measuring cylinder, the volume was adjusted to one litre and the contents shaken by covering the cylinder and inverting several times. The density of the suspension was measured at settling intervals of four minutes, two hours and seven hours. The temperature was recorded at the same time and corrections made for temperature and dispersing agent content.

The four minute reading gave the concentration of silt plus clay in the soil sample and the seven hour reading gave the concentration of clay. Sand was calculated by difference.

The two hour reading was taken solely to check that the clay fraction was adequately dispersed. Samples which showed a large difference in density between the two and seven hour reading were repeated using more dispersing agent.

The coarse sand fraction was measured on a separate soil sample by the wet sieving technique.

2. pH

The pH of the saturation paste or a 1:5 soil-water suspension was measured potentiometrically using a glass electrode.

3. Electrical Conductivity

The conductance of the saturation extract was measured using a conductivity bridge.

An aliquot was titrated against standard sodium versenate using Eriochrome Black T indicator, and a second aliquot was titrated against sodium versenate using Murexide indicator.

4. Total Nitrogen

A Kjeldahl digestion was followed by distillation of the freed ammonia into boric acid solution and subsequent titration against standard acid. The entire procedure was carried out on the semi-micro scale.

5. Organic Carbon

The wet oxidation method of Walkley and Black was used. The organic matter content was calculated assuming that only 77 per cent of the total organic carbon was recovered.

6. Total Extractable Phosphorus

Constant boiling hydrochloric acid was added to a sample of the soil and the mixture gently boiled for one hour. The mixture was filtered and the filtrate made up to a known volume with distilled water. An aliquot was taken and the yellow vanadomolybdophosphoric colour developed and read at a wavelength of 470 m μ .

7. Total Extractable Potassium

An aliquot of the solution obtained by digestion with constant boiling hydrochloric acid was suitably diluted and measured on the flame photometer.

8. Total Free Carbonate

An excess of standard hydrochloric acid was added to the soil, the mixture was boiled for five minutes, cooled, filtered and the remaining acid was backtitrated against standard alkali. The total carbonate in the soil was expressed as per cent Calcium Carbonate.

9. Analysis of the Saturation Extract

The saturation soil paste was prepared, allowed to stand for two hours then subjected to suction. The various soluble ions in the saturation extract were determined as follows:

(a) Calcium and Magnesium

An aliquot was titrated against standard sodium versenate using Eriochrome Black T indicator, and a second aliquot was titrated against sodium versenate using Murexide indicator.

(b) Sodium and Potassium

The potassium was determined directly on the saturation extract using the flame photometer. Sodium was determined on the flame photometer using suitably diluted solutions.

(c) Carbonate and Bicarbonate

An aliquot was titrated against standard acid using phenolphthalein indicator and the titration continued using methyl orange indicator.

(d) Chloride

An aliquot was titrated against standard silver nitrate solution using five per cent potassium chromate solution as indicator.

(e) Sulphate

The sulphate in an aliquot was precipitated by adding standard barium chloride solution and titrating the excess barium in solution against sodium versenate using Eriochrome Black T. When the end point was reached an aliquot of standard magnesium solution was added and the titration continued to the new end point.

10. Determination of Exchangeable Cations

The exchangeable cations were measured by shaking the soil for one hour with normal ammonium acetate adjusted to a pH of 8.4 using ammonium hydroxide.

(a) Sodium and Potassium

Flame photometric determination on the filtrate.

(b) Calcium and Magnesium

An aliquot was evaporated to dryness, redissolved in a mixture of concentrated nitric and hydrochloric acids, evaporated again and finally dissolved in a volume of water equal to the original aliquot.

Calcium and magnesium were determined by titration against standard sodium versenate.

11. Cation Exchange Capacity

The soil was shaken three times with normal sodium acetate solution, washed three times with isopropyl alcohol and the adsorbed sodium displaced by ammonium acetate. The displaced sodium concentration was measured on the flame photometer.

2.2 DESCRIPTIONS AND
ANALYSES

Pit: 2061
Location: Run D17. Photo: 089
Topography: Uneven. Sand dunes.
Cultivation and Land use: None.
Vegetation: Abundant Panicum tergidum.
Surface: Few kankars. Loose quartz sand.
Profile Description:

0-53 cm 7.5YR 4/4. Loamy sand. Dry loose structureless common pores; rapidly moisture absorbent; common long roots.
53-78 cm 4.5YR 6/3. Loamy sand. Dry loose structureless common pores; rapidly moisture absorbent; common long roots; few mica.
78-103 cm 4.5YR 4/6. Sandy loam; dry soft structureless; common pores; rapidly moisture absorbent; common long roots; some manganese nodules? and
103-128 cm 5YR 4/6. Very sparse soft calcium
128-153 cm 5YR 4/6. Very sparse soft calcium
153-178 cm 5YR 4/6. Very sparse soft calcium
178-203 cm 5YR 4/6. Very sparse soft calcium

2.2 DESCRIPTIONS AND ANALYSES

203-228 cm 5YR 4/6. Very sparse soft calcium
228-253 cm 5YR 4/6. Very sparse soft calcium
253-278 cm 5YR 4/6. Very sparse soft calcium
278-303 cm 5YR 4/6. Very sparse soft calcium

Pit: 2061
Location: Run D17. Photo: 089
Topography: Uneven. Sand dunes.
Cultivation and Land use: None.
Vegetation: Abundant Panicum turgidum.
Surface: Few kankars. Loose quartz sand.

Profile Description:

0- 53 cm	7.5YR 4/4. Loamy sand. Dry loose structureless; common pores; rapidly moisture absorbent; common long roots.
53- 78 cm	10YR 4/3. Loamy sand. Dry loose structureless; common pores; rapidly moisture absorbent; common long roots; few mica.
78-171 cm	10YR 4/3. Sandy loam; dry soft structureless; common pores; rapidly moisture absorbent; at 100-120 cm some manganese mottles? and few mottles 5YR 4/6. Very sparse soft calcium carbonate concretions. Few mica. Few roots up to 100 cm.
171-200 cm	10YR 5/4. Loamy sand. Dry loose structureless; rapidly moisture absorbent; few mica.

Soil Classification: Typic Quartzipsamment: Series C221

Land Classification: 6

Pit No.	Depth in case	Soil Particles %	
		Sand	Coarse Silt
2061	0-75	67	25
	75-171	40	40
	171-200	76	20

Pit No.	Depth in cms	Soil Particles %			pH 1:5	pH Paste	E.C. mmhos/cm	Sat %	Sol. Na Meq/100g Soil	Exch. Na Meq/100g Soil	Total Ext. Na Meq/100g Soil	C.E.C.	E.S.P.	
		Sand	Silt	Clay										
														Coarse
2061	0-78	47	40	2	11	9.30	8.65	0.30	23	0.06	1.1	1.2	8	14
	78-171	40	40	1	19	9.77	8.72	7.20	32	3.12	Nil	2.8	22	Nil
	171-200	36	49	1	14	9.75	8.85	1.14	26	0.25	2.5	2.8	11	23

Pit: 2106
Location: Run D10. Photo: 155
Topography: Uneven and sand dunes.
Cultivation and Land Use: Nil.
Vegetation: Sparse Acacia tortilis; common Panicum turgidum.
Surface: Loose quartz sand.

Profile Description:

0-150 cm	10YR 4/4. Fine to medium sand. First 40 cm . dry loose and slightly moist loose, structureless with sparse pores. Rapidly moisture absorbent. Few fine gravel. Common fine roots up to 40 cm, after this few fine roots.
150-200 cm	10YR 4/3. - 4/4. Slightly loamy sand. Slightly moist loose, structureless with common pores. Rapidly moisture absorbent. Few fine gravel. Few fine Calcium carbonate streaks. Few big roots.

Soil Classification: Typic Quartzipsamment: Series C222

Land Classification: 6

Pit No.	Depth in cms	Soil Particles %			pH 1:5	pH Paste	E.C. mmhos/cm	Sat %	Sol. Na Meq/100g Soil	Exch. Na Meq/100g Soil	Total Ext. Na Meq/100g Soil	C.E.C.	E.S.P.
		Sand	Silt	Clay									
2106	0-150	64	29	5	9.6	8.9	0.33	204	0.1	1.5	1.6	6	25
	150-200	-	24	28	10.20	9.3	0.66	192	0.15	2.3	2.4	16	14

Land Classification: 5a

Pit: 2562

Location: Run D11 : Photo 155

Topography: Flat and level; occasional slight hummocks.

Cultivation and Land Use: Grazed bare

Vegetation: *Capparis decidua*; *Acacia tortillis* var. *raddiana*

Surface: Thin broken raincrust; 4 cm loose powdery sub-surface; frequent sink holes and 2-10 cm cracks.

Profile description:

0-45 cm	10YR4/2 clay. Dry and extremely hard; strong, very coarse blocky; platy substructure; rapidly water absorbent; occasional 1-2 cm vertical cracks; rare pores; rare fine roots; rare kankars; frequent fine sand pockets.
45-75 cm	10YR3/3 - 7.5YR4/2 clay. Dry and hard; moderate medium wedge; weak fine slickensides; frequent fine fissures; slowly water absorbent; rare roots; frequent gypsum efflorescences along fissures; rare vein of fine sand.

75-115 cm	10YR4/3 fine sandy clay; rare fine mottles. Moist and friable; weak medium blocky to structureless; moderately water absorbent; abundant pores; rare roots; common pockets gypsum crystals; occasional diffuse white calcium carbonate; frequent fine quartz.
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200-300 cm	in bore.
115-300 cm	10YR5/4 - 10YR4/2 clay to fine sandy clay; frequent faint medium mottling. Moist and firm, becoming slightly wet and plastic below 250 cm; moderate to fine blocky; slowly water absorbent; rare fine fissures; no roots; occasional sand veins; rare manganese stains; occasional vertical white calcium carbonate concretions; rare kankars.

Soil Classification: Typic Natrargid: Series D112

Land Classification: 5a .

LABORATORY ANALYSIS SITE No. 2562

Depth (cm)	Soil particles %				Incorp. Carbonate	pH	
	Coarse sand 2.0-0.2 mm.	Fine sand 0.2-0.02 mm.	Silt 0.02-0.002 mm.	Clay under 0.002 mm.		Soil Paste	1:5 suspension
0-45	9	30	19	42	5.6	8.2	9.5
45-75	9	25	19	47	8.7	7.5	8.2
75-115	14	27	19	40	13.3	8.1	9.7
115-200	9	30	16	45	9.0	9.0	10.1

Sat. %	E.C. mmhos cm Sat. Ext	Total Nitrogen %	Total Org. Carbon %	Total Extractable	
				Phosphorus Mg/100g. soil	Potassium Mg/100g. soil
53	3.5	0.033	0.29	74	290
49	83.0	0.010	0.12	80	310
57	13.0	0.010	0.06	62	320
89	3.5	0.010	0.06	77	370

Depth (cm)	Soluble Anions m.e./litre				Soluble Cations m.e./litre			
	CO ₃	HCO ₃	Cl	SO ₄	Na	K	Ca	Mg
0-45	-	3.00	17.30	14.60	28.64	0.17	2.18	1.10
45-75	-	1.80	960.00	25.54	682.00	1.14	225.00	83.00
75-115	-	3.00	36.35	101.00	122.00	0.32	12.48	4.80
115-200	-	3.60	13.95	16.45	31.68	0.13	0.89	0.93

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch. Na	E.S.P.	Exchange Capacity Meq/100g.soil
	Na	K	Ca	Mg			
0-45	9.34	0.69	24.34	4.10	10.86	23	40
45-75	17.00	0.50	31.32	3.18	60.42	40	42
75-115	16.67	0.52	22.77	3.85	23.62	48	35
115-200	28.44	0.69	11.20	4.03	31.26	84	34

Pit: 2650
Location: Run D11 : Photo 207
Topography: Flat and level, close to steep gravel rise to west.
Cultivation and Land Use: Adjacent to irrigated Phaseolus lunatus
Vegetation: Cassia senna
Surface: Loose dry dusty surface; fine cracking under irrigation

Profile description:

0-40 cm 7.5YR4/4 - 10YR4/2; loam. Dry and slightly hard; structureless to weak platy near surface; rapidly water absorbent; common fine roots; abundant quartz sand and gravel; silt banding.

40-70 cm 10YR5/4; coarse sand. Dry and slightly hard; structureless to weak blocky; common coarse pores; rapidly water absorbent; frequent fine roots; frequent 2-5 cm calcium carbonate concretions; occasional weathered rock; abundant white calcium carbonate powder.

70-150 cm 10YR7/3; coarse sand. Moist and friable; structureless; part-weathered rock; rapidly water absorbent; rare roots; abundant white calcium carbonate.

150-200 cm Rock rubble; red sandstone (Nubian) weathered along horizontal bedding.

Soil Classification: Typic Calciorthid : Series D121

Land Classification: 2 h.

Depth (cm)	Cation Exchange Capacity				Sol. Exch. Na	E.S.P.	Exchange Capacity Meq/100g-soil
	Ca	Mg	K	Na			
0-40	0.25	0.57	17.66	2.48	0.28	1	20
40-70	0.25	0.47	16.31	2.39	0.28	1	23
70-150	0.30	0.35	13.61	4.08	0.35	1	22

LABORATORY ANALYSIS SITE No. 2650

Depth (cm)	Soil particles %				Incorp. Carbonate	pH	
	Coarse sand 2.0-0.2 mm.	Fine sand 0.2-0.02 mm.	Silt 0.02-0.002 mm.	Clay under 0.002 mm.		Soil Paste	1:5 suspension
0-40	32	34	12	22	10.4	7.6	8.6
40-70	29	29	10	22	12.2	7.8	8.9
70-150	30	28	15	27	22.9	7.8	8.8

Sat. %	E.C. mmhos cm Sat. Ext	Total Nitrogen %	Total Org. Carbon %	Total Extractable	
				Phosphorus Mg/100g. soil	Potassium Mg/100g. soil
29	0.9	0.037	0.26	74	240
32	0.6	0.014	0.13	20	100
33	0.7	0.014	0.10	14	60

Depth (cm)	Soluble Anions m.e./litre				Soluble Cations m.e./litre			
	CO ₃	HCO ₃	Cl	SO ₄	Na	K	Ca	Mg
0-40	-	3.70	1.55	3.61	1.08	0.40	5.20	2.43
40-70	-	3.50	1.15	2.01	1.08	0.38	3.37	2.03
70-150	-	4.10	1.95	1.08	1.41	0.37	2.97	2.38

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch Na	E.S.P.	Exchange Capacity Meq/100g.soil
	Na	K	Ca	Mg			
0-40	0.25	0.57	17.66	2.48	0.28	1	20
40-70	0.25	0.47	16.51	2.59	0.28	1	23
70-150	0.30	0.35	13.61	4.08	0.35	1	22

Pit: ANALYSIS 3496

Location: Run B5 : Photo 081

Topography: Flat level

Cultivation and Land Use: Desert Bush

Vegetation: Acacia raddiana
Maerua crassifolia

Surface: Loose blown sand mulch with common medium kankers.

Profile description :

0-16 cm 10YR3/4; sandy clay. Dry and hard; moderate sub-angular blocky; fine vertical cracks; rapidly moisture absorbent; common medium kankers; rare fine calcium carbonate concretions; rare medium quartz grains.

16-183 cm 10YR3/4 - 3/3; sandy clay. Dry and hard to dry and loose; weak medium sub-angular blocky; rapidly moisture absorbent; frequent diffuse calcium carbonate; frequent coarse calcium carbonate concretions.

183-200 cm 10YR4/3 - 3/3; sandy. Dry and loose; single grain; rapidly moisture absorbent; rare fine calcium carbonate concretions.

Soil Classification: Typic Natrargid : Series D111

Land Classification: 5as.

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch Na	E.S.P.	Exchange Capacity Meq/100g. soil
	Na	K	Ca	Mg			
0-16	2.44	0.37	10.62	8.41	3.06	11	22
16-183	14.95	0.31	19.07	3.12	20.84	50	30
183-200	13.52	0.18	9.46	5.39	14.24	45	30

LABORATORY ANALYSIS

SITE No. 3496

Depth (cm)	Soil particles %				Incorp. Carbonate	pH	
	Coarse sand 2.0-0.2 mm.	Fine sand 0.2-0.02 mm.	Silt 0.02-0.002 mm.	Clay under 0.002 mm.		Soil Paste	1:5 suspension
0-16	28	34	14	24	12.1	8.3	9.4
16-183	21	29	21	29	10.5	8.2	9.5
183-200	15	61	12	12	4.4	8.5	9.8

Sat. %	E.C. mmhos cm Sat. Ext	Total Nitrogen %	Total Org. Carbon %	Total Extractable	
				Phosphorus Mg/100g. soil	Potassium Mg/100g. soil
24	3.8	0.015	0.11	45	140
43	12.0	0.010	0.06	62	190
30	5.2	0.010	0.06	50	100

Depth (cm)	Soluble Anions m.e./litre				Soluble Cations m.e./litre			
	CO ₃	HCO ₃	Cl	SO ₄	Na	K	Ca	Mg
0-16	-	3.70	20.70	10.81	26.04	0.21	5.59	3.25
16-183	-	3.50	27.60	126.58	137.00	0.18	12.52	7.98
183-200	-	3.70	20.85	28.68	47.76	0.08	1.44	1.54

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch Na	E.S.P.	Exchange Capacity Meq/100g. soil
	Na	K	Ca	Mg			
0-16	2.44	0.37	10.62	8.41	3.06	11	22
16-183	14.95	0.31	19.07	3.11	20.84	50	30
183-200	13.52	0.18	9.46	5.39	14.24	45	30

Pit: 3579

Location: Run D11. Photo 214

Topography: Flat and level, dissected by drainage channels.

Cultivation and Land Use: Cleared Scrub.

Vegetation: Acacia seyal, Acacia albida, Ziziphus spina-christi,
Indigofera oblongifolia, Demostachya bipinnata.

Surface: Coarse granular mulch.

Profile Description:

0- 65 cm 10YR 4/3 - 3/3. Silty clay; dry and hard; strong coarse angular blocky with strong medium platy component; deep wide cracks and fine pores; rapidly moisture absorbent; few bush roots; rare fine quartz grains; rare fine shell fragments;

65-175 cm 10YR 3/2. Silty clay; moist and very firm; moderate medium angular blocky with weak slickensides; moderately moisture absorbent; mica; rare fine calcium carbonate concretions; rare kankars.

175-210 cm 10YR 5/2 - 4/2. Silty clay loam; moist and very firm; weak medium angular blocky; slowly moisture absorbent; sand in layers; mica; manganese stains; common calcium carbonate concretions.

200-300 cm From bore.

210-300 cm 10YR 5/3 - 5/4. Sand, moist and loose; no visible structure; rapidly moisture absorbent; some mica.

Soil Classification: Typic Grumustert: Series A111

Land Classification: 3ht.

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch Na	E.S.P.	Exchange Capacity Meq/100g soil
	Na	K	Ca	Mg			
0-65	1.37	2.37	33.91	8.18	1.39	7	38
65-175	4.23	2.14	30.17	10.48	5.30	7	48
175-200	5.48	0.73	24.72	8.14	7.23	10	37

LABORATORY ANALYSIS SITE No. 3579

4467

Depth (cm)	Soil particles %				Incorp. Carbonate	pH	
	Coarse sand 2.0-0.2 mm.	Fine sand 0.2-0.02 mm.	Silt 0.02-0.002 mm.	Clay under 0.002 mm.		Soil Paste	1:5 suspension
0-65	4	12	24	60	4.9	8.0	8.9
65-175	8	15	25	52	5.1	7.9	9.0
175-200	8	36	18	38	6.1	8.0	9.3

Sat. %	E.C. mmhos cm Sat. Ext	Total Nitrogen %	Total Org. Carbon %	Total Extractable	
				Phosphorus Mg/100g. soil	Potassium Mg/100g. soil
59	0.7	0.045	0.40	104	450
61	2.5	0.047	0.35	100	440
62	2.7	0.029	0.25	74	340

Depth (cm)	Soluble Anions m.e./litre				Soluble Cations m.e./litre			
	CO ₃	HCO ₃	Cl	SO ₄	Na	K	Ca	Mg
0-65	-	2.60	1.20	3.88	1.95	0.21	3.02	1.32
65-175	-	3.20	4.25	22.03	17.58	0.28	7.28	4.34
175-200	-	3.90	5.40	19.95	21.70	0.17	4.06	2.71

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch. Na	E.S.P.	Exchange Capacity Meq/100g.soil
	Na	K	Ca	Mg			
0-65	1.27	1.37	33.91	8.18	1.39	3	38
65-175	4.23	1.14	30.17	10.48	5.30	9	48
175-200	5.88	0.73	24.72	8.14	7.23	16	37

Pit: 4467

Location: Run D10. Photo: 153

Topography: Flat and level, but sand accumulation around bushes.

Cultivation and Land Use: Bare ground.

Vegetation: Acacia seyal and Capparis decidua.

Surface: 2 cm of loose, loamy, coarse sand.

Profile Description:

0- 35 cm 10YR 4/4. Loamy coarse sand to sand. Dry and slightly hard; structureless; rapidly moisture absorbent; fine roots and hair roots common; no salts or unweathered minerals.

35- 75 cm 10YR 3/3. Coarse sandy loam. Dry and very hard; weak, medium to coarse angular blocky structure; rapidly moisture absorbent; occasional fine roots and hair roots to 40 cm; single large tree root at 40 cm; common, fine, soft calcium carbonate concretions.

75-180 cm 10YR 4/3. Silty clay. Dry and very hard; structureless; moderately moisture absorbent; common kankars of less than 0.8 cm diameter.

180-200 cm 10YR 4/1.5. Clay. Moist and very firm; structureless; moderately moisture absorbent; abundant hard calcium carbonate concretions.

Soil Classification: Typic Haplorthent. Series: C111.

Land Classification: 401.

Depth (cm)	Exchangeable Cations m.e. %				Sol-Zinc Na	E.S.P.	Exchange Capacity Meq/100g soil
	Na	K	Ca	Mg			
0-35	0.73	0.41	16.38	1.56	0.28	2	18
35-75	1.62	0.40	15.71	1.27	1.81	8	21
75-180	5.02	0.45	15.18	1.35	8.27	27	22
180-200	13.93	0.55	17.58	1.79	17.36	35	40

LABORATORY ANALYSIS SITE No. 4467

Depth (cm)	Soil particles %				Incorp. Carbonate	pH	
	Coarse sand 2.0-0.2 mm.	Fine sand 0.2-0.02 mm.	Silt 0.02-0.002 mm.	Clay under 0.002 mm.		Soil Paste	1:5 suspension
0-35	45	35	7	13	4.0	8.5	9.5
35-75	27	43	12	18	3.8	8.3	9.6
75-180	18	34	16	32	6.3	8.5	10.0
180-200	13	17	22	48	10.2	8.3	9.8

Sat. %	E.C. mmhos cm Sat. Ext	Total Nitrogen %	Total Org. Carbon %	Total Extractable	
				Phosphorus Mg/100g. soil	Potassium Mg/100g. soil
20	0.7	0.015	0.10	34	160
24	1.0	0.015	0.10	42	260
30	1.1	0.010	0.07	59	280
59	5.2	0.015	0.10	80	490

Depth (cm)	Soluble Anions m.e./litre				Soluble Cations m.e./litre			
	CO ₃	HCO ₃	Cl	SO ₄	Na	K	Ca	Mg
0.35	-	3.10	1.55	3.71	2.39	0.35	3.12	1.48
35-75	-	4.60	2.00	4.54	8.03	0.14	1.44	0.58
75-180	-	4.30	5.39	2.19	8.46	0.09	1.24	0.78
180-200	-	4.20	24.95	28.41	58.16	0.18	2.72	1.57

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch Na	E.S.P.	Exchange Capacity Meq/100g. soil
	Na	K	Ca	Mg			
0-35	0.23	0.41	10.00	1.86	0.28	2	10
35-75	1.62	0.48	15.71	3.89	1.81	8	21
75-180	6.02	0.45	15.14	2.89	6.27	27	22
180-200	13.93	0.85	17.58	5.79	17.36	35	40

Pit: 4488
Location: Run: D10. Photo: 115
Topography: Flat and level.
Cultivation and Land Use: Nil.
Vegetation: Acacia seyal.
Surface: 3 cm of coarse, loose mulch.

Profile Description:

Depth (cm)	Soil Description
0-50 cm	10YR 3.5/2. Sandy clay loam. Dry and hard to moist and firm at 15 cm; small (0.5 cm) cracks to 10 cm depth forming moderate, very coarse prismatic structure with a substructure of moderate medium angular blocky which extends to the boundary of the horizon; rapidly moisture absorbent; no roots; common quartz grains.
50-115 cm	10YR 3.5/2. Clay. Moist and very firm; weak medium to coarse angular blocky structure; slowly moisture absorbent; common quartz grains.
115-165 cm	10YR 4/3 with common, medium distinct mottles of 7.5 YR 5/6. Silty clay. Moist and friable; structureless; moderately moisture absorbent; occasional, soft, black inclusions of less than 1 sq cm area possibly of manganese; white efflorescence, probably of salt.
165-200 cm	10YR 4/2.5. Silt. Moist and very friable; structureless, but with many fine pores; rapidly moisture absorbent; no roots.

Soil Classification: Natrargidic Haplorthent: Series C212

Land Classification: 5ase.

Depth (cm)	Exchangeable Cations m.e. %				Sol-Exch Na	E.S.P.	Exchange Capacity Meq/100g. soil
	Na	K	Ca	Mg			
0-50	36.98	0.68	12.08	2.00	54.26	77	48
50-115	38.37	0.29	8.87	3.57	41.74	98	39
115-165	38.13	0.22	11.66	2.09	40.35	85	45
165-200	27.93	0.15	10.83	3.32	39.21	75	37

LABORATORY ANALYSIS SITE No. 4488

Depth (cm)	Soil particles %				Incorp. Carbonate	pH	
	Coarse sand 2.0-0.2 mm.	Fine sand 0.2-0.02 mm.	Silt 0.02-0.002 mm.	Clay under 0.002 mm.		Soil Paste	1:5 suspension
0-50	13	20	29	38	8.9	9.3	10.0
50-115	8	12	22	58	10.5	9.7	10.2
115-165	8	32	30	30	11.8	9.2	10.2
165-200	12	48	17	23	6.1	9.1	10.0

Sat. %	E.C. mmhos cm Sat. Ext	Total Nitrogen %	Total Org. Carbon %	Total Extractable	
				Phosphorus Mg/100g. soil	Potassium Mg/100g. soil
53	26.9	0.028	0.20	74	360
86	3.9	0.010	0.09	71	360
70	3.5	0.010	0.06	77	285
44	2.9	0.010	0.06	74	230

Depth (cm)	Soluble Anions m.e./litre				Soluble Cations m.e./litre			
	CO ₃	HCO ₃	Cl	SO ₄	Na	K	Ca	Mg
0-50	1.30	5.00	73.80	251.00	326.00	0.38	4.38	0.52
50-115	3.10	6.60	11.40	17.45	36.90	0.10	0.83	0.72
115-165	2.40	6.50	11.10	12.97	31.68	0.05	0.63	0.61
165-200	3.40	7.20	8.65	11.73	29.08	0.03	0.37	0.20

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch. Na	E.S.P.	Exchange Capacity Meq/100g.soil
	Na	K	Ca	Mg			
0-50	36.98	0.66	12.08	2.00	54.26	77	48
50-115	38.37	0.29	8.87	3.57	41.74	98	39
115-165	38.13	0.22	11.66	2.09	40.35	85	45
165-200	27.93	0.15	10.83	3.32	29.21	75	37

Pit: 4557
Location: Run: D10. Photo: 038
Topography: Flat and level.

LABORATORY ANALYSIS

SITE No 4557

Cultivation and Land Use: Nil.

Vegetation: *Capparis decidua*.

Surface: Fine cracked raincrust on firm surface horizon.

Profile Description:

Depth (cm)	0-15	15-35	35-200	Soil description
	0-15 cm	15-35 cm	35-200 cm	10YR 4/3.5 . Clay. Dry and slightly hard; weak, medium angular blocky structure; rapidly moisture absorbent; common fine roots; common fine quartz grains up to 5 mm diameter.

15-35 cm 10YR 4/3. Loamy coarse sand. Dry and hard; granular; rapidly moisture absorbent; common fine roots; many stones of less than 5 cm diameter.

Sat. %	E.C. mmhos/cm	Total Nitrogen %	Soil description
35	0.5	0.024	10YR 8/1 chalk fraction; 10YR 5/3 soil fraction. Stony, loamy sand and massive chalk. Dry and extremely hard; structureless; rapidly moisture absorbent; bands of large stones at 100 cm and 160 cm; horizon almost all massive calcium carbonate.
26	0.4	0.015	
27	0.6	0.010	

Soil Classification: Typic Calciorthid: Series D121

Land Classification: 3e.

Depth (cm)	Soluble Anions m.e./litre				Soluble Cations m.e./litre			
	CO ₃	HCO ₃	Cl	SO ₄	Na	K	Ca	Mg
0-15	-	3.00	1.00	1.71	0.65	0.21	3.17	0.97
15-35	-	2.50	1.47	0.50	0.76	0.17	2.57	0.97
35-200	-	2.50	2.21	2.15	1.41	0.15	3.07	2.23

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch Na	E.S.P.	Exchange Capacity Meq/100g. soil
	Na	K	Ca	Mg			
0-15	0.33	0.85	27.03	2.45	0.35	1	38
15-35	0.33	0.57	21.98	2.01	0.35	2	21
35-200	0.31	0.26	16.54	2.07	0.35	2	18

Pit:

Location:

Run: 85. Photo: 155

Topography:

Flat and level.

LABORATORY ANALYSIS

SITE No. 4557

Land Use:

Edge of formerly cultivated area, probably rain

Depth (cm)	Soil particles %				Incorp. Carbonate	pH	
	Coarse sand 2.0-0.2 mm.	Fine sand 0.2-0.02 mm.	Silt 0.02-0.002 mm.	Clay under 0.002 mm.		Soil Paste	1:5 suspension
0-15	18	18	27	37	3.8	8.1	9.0
15-35	17	55	8	20	2.8	8.4	9.2
35-200	41	20	18	21	25.0	8.5	9.3

Sat. %	E.C. mmhos cm Sat. Ext	Total Nitrogen %	Total Org. Carbon %	Total Extractable	
				Phosphorus Mg/100g. soil	Potassium Mg/100g. soil
35	0.5	0.024	0.16	62	380
26	0.4	0.015	0.10	31	230
27	0.6	0.010	0.06	26	110

Depth (cm)	Soluble Anions m.e./litre				Soluble Cations m.e./litre			
	CO ₃	HCO ₃	Cl	SO ₄	Na	K	Ca	Mg
0-15	-	3.00	1.00	1.71	0.65	0.21	3.17	0.97
15-35	-	2.50	1.47	0.50	0.76	0.17	2.57	0.97
35-200	-	2.50	2.21	2.15	1.41	0.15	3.07	2.23

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch Na	E.S.P.	Exchange Capacity Meq/100g. soil
	Na	K	Ca	Mg			
0-15	0.33	0.85	27.03	2.45	0.35	1	38
15-35	0.33	0.57	21.98	2.01	0.35	2	21
35-200	0.31	0.26	16.54	2.07	0.35	2	18

Pit: 5509
Location: Run: 85. Photo: 155
Topography: Flat and level.

Cultivation and Land Use: Edge of formerly cultivated area, probably rain dura.

Vegetation: Hyphaene thebaica; Capparis decidua.

Surface: Soft powdery surface; few gravel and kankars; no cracks.

Profile Description:

0-80	0-80 cm	10YR 3/2. Silty clay loam. Dry and slightly hard; weak medium subangular blocky, with well developed platy substructure due to bedding; occasional cracks; common pores; rapidly moisture absorbent; few roots; common fine quartz grains; few mica flakes.
80-120	80-120 cm	10YR 4/2. Silty clay. Moist and very firm; moderate medium angular blocky; few fine cracks; no pores; slowly moisture absorbent; no roots; few quartz grains; occasional small calcium carbonate concretions.
120-190	120-190 cm	10YR 4/2. Clay loam. Slightly moist and firm; weak medium angular blocky; no cracks; no pores; moderately moisture absorbent; no roots; frequent quartz grains; few calcium carbonate concretions.
190-200	190-200 cm	10YR 5/2. Gravelly sandy loam. Dry and hard, slightly cemented; no structure; some bands of clay; no cracks; occasional large pores; moderately moisture absorbent; no roots; frequent gravel, mainly quartz; frequent calcium carbonate diffuse and concretionary.

Soil Classification: Typic Haplorthent : Series C111
Typic Natrargid. D112

Land Classification: 5ae.

Depth (cm)	Ca	Mg	Na	K	Exchange Capacity
0-80	37.64	7.54	4.32	7	56
80-120	22.70	4.79	21.87	34	53
120-190	15.18	2.64	40.96	60	62

Pit: 5520

Location: Run: B9. Photo: 203

LABORATORY ANALYSIS

SITE No. 5509

Depth (cm)	Soil particles %				Incorp. Carbonate	pH	
	Coarse sand 2.0-0.2 mm.	Fine sand 0.2-0.02 mm.	Silt 0.02-0.002 mm.	Clay under 0.002 mm.		Soil Paste	1:5 suspension
0-80	3	8	57	32	8.7	8.2	9.3
80-120	2	11	43	44	8.8	8.3	9.6
120-190	4	28	31	37	8.7	8.6	10.1

Sat. %	E.C. mmhos cm Sat. Ext	Total Nitrogen %	Total Org. Carbon %	Total Extractable	
				Phosphorus Mg/100g. soil	Potassium Mg/100g. soil
48	1.3	0.045	0.36	101	240
61	5.8	0.030	0.27	107	190
55	6.4	0.010	0.06	85	140

Depth (cm)	Soluble Anions m.e./litre				Soluble Cations m.e./litre			
	CO ₃	HCO ₃	Cl	SO ₄	Na	K	Ca	Mg
0-80	-	4.00	3.15	4.10	8.68	0.11	2.03	1.15
80-120	-	3.40	7.30	41.55	50.36	0.10	3.27	1.63
120-190	-	3.50	8.95	53.07	66.84	0.08	1.44	1.24

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch. Na	E.S.P.	Exchange Capacity Meq/100g.soil
	Na	K	Ca	Mg			
0-80	3.84	0.67	37.64	7.54	4.32	7	56
80-120	18.14	0.41	22.70	4.79	21.87	34	53
120-190	37.08	0.28	15.18	2.64	40.96	60	62

Pit: 5520
Location: Run: B9. Photo: 203
Topography: Flat and level.

Cultivation and Land Use: Nil.

Vegetation: Capparis decidua.

Surface: Thin soft crust on powdery surface; no cracks; occasional kankars.

Profile Description:

0-20	0-20 cm	10YR 4/2 - 3/3. Sandy clay loam. Dry and very hard; weak coarse prismatic with moderate coarse angular blocky substructure; common cracks; few pores; moderately moisture absorbent; common roots; occasional kankars; few gravel and quartz grains.
20-55	20-55 cm	10YR 4/2. Silty clay loam. Dry and slightly hard; very strong fine subangular blocky to granular; no cracks; no pores; moderately moisture absorbent; few roots; occasional kankars; abundant gypsum; few calcium carbonate concretions.
55-125	55-125 cm	10YR 4/2 Clay loam. Dry and very hard; moderate medium subangular blocky; no cracks- occasional pores; moderately to slowly moisture absorbent; no roots; few to occasional kankars; few calcium carbonate concretions; occasional gypsum; 5 cm caliche layer at base.
125-200	125-200 cm	10YR 4/3. Sandy loam to loamy sand. Dry and very hard; cemented; weak coarse angular blocky; bedded; no cracks; common pores; rapidly moisture absorbent; no roots; abundant quartz grains. common diffuse calcium carbonate.

Soil Classification: Typic Natrargid: Series D112

Depth (cm)	Exchangeable Cations m.e. %				Sol-Exch Na	C.E.C.	Exchange Capacity Meq/100g. soil
	Na	K	Ca	Mg			
0-20	6.60	0.60	20.05	4.28	8.69	22	30
20-55	27.00	0.62	25.40	1.13	41.00	56	48
55-125	16.74	0.62	23.92	5.02	24.90	35	48
125-200	6.24	0.20	10.50	0.76	8.08	39	16

LABORATORY ANALYSIS SITE No. 5520

Depth (cm)	Soil particles %				Incorp. Carbonate	pH	
	Coarse sand 2.0-0.2 mm.	Fine sand 0.2-0.02 mm.	Silt 0.02-0.002 mm.	Clay under 0.002 mm.		Soil Paste	1:5 suspension
0-20	14	32	21	33	10.0	8.6	9.9
20-55	6	10	45	39	11.1	8.5	9.3
55-125	8	15	42	35	11.1	8.2	9.4
125-200	17	64	6	13	6.8	8.9	10.0

Sat. %	E.C. mmhos cm Sat. Ext	Total Nitrogen %	Total Org. Carbon %	Total Extractable	
				Phosphorus Mg/100g. soil	Potassium Mg/100g. soil
54	4.2	0.010	0.07	74	210
56	21.6	0.010	0.12	107	260
53	13.5	0.020	0.14	97	270
42	4.3	0.010	0.06	29	70

Depth (cm)	Soluble Anions m.e./litre				Soluble Cations m.e./litre			
	CO ₃	HCO ₃	Cl	SO ₄	Na	K	Ca	Mg
0-20	0.90	3.15	16.25	22.20	38.62	0.17	3.13	1.10
20-55	-	4.00	71.70	203.00	250.00	0.43	23.28	4.66
55-125	-	4.20	97.80	50.37	135.00	0.26	13.99	5.08
125-200	1.00	4.10	15.90	21.19	43.84	0.08	1.77	0.50

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch. Na	E.S.P.	Exchange Capacity Meq/100g. soil
	Na	K	Ca	Mg			
0-20	6.60	0.60	20.05	4.28	8.69	22	30
20-55	27.00	0.62	25.40	1.13	41.00	56	48
55-125	16.74	0.62	23.92	5.02	24.90	35	48
125-200	6.24	0.20	10.50	0.76	8.08	39	16

LABORATORY ANALYSIS SITE No. 5589

Depth (cm)	Soil particles %				Incorp. Carbonate	pH	
	Coarse sand 2.0-0.2 mm.	Fine sand 0.2-0.02 mm.	Silt 0.02-0.002 mm.	Clay under 0.002 mm.		Soil Paste	1:5 suspension
0-45	1	7	49	43	5.4	8.1	8.8
45-160	1	12	32	55	4.7	7.9	8.7
160-200	5	47	16	32	3.5	8.2	9.0

Sat. %	E.C. mmhos cm Sat. Ext	Total Nitrogen %	Total Org. Carbon %	Total Extractable	
				Phosphorus Mg/100g. soil	Potassium Mg/100g. soil
56	0.8	0.087	0.77	93	390
61	0.4	0.054	0.39	130	500
41	0.4	0.018	0.21	92	320

Depth (cm)	Soluble Anions m.e./litre				Soluble Cations m.e./litre			
	CO ₃	HCO ₃	Cl	SO ₄	Na	K	Ca	Mg
0-45	-	2.60	2.15	3.78	1.08	0.24	4.90	1.82
45-160	-	2.20	0.98	1.32	0.98	0.14	2.03	1.35
160-200	-	3.00	1.47	0.37	1.74	0.17	1.49	1.44

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch. Na	E.S.P.	Exchange Capacity Meq/100g. soil
	Na	K	Ca	Mg			
0-45	0.64	1.16	32.12	6.61	0.70	1	46
45-160	0.64	1.30	36.87	9.35	0.70	1	52
160-200	0.56	0.65	18.36	3.78	0.63	2	25

Pit: 5589

Location: Run: D10. Photo: 131

Topography: Flat and level

Cultivation and Land Use: Nil.

Vegetation: Ziziphus spina-christi.

Surface: Loose, slightly granular surface; no cracks.

Profile Description:

Surface: Loose sandy surface; no cracks.

0-45 cm 10YR 4/2 - 3/2. Silty clay. Dry and slightly hard; weak to moderate medium to fine subangular blocky with very weak platy component; few to occasional fine cracks; occasional pores; rapidly moisture absorbent; occasional to common roots; few fine quartz grains; occasional mica.

0-70 cm 10YR 4/3. Sandy clay loam. Dry and slightly hard; weak coarse angular blocky; no cracks; occasional pores; rapidly moisture absorbent; few roots; abundant quartz grains.

45-160 cm 10YR 3/2. Clay. Slightly moist and firm; moderate coarse angular blocky with moderate wedge; occasional slickensides; occasional cracks; moderately moisture absorbent; few roots along cracks; few to occasional mica flakes; few fine nodules.

200-300 cm in bore.

160-300 cm 10YR 3/2 - 4/2. Sandy clay loam. Dry and slightly hard; weak coarse angular blocky; no cracks; common pores; rapidly moisture absorbent; no roots; occasional to common mica; frequent fine quartz grains.

280-300 cm 10YR 5/3. Clay loam. Dry and hard; moderate coarse angular blocky; no cracks; few pores; moderately moisture absorbent; no roots; few fine quartz grains; frequent calcium carbonate, both diffuse and concretionary.

Soil Classification: Typic Haplorthent : Series C112

Land Classification: 3h

Soil Classification: Typic Haplorthent : Series C111

Land Classification: 40lt

LABORATORY ANALYSIS ST 5592

Location: Run: D10. Photo: 162

Topography: Flat and level; slightly moundy.

Depth (cm)	<u>Cultivation and Land Use:</u>	Nil.	Clay	Incorp. Carbonate	Soil Paste	1:5 suspension
0-70	<u>Vegetation:</u>	0.02	under			
70-160	<u>Surface:</u>	27			8.2	9.3
160-190	<u>Profile Description:</u>	25		3.5	8.1	9.2
	0-70 cm	32	33	12.5	8.1	8.9

10YR 4/3. Sandy clay loam. Dry and slightly hard; weak coarse angular blocky; no cracks; occasional pores; rapidly moisture absorbent; few roots; abundant quartz grains.

Sat. %	70-160 cm	Total Nitrogen %	10YR 4/3. Sandy clay loam. Dry and hard; weak to moderate coarse angular blocky; no cracks; occasional pores; rapidly moisture absorbent; few roots; abundant quartz grains; occasional fine calcium carbonate concretions.
22	0.7	0.013	
23	0.6	0.01	
44	0.8	0.026	200-300 cm in bore.

160-280 cm 10YR 5/3. Clay loam. Dry and hard; moderate coarse angular blocky; no cracks; few pores; moderately moisture absorbent; no roots;

Depth (cm)	Soluble Anions	CO ₃	HCO ₃	10YR 5/3. Clay loam. Dry and hard; rapidly moisture absorbent; no roots; few quartz grains; occasional calcium carbonate concretions.
0-70	280-300 cm	2.20	2.40	
70-160		-	2.40	
160-190		-	2.60	

Soil Classification: Typic Haplorthent : Series C111

Land Classification: 40lt

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch Na	B.S.P.	Exchange Capacity Meq/100g. soil
	Na	K	Ca	Mg			
0-70	0.52	0.67	15.44	3.85	0.63	3	18
70-160	0.24	0.43	14.47	2.56	0.28	1	19
160-190	0.55	0.82	20.71	11.63	0.63	2	26

LABORATORY ANALYSIS SITE No. 5592

Depth (cm)	Soil particles %				Incorp. Carbonate	pH	
	Coarse sand 2.0-0.2 mm.	Fine sand 0.2-0.02 mm.	Silt 0.02-0.002 mm.	Clay under 0.002 mm.		Soil Paste	1:5 suspension
0-70	43	27	9	21	2.8	8.2	9.3
70-160	47	25	8	20	3.5	8.1	9.2
160-190	21	14	32	33	12.5	8.1	8.9

Sat. %	E.C. mmhos cm Sat. Ext	Total Nitrogen %	Total Org. Carbon %	Total Extractable	
				Phosphorus Mg/100g. soil	Potassium Mg/100g. soil
22	0.7	0.013	0.09	50	270
23	0.6	0.010	0.10	45	295
44	0.8	0.026	0.17	53	330

Depth (cm)	Soluble Anions m.e./litre				Soluble Cations m.e./litre			
	CO ₃	HCO ₃	Cl	SO ₄	Na	K	Ca	Mg
0-70	-	2.20	1.76	3.22	3.26	0.28	2.67	0.97
70-160	-	2.40	2.55	1.67	1.63	0.34	3.17	1.48
160-190	-	2.60	3.66	0.84	2.48	0.29	3.66	1.67

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch. Na	E.S.P.	Exchange Capacity Meq/100g. soil
	Na	K	Ca	Mg			
0-70	0.52	0.67	15.44	3.85	0.63	3	18
70-160	0.24	0.43	14.47	2.56	0.28	1	19
160-190	0.55	0.82	20.71	11.63	0.63	2	36

LABORATORY ANALYSIS SITE No. 5608

Pit: 5608

Location: Soil pit Run D11 : Photo 248

Topography: Flat and level

Cultivation and Land Use: Nil

Vegetation: Capparis decidua

Surface: Loose powdery top; occasional moderate cracks; slightly pitted; few shells.

Profile description:

0-45 cm 10YR4/3; silty clay. Dry and hard; moderate to strong coarse to medium angular blocky structure with moderate platy component;

occasional moderate cracks; occasional pores; moderately to rapidly moisture absorbent; occasional roots in upper part of horizon; few quartz grains; occasional mica; few shells.

45-130 cm 10YR4/3 - 3/3; silty to clay. Slightly moist and very firm; weak coarse angular blocky; weak to moderate platy; few fine cracks; few pores; moderately moisture absorbent; no roots; few quartz grains; occasional mica.

130-200 cm 10YR3/3; few 10YR3/1 patches; clay. Moist and very firm; very weak coarse angular blocky; moderately moisture absorbent; no roots; few quartz grains; occasional mica; few soft carbonate concretions.

Soil Classification: Grumustertic Haplorthent : Series C121

Land Classification: 3he

Depth (cm)	Cations m.e. %				Sol-Exch Na	E.S.P.	Exchange Capacity Meq/100g soil
	Na	K	Ca	Mg			
0-45	0.58	1.27	28.42	6.72	0.63	1	44
45-130	0.63	1.21	28.86	7.41	0.70	2	42
130-200	0.73	1.13	29.45	8.52	0.83	2	44

LABORATORY ANALYSIS SITE No. 5608

Depth (cm)	Soil particles %				Incorp. Carbonate	pH	
	Coarse sand 2.0-0.2 mm.	Fine sand 0.2-0.02 mm.	Silt 0.02-0.002 mm.	Clay under 0.002 mm.		Soil Paste	1:5 suspension
0-45	3	12	35	50	4.4	7.9	8.8
45-130	4	11	27	58	4.5	7.9	8.7
130-200	4	26	20	50	4.5	7.7	8.6

Sat. %	E.C. mmhos cm Sat. Ext	Total Nitrogen %	Total Org. Carbon %	Total Extractable	
				Phosphorus Mg/100g. soil	Potassium Mg/100g. soil
49	0.5	0.031	0.22	88	430
55	0.5	0.028	0.23	95	450
51	0.7	0.014	0.22	97	430

Depth (cm)	Soluble Anions m.e./litre				Soluble Cations m.e./litre			
	CO ₃	HCO ₃	Cl	SO ₄	Na	K	Ca	Mg
0-45	-	3.10	1.75	0.81	0.98	0.19	3.17	1.32
45-130	-	3.20	0.65	1.81	1.30	0.17	2.28	1.91
130-200	-	3.20	0.55	4.69	2.01	0.24	3.02	2.94

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch. Na	E.S.P.	Exchange Capacity Meq/100g. soil
	Na	K	Ca	Mg			
0-45	0.58	1.27	28.42	6.72	0.63	1	44
45-130	0.63	1.21	28.86	7.41	0.70	2	42
130-200	0.73	1.13	29.45	8.52	0.83	2	44

Pit: 5620.
Location: Run: D10. Photo: 063
Topography: Flat and undulating.

<u>Cultivation and Land Use:</u>		Nil.	
<u>Vegetation:</u>	Ziziphus spina-christi; scrub Acacia seyal.		
<u>Surface:</u>	Loose granular top; occasional moderate cracks; slightly pitted.		
<u>Profile Description:</u>			
0-18	0-18 cm	24	63
18-50		24	58
50-110		22	58
110-160		30	27
		10YR 4/3. Silty clay; Dry and very hard; weak coarse angular blocky; occasional large cracks; rare pores; moderately moisture absorbent; few roots in top; few quartz grains; occasional mica.	

18-50 cm		10YR 4/3. Clay. Slightly moist and very firm; moderate to strong wedges; occasional large cracks; occasional weakly developed slickensides; moderately moisture absorbent; no roots; occasional mica; few fine nodules.	
Sat. %	E.C. mmhos cm Sat. Ext	Total Nitrogen %	Total Carbon %
57	0.4	0.024	0.25
51	0.4	0.030	0.25
56	50-110 cm	0.028	0.13
40	0.6	0.014	0.13
		10YR 3/3. Clay. Moist and very firm; weak wedges; no cracks or pores; few slickensides; no roots; few mica.	

110-160 cm		7.5YR 4/4. Loam. Moist and friable; structureless; no cracks or pores; rapidly moisture absorbent; no roots; frequent quartz grains; few to occasional carbonised organic matter; coarse sand band 110-115 cm.	
Depth (cm)	CO ₂	HCO ₃	Bore 200-250
0-18	-	2.90	0.76 0.12 1.88 1.71
18-50	-	3.30	1.79 0.18 2.67 2.48
50-110	-	2.60	
110-160	-	2.20	
160-250 cm		7.5YR 4/4. Gravelly loamy coarse sand. Moist and friable; structureless; no cracks; rapidly moisture absorbent; abundant quartz grains; common gravel, mainly quartz; few carbonised organic matter.	

<u>Soil Classification:</u>		Entic Grumustert : Series A121	
<u>Land Classification:</u>		3hte	
Depth (cm)	Na	K	Ca
0-18	0.57	0.79	27.66
18-50	1.01	1.03	29.32
50-110	0.35	0.41	16.68
110-160			

LABORATORY ANALYSIS SITE No. 5620

Depth (cm)	Soil particles %				Incorp. Carbonate	pH	
	Coarse sand 2.0-0.2 mm.	Fine sand 0.2-0.02 mm.	Silt 0.02-0.002 mm.	Clay under 0.002 mm.		Soil Paste	1:5 suspension
0-18	2	11	24	63	3.8	7.9	8.7
18-50	8	10	24	58	3.9	7.9	8.9
50-110	6	12	22	60	3.8	7.8	8.7
110-160	30	27	13	30	2.9	7.9	9.0

Sat. %	E.C. mmhos cm Sat. Ext	Total Nitrogen %	Total Org. Carbon %	Total Extractable	
				Phosphorus Mg/100g. soil	Potassium Mg/100g. soil
57	0.4	0.024	0.16	75	450
51	0.4	0.030	0.25	62	420
56	0.5	0.028	0.29	62	410
40	0.6	0.014	0.13	41	320

Depth (cm)	Soluble Anions m.e./litre				Soluble Cations m.e./litre			
	CO ₃	HCO ₃	Cl	SO ₄	Na	K	Ca	Mg
0-18	-	2.90	1.25	1.09	0.76	0.19	2.62	1.67
18-50	-	3.30	1.20	0.85	1.14	0.23	2.87	1.42
50-110	-	2.60	0.80	1.07	0.76	0.12	1.88	1.71
110-160	-	2.20	1.57	3.35	1.79	0.18	2.67	2.48

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch. Na	E.S.P.	Exchange Capacity Meq/100g.soil
	Na	K	Ca	Mg			
0-18	0.52	1.33	31.73	8.29	0.56	1	47
18-50	0.57	0.79	27.66	7.15	0.63	2	38
50-110	1.01	1.03	29.32	10.57	1.05	2	44
110-160	0.35	0.41	16.68	2.91	0.42	2	21

Pit: 6594 No. 6594

Location: Run D10 : Photo 061

Topography: Flat and level; nearby rock out-crop (granite)

Cultivation and Land Use: Forest Reserve

Vegetation: Acacia seyal

Surface: Broken rain crust; medium mulch.

Profile description:

0-30 cm 10YR4/3 - 7.5YR5/3 clay. Dry and very hard; moderate coarse prismatic; few cracks 1-3 cm wide 20 cm deep; rapidly water absorbent; common fine roots; occasional large roots; common fine quartz gravel.

30-95 cm 10YR5/2 - 5/3 sandy clay. Dry and hard; moderate medium coarse angular blocky; rapidly water absorbent; occasional large tree roots; common calcium carbonate concretions (white); common kankars; common very fine quartz gravel.

95-130 cm 10YR5/2 - 6/2 sandy clay to clay. Dry and slightly hard; weak medium angular blocky; rapidly water absorbent; rare tree roots; frequent soft calcium carbonate concretions; common quartz gravel up to 9 cm; occasional black kankars.

130-200 cm 10YR7-2 partly weathered granitic rock.

Soil Classification: Typic Calciorthid : Series D122

Land Classification: 3 h

Depth (cm)	Exchangeable Cations m.e. %				Sol-Soln %	C.S.F.	Exchange Capacity meq/100g soil
	Na	K	Ca	Mg			
0-30	0.43	1.35	29.57	6.95	0.45	1	44
30-95	0.30	0.45	24.90	1.80	0.35	2	20
95-130	0.35	0.49	20.75	6.90	0.42	1	29
130-200	0.41	0.25	14.19	2.72	0.49	4.1	16

LABORATORY ANALYSIS SITE No. 6594

Depth (cm)	Soil particles %				Incorp. Carbonate	pH	
	Coarse sand 2.0-0.2 mm.	Fine sand 0.2-0.02 mm.	Silt 0.02-0.002 mm.	Clay under 0.002 mm.		Soil Paste	1:5 suspension
0-30	8	20	14	58	4.2	7.5	8.6
30-95	48	25	7	20	2.9	7.9	9.0
95-130	32	31	9	28	16.0	7.9	9.1
130-200	43	20	19	18	25.0	8.1	9.2

Sat. %	E.C. mmhos cm Sat. Ext	Total Nitrogen %	Total Org. Carbon %	Total Extractable	
				Phosphorus Mg/100g. soil	Potassium Mg/100g. soil
87	0.5	0.030	0.44	65	480
23	0.6	0.006	0.11	30	200
36	0.7	0.016	0.12	28	140
33	1.1	0.014	0.12	38	240

Depth (cm)	Soluble Anions m.e./litre				Soluble Cations m.e./litre			
	CO ₃	HCO ₃	Cl	SO ₄	Na	K	Ca	Mg
0-30	-	3.40	2.40	0.28	0.65	0.23	3.17	2.03
30-95	-	3.00	2.60	1.79	2.07	0.22	3.07	2.03
95-130	-	3.70	1.80	2.91	1.96	0.24	3.07	3.14
130-200	-	2.50	3.15	5.73	2.39	0.29	4.26	4.44

Depth (cm)	Exchangeable Cations m.e. %				Sol+Exch. Na	E.S.P.	Exchange Capacity Meq/100g. soil
	Na	K	Ca	Mg			
0-30	0.43	1.35	29.57	6.99	0.49	1	44
30-95	0.30	0.45	14.96	1.98	0.35	2	20
95-130	0.35	0.49	20.75	6.90	0.42	1	29
130-200	0.41	0.25	14.19	2.71	0.49	43	16

APPENDIX 3.1

COMPARISON OF ESTIMATED AND
APPENDIX 3
CALCULATED ESP VALUES

LABORATORY ANALYSES OF
AUGER HOLES AND PITS

No.	Depth	No.	ESP	E.S.P.	E.S.P.	Land Class	Land Class
				Clay	C.E.C.	Clay E.S.P.	C.E.C. E.S.P.
2511	0-45	10	12.0	71	-	5ae	5ae
	-90	14	23.2	43	33		
2512	0-45	9	0.7	75	30	5a	5a
2513	0-45	17	12.4	73	50	5a	4a
2514	0-45	15	9.6	56	29	3e	3e
	-90	17	9.6	56	29		
2522	0-45	22	2.2	10	6	3e	3e
	-90	22	2.1	10	6		
2523	0-45	24	5.10	21	13	4at	4at
	-90	37	10.4	28	-		
2525	0-45	9	0.86	10	5	6t	6t
	-90	-	-	-	-		
2527	0-45	12	1.2	10	8	5a	5a
	-90	44	20.7	47	-		
2529	0-45	34	37.4	112	-	5ase	5ase
	-90	37	26.8	72	55		
2531	0-45	32	6.8	21	26	5ae	5ae
	-90	47	23.2	49	-		
2536	0-45	32	14.1	44	53	5ae	5ae
	-90	42	25.7	61	-		
2539	0-45	27	6.2	23	16	5e	5e
	-90	37	10.5	28	-		
2540	0-45	32	7.7	24	17	5ae	4e
	-90	39	12.1	31	24		
2549	0-45	17	1.46	9	5	6t	6t
	-90	-	-	-	-		
2551	0-45	14	1.4	10	6	5e	5e
	-90	14	3.8	27	-		

APPENDIX 3.1

COMPARISON OF ESTIMATED AND
CALCULATED ESP VALUES

Site No.	Depth	Clay	Ex Sod.	E.S.P. Clay	E.S.P. C.E.C.	Land Class Clay E.S.P.	Land Class C.E.C. E.S.P.
2498	0-45	29	21	72	57	5ae	5ae
	-90	57	44	78	77		
2500	0-45	26	24.4	94	53	5aue	5aue
	-90	26	36.8	138	-		
2502	0-45	19	12.88	68	39	5a	5a
	-90	36	26.60	74	53		
2504	0-45	77	6.1	8	12	3ae	4ae
	-90	57	10.48	18	26		
2505	0-45	23	29.5	128	-	5ae	5ae
	-90	29	44.7	155	86		
2506	0-45	17	12.0	71	-	5ae	5ae
	-90	24	23.8	99	79		
2508	0-45	16	25.6	160	-	5ast	5ast
	-90	25	34.6	138	60		
2517	0-45	37	6.0	16	13	5a	5a
	-90	54	23.1	43	33		
2518	0-45	7	8.3	119	38	5a	5a
	-90	9	6.7	75	30		
2519	0-45	17	12.4	73	50	5a	4a
	-90	7	15.41	220	55		
2523	0-45	19	9.8	52	27	3e	3e
	-90	17	9.6	56	29		
2524	0-45	22	2.2	10	6	3e	3e
	-90	22	2.1	10	6		
2525	0-45	24	5.10	21	13	4ate	4ate
	-90	37	10.4	28	-76		
2526	0-45	9	0.86	10	5	6t	6t
	-90	-	-	-	-		
2527	0-45	12	1.2	10	8	5a	5a
	-90	44	20.7	47	-		
2529	0-45	34	37.9	112	-	5ase	5ase
	-90	37	26.8	72	55		
2531	0-45	32	6.8	21	26	5ae	5ae
	-90	47	23.2	49	-		
2536	0-45	32	14.1	44	53	5ae	5ae
	-90	42	25.7	61	-		
2539	0-45	27	6.2	23	16	5e	5e
	-90	37	10.5	28	-		
2540	0-45	32	7.7	24	17	5ae	4e
	-90	39	12.1	31	24		
2549	0-45	17	1.46	9	5	6t	6t
	-90	-	-	-	-		
2551	0-45	14	1.4	10	6	5e	5e
	-90	14	3.8	27	-		
2597	0-45	24	5.89	25	14	5at	5at
	-90	37	13.76	37	-		
2598	0-45	32	16.56	52	36	5a	5a
	-90	22	17.9	81	-		

Site No.	Depth	Clay	Ex Sod.	E.S.P.		Land Class	
				Clay	C.E.C.	Clay E.S.P.	C.E.C. E.S.P.
2555	0-45	35	7.6	22	20	5a	5a
	-90	38	15.2	40	-		
2556	0-45	28	5.9	21	14	5a	5a
	-90	33	12.3	37	-		
2560	0-45	28	6.0	21	14	5a	5a
	-90	30	11.2	37	-		
2561	0-45	33	7.45	23	20	5a	5a
	-90	35	16.6	47	-		
2565	0-45	29	26.6	92	-	5ae	5ae
	-90	36	32.6	97	100		
2566	0-45	26	12.5	48	-	5a	5a
	-90	26	25.5	98	80		
2567	0-45	16	1.1	7	5	6t	6t
	-90	-	-	-	-		
2568	0-45	16	3.8	24	19	5a	4a
	-90	21	11.7	56	29		
2569	0-45	29	15.3	53	36	5a	5a
	-90	32	25.3	79	44		
2571	0-45	19	1.5	8	6	4lt	4lt
	-90	9	0.71	8	5		
2572	0-45	31	14.3	46	-	5a	5a
	-90	36	23.8	66	9		
2573	0-45	36	14.5	40	-	5ae	5ae
	-90	44	27.2	62	76		
2574	0-45	14	0.91	7	5	4lt	4lt
	-90	-	-	-	-		
2575	0-45	24	1.7	7	4	5a	5a
	-90	26	12.4	48	-		
2577	0-45	24	1.4	6	-	1	1
	-90	34	4.8	14	11		
2583	0-45	44	26.55	60	78	5a	5a
	-90	44	24.00	55	-		
2584	0-45	27	2.51	9	6	3a	1
	-90	24	4.02	17	13		
2587	0-45	29	19.35	67	65	5a	5a
	-90	32	26.20	82	-		
2588	0-45	14	1.09	8	4	4lt	4lt
	-90	22	1.12	5	-		
2590	0-45	29	14.60	50	52	5a	5a
	-90	24	23.8	100	87		
2595	0-45	12	0.25	2	-	4lt	4lt
	-90	22	4.78	22	16		
2597	0-45	24	5.89	25	14	5at	5at
	-90	37	13.76	37	-		
2598	0-45	32	16.56	52	38	5a	5a
	-90	22	17.9	81	-		

Site No.	Depth	Clay	Ex Sod.	E.S.P.		Land Class	
				Clay	C.E.C.	Clay E.S.P.	C.E.C. E.S.P.
2611	0-45	14	2.80	20	13	5a	5a
	-90	32	22.25	70	55		
2613	0-45	22	55.60	252	-	5as	5as
	-90	9	59.80	90	84		
2615	0-45	29	35.10	121	130	5a	5a
	-90	34	34.30	101	-		
2616	0-45	34	2.50	7	6	3ah	3ah
	-90	49	9.20	19	-		
2629	0-45	31	27.60	89	67	5a	5a
	-90	19	38.90	204	-		
2631	0-45	19	20.17	109	56	6at	6at
	-90	11	29.58	270	80		
2632	0-45	24	5.63	23	18	5a	5a
	-90	36	17.42	49	-		
2633	0-45	11	0.76	7	9	4lt	4lt
	-90	14	1.85	13	18		
2638	0-45	11	0.75	7	8	6at	6at
	-90	14	4.35	31	-		
2639	0-45	41	21.50	52	-	5a	5a
	-90	14	8.20	59	61		
2647	0-45	30	0.84	3	-	3a	2h
	-90	33	6.30	19	15		
2651	0-45	25	0.74	3	-	3l	3l
	-90	10	0.71	7	10		
2654	0-45	35	5.88	17	15	4a	1
	-90	23	0.71	3	-		
2663	0-45	48	12.08	25	-	4a	5a
	-90	43	13.10	30	59		
2665	0-45	35	8.34	24	19	5a	5a
	-90	35	19.6	56	-		
2667	0-45	30	1.03	3	-	1	1
	-90	15	1.18	8	3		
2674	0-45	14	0.74	5	-	4Olt	4Olt
	-90	14	1.47	11	12		
2675	0-45	44	1.10	3	-	2h	2h
	-90	24	3.66	15	12		
2678	0-45	36	2.17	6	-	2h	2h
	-90	16	1.10	7	6		
2679	0-45	36	1.10	3	-	4at	3at
	-90	29	3.47	12	9		
2680	0-45	31	5.64	18	14	4Olt	4Olt
	-90	31	5.88	19	-		
2683	0-45	9	0.78	9	7	4Olt	4Olt
	-90	14	0.77	6	-		

4olt

4olt

Site No.	Depth	Clay	Ex Sod.	E.S.P.		Land Class	
				Clay	C.E.C.	Clay E.S.P.	C.E.C. E.S.P.
3450	0-45	13	4.60	35	-	6at	4at
	-90	13	8.42	65	26		
3454	0-45	8	1.27	16	16	6at	6at
	-90	15	12.70	85	-		
3459	0-45	35	9.28	27	28	5a	4a
	-90	40	17.80	44	2		
3462	0-45	20	2.16	11	6	3a	3a
	-90	15	3.59	24	20		
3464	0-45	20	1.88	9	4	3a	3a
	-90	20	3.65	18	8		
3465	0-45	13	48.6	370	-	5as	5as
	-90	30	40.6	135	95		
3472	0-45	30	7.95	27	18	5a	5a
	-90	40	22.8	57	62		
3473	0-45	13	1.93	15	6	4O1	4O1
	-90	13	3.90	30	-		
3475	0-45	10	2.03	20	5	4a	4a
	-90	10	2.98	30	-		
3477	0-45	22	1.49	7	4	1	1
	-90	20	1.14	6	-		
3481	0-45	27	7.72	26	20	6t	6t
	-90	27	6.60	24	-		
3483	0-45	17	0.48	7	-	4O1t	4O1t
	-90	17	2.88	13	8		
3484	0-45	27	1.11	4	-	5a	5a
	-90	15	19.08	127	42		
3486	0-45	10	0.74	7	4	5a	5a
	-90	30	20.73	69	86		
3490	0-45	5	3.83	77	18	6at	6t
	-90	5	0.58	12	6		
3491	0-45	15	1.51	10	-	4O1	4O1
	-90	7	1.37	20	5		
3493	0-45	35	1.49	4	4	3t	3t
	-90	5	0.66	13	1		
3495	0-45	32	2.71	8	10	5a	5a
	-90	27	17.89	66	87		
3497	0-45	20	16.22	81	46	5a	5a
	-90	20	4.30	22	-		
3498	0-45	27	19.18	71	86	5a	5a
	-90	17	0.75	4	-		
3499	0-45	22	2.97	14	13	2a	2a
	-90	20	1.24	6	-		
3500	0-45	22	5.85	27	30	5a	5a
	-90	20	1.77	8	7		

Site No.	Depth	Clay	Ex Sod.	E.S.P.		Land Class	
				Clay	C.E.C.	Clay E.S.P.	C.E.C. E.S.P.
3501	0-45	25	5.01	20	-	5a	5a
	-90	25	12.76	51	49		
3503	0-45	17	2.15	13	6	40	40
	-90	10	0.57	6	-		
3504	0-45	12	1.47	12	7	40	40
	-90	15	2.24	15	19		
3511	0-45	25	0.89	4	-	40	40
	-90	32	6.22	19	18		
3512	0-45	22	23.28	11	7	5a	5a
	-90	25	35.80	143	92		
3514	0-45	19	1.09	6	-	40 lt	40 lt
	-90	32	5.69	18	30		
3525	0-45	22	0.77	4	-	40 lt	40 lt
	-90	9	0.77	9	14		
3526	0-45	24	9.12	38	-	5a	5a
	-90	19	13.95	73	87		
3531	0-45	34	7.64	23	30	5a	5a
	-90	39	12.28	31	-		
3534	0-45	24	0.66	3	-	2h lt	2h lt
	-90	32	4.46	14	14		
3538	0-45	26	5.06	19	31	5a lt	5a lt
	-90	34	14.80	43	-		
3543	0-45	11	0.75	7	6	40	40
	-90	16	0.74	5	-		
3546	0-45	32	4.68	15	22	4a	4a
	-90	44	10.14	23	-		
3547	0-45	32	7.54	24	30	4a	5a
	-90	44	8.66	20	-		
3549	0-45	37	9.90	27	-	6t	6t
	-90	34	24.68	73	77		
3550	0-45	19	1.14	6	-	40 lt	40 lt
	-90	22	5.39	24	12		
3551	0-45	24	2.64	11	11	5a	5a
	-90	47	14.38	31	-		
3554	0-45	24	2.99	12	16	5a	5a
	-90	30	9.9	33	-		
3556	0-45	10	0.75	8	8	6t	6t
	-90	17	0.75	4	-		
3557	0-45	12	1.02	9	7	40 l	40 l
	-90	20	1.40	7	14		
3558	0-45	32	2.59	8	8	4at	4at
	-90	40	10.52	26	-		
3559	0-45	22	1.52	7	5	1	1
	-90	22	1.14	5	-		

Site No.	Depth	Clay	Ex Sod.	E.S.P.		Land Class	
				Clay	C.E.C.	Clay E.S.P.	C.E.C. E.S.P.
3562	0-45	47	1.51	3	-	3h	3h
	-90	15	1.15	8	9		
3565	0-45	35	3.65	10	13	4a	4a
	-90	37	11.22	30	-		
3567	0-45	27	2.20	8	5	5a	5a
	-90	27	9.25	34	-		
3569	0-45	25	1.05	4	-	1	1
	-90	31	2.93	9	8		
3586	0-45	30	12.90	39	-	5a	5a
	-90	32	24.55	77	71		
3595	0-45	21	3.24	5	-	5a	5a
	-90	23	24.10	105	86		
4353	0-45	30	4.45	15	16	4a	4a
	-90	42	11.25	27	-		
4354	0-45	32	7.80	24	21	5a	5a
	-90	40	12.8	32	-		
4355	0-45	15	1½03	7	5	3e	3e
	-90	12	1.07	9	5		
4358	0-45	20	2.92	15	8	40 lt	40 lt
	-90	15	2.34	15	7		
4359	0-45	17	1.75	10	7	40 lt	40 lt
	-90	12	1.84	15	-		
4360	0-45	17	2.90	17	16	5a	5a
	-90	15	6.37	42	-		
4361	0-45	32	12.23	38	-	5a	5a
	-90	32	15.58	50	50		
4363	0-45	22	5.38	24	24	5at	5at
	-90	47	22.5	48	-		
4364	0-45	30	4.10	14	14	5ae	5ae
	-90	45	17.7	39	-		
4367	0-45	17	10.32	61	30	5ae	5ae
	-90	15	16.01	107	47		
4373	0-45	27	2.17	8	7	3e	3e
	-90	37	3.54	10	-		
4376	0-45	20	2.96	15	15	6t	6t
	-90	32	7.17	22	22		
4382	0-45	21	11.40	54	47	5a	5a
	-90	14	8.96	64	24		
4399	0-45	19	5.28	28	-	4ae	4ae
	-90	19	4.81	25	11		
4402	0-45	31	2.01	7	16	4ae	4ae
	-90	41	9.60	23	-		
4403	0-45	31	3.88	13	12	4ae	4ae
	-90	31	8.06	25	-		

Site No.	Depth	Clay	Ex Sod.	E.S.P. Clay	E.S.P. C.E.C.	Land Class Clay E.S.P.	Land Class C.E.C. E.S.P.
4466	0-45	7	0.76	11	8	6t	6t
4514	-90	10	1.08	11	14	3ht	3ht
4467	0-45	10	1.45	15	17	4O1	4O1
4515	-90	17	1.46	9	16	1	1
4468	0-45	25	5.39	22	28	5a	5a
4523	-90	42	17.49	42	-	4au	5a
4469	0-45	30	30.00	100	-	5a	5a
4538	-90	25	40.93	168	100	1	1
4470	0-45	17	1.54	9	11	4Olt	4Olt
4546	-90	13	0.76	6	-	2te	4at
4472	0-45	10	0.76	8	11	6t	6t
4548	-90	15	1.87	12	16	3ae	3ae
4473	0-45	15	2.19	15	23	5a	5a
4552	-90	22	8.03	36	-	5t	5t
4475	0-45	22	4.18	19	21	5a	5a
5489	-90	32	10.3	32	-	4Olt	4Olt
4486	0-45	30	6.19	21	19	5ae	5ae
5492	-90	30	20.25	68	70	3h	3h
4487	0-45	22	8.42	38	3	5a	5a
5499	-90	27	21.50	80	92	3h	3h
4488	0-45	32	33.70	105	-	5ase	5ase
5505	-90	42	22.60	54	92	5ae	5ae
4489	0-45	42	1.14	3	-	3h	3h
5506	-90	22	2.17	10	15	2ht	2ht
4490	0-45	30	3.32	11	14	5a	5a
5507	-90	27	10.95	41	-	2h	2h
4491	0-45	40	1.10	3	-	3aht	4at
5509	-90	30	5.68	19	29	5ae	5ae
4493	0-45	28	2.21	8	10	3a	5a
5514	-90	33	6.91	21	35	5ae	5ae
4496	0-45	25	19.15	77	60	5a	5a
5516	-90	30	6.66	17	22	3h	3h
4497	0-45	18	11.66	65	83	5a	5a
5518	-90	35	1.40	4	7	4O1	1
4498	0-45	30	5.19	17	22	5a	5a
5520	-90	35	16.98	48	-	5a	5a
4499	0-45	50	2.10	4	-	3h	3h
5522	-90	23	2.20	10	11	5ae	5ae
4500	0-45	15	1.12	7	11	5a	5a
5523	-90	23	7.09	31	8	2ah	2h
4506	0-45	30	8.28	28	7	5a	5a
5525	-90	38	26.30	69	77	3hte	3hte
4507	0-45	35	14.2	41	-	5at	5at
5527	-90	38	31.0	82	77	5ae	5ae
4508	0-45	18	1.49	8	12	4Olt	4Olt
	-90	33	4.56	14	19		

Site No.	Depth	Clay	Ex Sod.	E.S.P.		Land Class	
				Clay	C.E.C.	Clay E.S.P.	C.E.C. E.S.P.
4514	0-45	48	2.10	4	-	3ht	3ht
	90	28	2.12	8	7		
4515	0-45	18	1.12	6	-	1	1
	-90	28	1.89	7	6		
4523	0-45	28	6.35	23	36	4au	5a
	-90	38	0.73	2	-		
4538	0-45	18	0.74	4	-	1	1
	-90	13	1.11	9	6		
4546	0-45	21	0.74	4	-	2te	4at
	-90	13	1.65	13	27		
4548	0-45	21	1.82	9	6	3ae	3ae
	-90	36	8.78	24	-		
4552	0-45	18	2.23	12	13	5t	5t
	-90	33	9.27	28	-		
5489	0-45	17	2.46	14	12	4Olt	4Olt
	-90	42	9.02	21	-		
5492	0-45	55	0.77	1	1	3h	3h
	-90	52	1.36	3	3		
5499	0-45	35	2.88	9	9	3h	3h
	-90	45	2.12	5			
5505	0-45	35	4.91	14	14	5ae	5ae
	-90	42	13.55	32	-		
5506	0-45	15	1.08	7	3	2ht	2ht
	-90	27	1.41	5	-		
5507	0-45	15	1.08	7	3	2h	2h
	-90	27	1.41	5	-		
5509	0-45	27	2.99	11	7	5ae	5ae
	-90	37	11.38	31	-		
5514	0-45	42	14.04	33	7	5ae	5ae
	-90	51	34.8	68	-		
5516	0-45	32	3.32	10	8	3h	3h
	-90	45	5.66	13	-		
5518	0-45	12	2.52	21	7	4O1	1
	-90	17	2.02	12	8		
5520	0-45	10	22.0	55	53	5a	5a
	-90	16	29.2	79	-		
5522	0-45	32	7.23	23	14	5ae	5ae
	-90	40	20.7	52	56		
5523	0-45	12	1.72	14	8	2ah	2h
	-90	17	1.94	11	7		
5525	0-45	27	2.18	8	5	3hte	3hte
	-90	42	3.75	9	-		
5527	0-45	32	6.08	19	16	5ae	5ae
	-90	45	19.26	43	-		

Site No.	Depth	Clay	Ex Sod.	E.S.P.		Land Class	
				Clay	C.E.C.	Clay E.S.P.	C.E.C. E.S.P.
5535	0-45	30	2.88	10	9	5a	5a
	-90	42	24.26	59	-		
5537	0-45	17	1.91	11	9	40 lt	40 lt
	-90	12	1.55	13	12		
5541	0-45	32	8.23	26	28	5a	5a
	-90	47	22.4	48	-		
5543	0-45	30	2.98	10	8	5ae	5ae
	-90	42	14.00	33	-		
5544	0-45	12	0.97	8	2	4ae	4ae
	-90	25	0.65	26	-		
5545	0-45	15	0.75	5	-	40lt	40lt
	-90	10	1.50	15	13		
5546	0-45	30	4.54	15	10	5ae	5ae
	-90	30	18.65	62	44		
5547	0-45	15	0.75	9	7	5a	5a
	-90	15	8.06	54	39		
5550	0-45	32	4.74	15	14	5at	5at
	-90	17	15.68	92	82		
5552	0-45	22	5.50	25	15	5a	5a
	-90	32	20.08	65	80		
5555	0-45	20	5.91	30	51	5a	5a
	-90	22	12.37	56	-		
5557	0-45	15	1.20	8	4	40 lt	40 lt
	-90	12	0.95	8	4		
5563	0-45	15	15.65	104	45	5a	5a
	-90	22	13.76	62	43		
5564	0-45	36	34.60	290	-	5ase	5ase
	-90	56	11.2	37	103		
5566	0-45	27	25.6	95	98	5ae	5ae
	-90	25	30.7	123	-		
5567	0-45	32	17.71	55	52	5ae	5ae
	-90	30	15.96	53	54		
5568	0-45	22	13.11	60	73	5at	5at
	-90	17	3.85	23	33		
5570	0-45	30	28.65	96	20	5ase	5ase
	-90	30	48.20	161	-		
5572	0-45	32	30.88	97	102	5ae	5ae
	-90	22	72.10	328	-		
5580	0-45	11	2.32	21	29	40 lt	40 lt
	-90	11	0.65	6	-		
5582	0-45	26	1.44	6	-	4a	5a
	-90	29	7.39	25	35		
5583	0-45	26	19.85	76	43	5a	5a
	-90	34	29.20	86	81		

Site No.	Depth	Clay	Ex Sod.	E.S.P.		Land Class	
				Clay	C.E.C.	Clay E.S.P.	C.E.C. E.S.P.
5584	0-45	29	11.86	41	-	5a	5a
	-90	22	22.54	102	62		
5586	0-45	15	0.71	5	-	4a	5a
	-90	15	3.77	25	32		
5587	0-45	20	12.62	63	66	5ae	5ae
	-90	22	24.1	109	-		
5588	0-45	40	2.26	6	-	3at	2ht
	-90	17	2.64	16	5		
5590	0-45	22	5.94	27	20	5ae	5ae
	-90	27	21.20	79	-		
5591	0-45	32	10.60	33	-	5ae	5ae
	-90	37	27.11	73	73		
5592	0-45	17	1.11	7	11	40 lt	40 lt
	-90	22	1.55	7	9		
5593	0-45	15	0.73	5	-	40 l	40 l
	-90	17	1.45	9	11		
5595	0-45	12	1.51	13	39	40 lt	5a
	-90	12	0.75	6	-		
5612	0-45	33	1.54	5	-	1	1
	-90	20	1.37	7	9		
5613	0-45	15	1.54	10	12	5a	5a
	-90	10	4.65	47	-		
5614	0-45	15	1.17	8	10	2e	2e
	-90	28	1.54	6	-		
5615	0-45	35	2.94	8	12	5a	5a
	-90	18	9.16	51	-		
5623	0-45	18	1.15	6	-	40 lt	40 lt
	-90	15	1.04	7	7		
6438	0-45	15	1.66	11	4	1	1
	-90	22	1.77	9	4		
6439	0-45	12	1.09	9	3	40 lt	40 lt
	-90	15	1.49	10	4		
6440	0-45	20	1.36	7	3	40 lt	40 lt
	-90	27	4.50	17	9		
6444	0-45	17	1.70	10	5	40 lt	40 lt
	-90	17	1.30	8	4		
6456	0-45	7	0.70	10	9	5e	5e
	-90	7	1.14	16	19		
6458	0-45	35	28.09	80	-	5ae	5ae
	-90	47	28.20	60	67		
6460	0-45	25	5.94	24	16	5a	5a
	-90	35	21.47	61	-		
6462	0-45	22	2.86	13	8	2at	2t
	-90	20	1.46	7	4		

Site No.	Depth	Clay	Ex Sod.	E.S.P.	E.S.P.	Land Class	
				Clay	C.E.C.	Clay E.S.P.	C.E.C. E.S.P.
6463	0-45	25	1.38	6	-	2e	2e
	-90	15	2.05	14	10		
6470	0-45	45	11.34	25	21	5a	5a
	-90	58	24.45	42	44		
6471	0-45	13	0.97	7	6	4Olt	4Olt
	-90	25	6.05	24	20		
6473	0-45	30	7.0	23	18	6t	6t
	-90	33	9.24	28	23		
6474	0-45	28	3.43	12	7	6t	6t
	-90	28	4.32	15	15		
6475	0-45	8	1.03	13	26	6	6
	-90	-	-	-	-		
6485	0-45	25	3.86	15	10	4e	4e
	-90	25	4.00	16	-		
6486	0-45	20	3.44	17	15	5ate	5ate
	-90	33	20.72	63	-		
6487	0-45	10	0.70	7	6	4Olt	4Olt
	-90	15	1.86	12	13		
6490	0-45	18	1.44	8	8	40lt	40lt
	-90	15	0.92	6	-		
6495	0-45	30	3.76	13	13	4e	4e
	-90	33	6.05	18	20		
6497	0-45	28	27.66	100	79	5ae	5ae
	-90	25	41.86	170	-		
6505	0-45	36	8.54	24	-	4at	4at
	-90	34	3.23	10	10		
6509	0-45	35	9.24	26	25	5a	5a
	-90	40	18.16	45	-		
6510	0-45	17	3.30	19	22	5at	5at
	-90	20	10.78	45	-		
6512	0-45	32	10.71	33	-	5a	5a
	-90	12	13.7	114	50		
6513	0-45	30	7.07	24	25	5al	5al
	-90	27	9.35	37	-		
6521	0-45	45	17.42	39	-	5a	5a
	-90	40	26.40	66	61		
6524	0-45	10	0.77	8	16	6t	6t
	-90	13	1.12	9	11		
6525	0-45	10	0.77	8	7	6t	6t
	-90	13	0.74	6	-		
5227	0-45	16	28.96	161	-	5ae	5ae
	-90	16	49.38	130	76		
6528	0-45	10	1.36	14	14	6t	6t
	-90	15	1.07	7	11		

Site No.	Depth	Clay	Ex Sod.	E.S.P. Clay	E.S.P. C.E.C.	Land Class Clay E.S.P.	Land Class C.E.C. E.S.P.
6529	0-45	10	0.70	7	7	6t	6t
	-90	13	1.58	12	11		
6530	0-45	18	1.17	7	8	40lt	40lt
	-90	13	0.77	6	-		
6533	0-45	15	3.48	23	9	5at	5at
	-90	13	8.01	62	-		
6549	0-45	33	3.16	10	11	3a	3a
	-90	35	7.34	21	-		
6551	0-45	23	1.18	5	-	2ht	2ht
	-90	33	2.57	8	7		
6553	0-45	8	0.74	9	12	2l	2l
	-90	25	0.73	3	-		
6562	0-45	18	0.71	4	-	40lt	40lt
	-90	28	2.87	10	7		
6564	0-45	14	1.56	11	9	40lt	40lt
	-90	11	0.73	7	8		
6576	0-45	-	5.79	-	-	3a	3a
	-90	29	5.24	18	15		
6589	0-45	11	0.77	7	10	5e	5e
	-90	16	0.76	5	-		
6591	0-45	11	0.70	6	-	5e	5e
	-90	14	1.02	7	5		
6592	0-45	24	2.36	10	8	5e	5e
	-90	24	4.00	17	-		
6597	0-45	21	2.1	10	6	6k	6k
	-90	-	-	-	-		

APPENDIX 3.2
ROCK ANALYSES FROM
AUGER BORINGS

Site No.	Depth (cm.)	Mechanical Analysis			E.G. mmhos/cm at 25°C	Sat. %	Sol. No Neg 100 g.	Exch. No Neg 100 g.	E.S.P.	Soil Class	Liqd Class
		Sand 2.0-0.075 mm.	Silt 0.075-0.002 mm.	Clay 0.002 mm.							
2498	0-25	58	13	29	5.7	71	4.6	21.0	72	DI11	5cc
	25-50	25	18	57	11.00	75	7.20	44.00	77		
2499	0-25	59	20	21	4.85	96	4.10	11.9	56	DI12	5ms
	25-50	67	11	22	12	53	5.30	17.4	79		
2500	0-25	43	31	26	5.30	43	2.40	24.4	94	DI12	5cl
	25-50	38	36	26	19	56	11.20	36.8	142		
2501	0-45	57	21	22	13	71	6.40	8.8	30	CI11	5a
	45-90	48	26	26	11	64	5.40	15.8	3		
2502	0-45	65	16	19	2.20	32	0.72	12.88	68	DI11	5a
	45-90	29	35	36	4.60	49	2.20	25.60	74		
2503	0-45	30	30	40	6.00	52	2.93	17.57	44	CI12	5a
	45-90	13	26	69	16	62	9.30	43.50	63		
	90-150				22	50					
2504	0-45	10	13	77	1.00	33	0.35	6.2	8	CI21	3cl
	45-90	23	80			64	1.52	10.48	18		
2505	0-45	57	12	23	11	75	9.7	29.5	128	DI11	5cc
	45-90	50				75	7.3	44.7	155		
2506	0-45	68	15	17	4.5	55	5.60	12.0	71	DI11	5cc
	45-90	57	19	24	4.40	52	2.60	23.8	99		
2507	0-45	60	14	26	4.0	41	13.6	12.8	8	DI11	5ms
	45-90	55	18	27	12	69	7.8	21.8	31		
2508	0-45	73	11	16	13	49					
	45-90	33	22	25	4.30	60	14.4	25.6	1.0	DI11	5cl
2509	0-45	52	21	27	12	37	4.4	17.4	67	CI11	5a
	45-90	69	12	19	12	74	7.8	23.1	73		
2510	0-45	44	20	36	14	51	4.5	5.9	16	CI12	5a
	45-90	37	24	39	14	65	6.1	15.9	42		
2511	0-45	39	17	44	12	50	5.4	8.2	34	CI11	5a
	45-90	55	16	29	17	55	8.0	11.2	19		
2512	0-45	57	19	24	24	52	13.8	16.6	69	CI21	5ms
	45-90	39	21	20	24	51	12.8	46.4	232		
2513	0-45	47	12	41	16	60	9.0	15.8	39	CI12	5a
	45-90	28	15	37	8	77	5.6	20.8	16		
2514	0-45	17	8	35	13	40	4.7	8.1	34	CI11	5a
	45-90	82	7	11	16	37	4.6	5.8	53		
2515	0-45	34	19	47	4.5	60	2.1	5.9	13	CI21	5a
	45-90	19	32	49	16	82	13.9	22.1	43		
2516	0-45	71	15	14	13	33	4.5	11.5	82	CI11	5a
	45-90	54	27	19	18	57	11.4	43.0	286		

APPENDIX 3.2

ROUTINE ANALYSES FROM
AUGER BORINGS

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
2498	0-45	58	13	29	5.6	71	4.6	21.0	72	D111	5ae
	-90	25	18	57	11.00	75	7.20	44.00	77		
	-150				4.85	96					
2499	0-45	59	20	21	12	40	4.10	11.9	56	D111	5aue
	-90	67	11	22	12	53	5.90	17.4	79		
2500	0-45	43	31	26	5.30	43	2.40	24.4	94	D111	5a1
	-90	38	36	26	19	56	11.20	36.8	142		
2501	0-45	57	21	22	13	71	6.40	8.8	10	C211	5a
	-90	48	26	26	11	64	5.40	15.8	61		
2502	0-45	65	16	19	2.20	32	0.72	12.88	68	D111	5a
	-90	29	35	36	4.60	49	2.20	26.60	74		
2503	0-45	30	30	40	6.00	52	2.93	17.67	44	C212	5a
	-90	13	28	69	16	62	9.30	43.50	63		
	-150				22	50					
2504	0-45	10	13	77	1.00	38	0.35	6.1	8	C121	3a1
	-90	23	20	57	2.50	64	1.52	10.48	18		
2505	0-45	65	12	23	11	75	9.7	29.5	128	D111	5ae
	-90	50	21	29	12.00	82	7.3	44.7	155		
2506	0-45	68	15	17	11	55	5.60	12.0	71	D111	5ae
	-90	57	19	24	4.40	52	2.60	23.8	99		
2507	0-45	60	14	26	40	41	13.6	12.8	49	D111	5ase
	-90	55	18	27	12	69	7.8	21.8	81		
	-150				13	49					
2508	0-45	73	11	16	47	30	14.4	25.6	160	D111	5ast
	-90	53	22	25	4.30	60	3.0	34.6	138		
2509	0-45	53	21	26	12	37	4.4	17.4	67	C211	5ae
	-90	69	12	19	12	74	7.6	13.4	71		
2510	0-45	44	20	36	14	51	4.5	5.9	16	C212	5ae
	-90	37	24	39	14	65	8.1	15.9	41		
2511	0-45	59	17	24	12	50	5.4	8.2	34	C211	5ae
	-90	55	16	29	17	55	8.0	11.2	39		
	-150				3.2	56					
2512	0-45	57	19	24	26	52	13.8	16.6	69	C211	5ase
	-90	59	21	20	24	51	12.8	46.4	232		
2513	0-45	47	12	41	16	60	9.0	15.8	39	C212	5ae
	-90	28	15	57	8	77	5.6	20.8	36		
2514	0-45	77	8	15	13	40	4.7	8.1	54	C211	5ae
	-90	82	7	11	16	37	4.6	5.8	53		
2515	0-45	34	19	47	4.5	60	2.1	5.9	13	C121	4ae
	-90	19	32	49	16	82	13.9	22.1	45		
	-150				20	64					
2516	0-45	71	15	14	13	33	4.5	11.5	82	C211	5ae
	-90	54	27	19	18	57	11.4	43.0	226		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
2517	0-45	36	27	37	5.3	50	2.0	6.0	16	C112	5a
	-90	21	25	54	19	62	10.5	23.1	43		
2518	0-45	84	9	7	3.2	39	1.3	8.3	118	C222	5a
	-90	81	10	9	6.1	37	2.1	6.7	74		
2519	0-45	66	17	17	1.1	39	0.37	12.4	73	C211	5a
	-90	84	9	7	1.6	36	0.59	15.41	220		
2520	0-45	59	27	14	23	52	11.4	21.0	150	D111	5ase
	-90	64	27	9	14	56	6.3	25.3	281		
2521	0-45	69	9	22	24	36	7.7	24.9	113	C211	5ase
	-90	46	32	22	27	46	12.1	22.3	102		
2522	0-45	84	7	9	3.0	23	0.75	4.05	45	C222	5at
	-90	79	9	12	7.0	26	1.8	7.8	65		
2523	0-45	71	10	19	6.7	35	2.2	9.8	52	D111	5a
	-90	71	12	17	8.1	32	2.4	9.6	56		
	-150				12	28					
2524	0-45	66	12	22	0.8	31	0.2	2.2	10	C111	3e
	-90	59	19	22	5.8	38	1.1	2.1	9		
2525	0-45	61	15	24	1.60	31	0.50	5.10	13	C111	4at
	-90	46	17	37	10.00	61	6.4	10.4	-		
2526	0-45	79	12	9	0.75	18	0.14	0.86	9	C221	6t
	-90										
2527	0-45	79	9	12	2.90	20	0.40	1.2	10	C111 D112	5a
	-90	29	27	44	11	35	3.30	20.7	47		
2528	0-45	49	14	37	27	53	11.10	16.1	44	D112	5ast
	-90	39	39	22	19	44	7.30	11.9	54		
2529	0-45	49	17	34	23	60	14.9	37.9	111	D112	5ase
	-90	39	24	37	7	72	5.2	26.8	72		
2530	0-45	46	12	42	2.9	51	1.5	10.9	26	C212	5ae
	-90	24	24	52	12	83	10.3	29.7	57		
2531	0-45	59	9	32	2.7	44	1.2	6.8	21	D112	5ae
	-90	39	14	47	13	70	8.8	23.2	49		
	-150				17	51					
2532	0-45	16	45	39	21	78	18.2	26.6	59	C212	5ase
	-90	14	34	52	16	86	14	38.4	74		
2533	0-45	26	30	44	2.9	68	1.0	3.0	7	C112	4a
	-90	24	24	52	4.5	68	3.1	14.5	28		
2534	0-45	36	17	47	1.7	56	0.7	4.1	9	C112	4ae
	-90	26	20	54	10	65	6.0	17.2	32		
	-150				13	70					
2535	0-45	61	10	29	1.25	35	0.44	9.16	32	D111	5ae
	-90	46	12	42	2.80	63	1.90	19.7	47		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
2536	0-45	61	7	32	6.1	47	2.7	14.1	44	D112	5ae
	-90	49	9	42	19	73	13.5	25.7	61		
2537	0-45	49	17	34	16	53	7.4	16.6	49	D112	5ase
	-90	44	17	39	23	57	11.1	20.9	54		
2538	0-45	51	25	24	11	59	4.3	11.7	49	D111	5ae
	-90	39	24	37	22	46					
2539	0-45	61	12	27	4.3	38	1.4	6.2	23	C211	5e
	-90	46	17	37	16	50	6.3	10.5	28		
2540	0-45	46	22	32	2.4	49	1.1	7.7	24	C212	5ae
	-90	39	22	39	8.1	57	3.9	12.1	31		
2541	0-45	36	17	47	6.80	63	4.25	14.9	32	D112	5ae
	-90	16	27	57	15	79	11.1	23.3	41		
2542	0-45	29	37	34	11	63	6.0	15.6	46	D112	5ae
	-90	31	42	27	13	70	9.3	17.9	66		
2543	0-45	31	35	34	1.80	51	0.93	14.27	42	C212	5ae
	-90	26	37	37	5.90	64	3.5	14.90	40		
2544	0-45	41	27	32	35	48	14.4	49.6	155	D112	5ase
	-90	59	19	22	34	40	14.5	76.7	350		
2545	0-45	36	25	39	54	51	17.90	16.5	42	C212	5ase
	-90	31	22	47	38	58	17.40	40.2	85		
2546	0-45	29	22	49	54	54	13.00	23.8	49	C212	5ase
	-90	21	20	59	18	58	4.83	28.8	49		
2547	0-45	36	22	42	19	54	5.40	13.8	33	C212	5ase
	-90	26	17	57	40	57	9.8	18.2	32		
2548	0-45	59	17	24	42	41	7.8	12.2	51	D111	5ase
	-90	54	14	32	35	44	9.9	29.3	91		
2549	0-45	64	19	17	0.57	27	0.14	1.46	9	C111	6t
2550	0-45	74	12	14	17	27	1.7	1.9	14	D121	6ts
	-90	61	17	22	38	42	3.4	6.2	28		
2551	0-45	69	17	14	4.3	38	0.6	1.4	10	C111	5e
	-90	66	20	14	20	32	1.8	3.8	27		
2552	0-45	36	22	42	18	35	4.7	8.1	19	C212	6ts
	-90	64	9	27	38	22	5.5	7.9	29		
2553	0-45	59	17	24	0.52	37	0.14	0.66	3	C111	2e
	-90	51	14	35	0.72	44	0.33	1.27	4		
2554	0-45	38	22	40	0.84	44	0.40	4.0	10	C121	3ah
	-90	33	17	50	3.6	55	1.86	10.1	20		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
2555	0-45	46	19	35	1.00	41	0.37	7.6	22	C212	5a
	-90	46	16	38	5.3	60	3.16	15.2	40		
2556	0-45	56	16	28	1.3	41	0.51	5.9	21	C111	5a
	-90	53	14	33	5.2	58	3.30	12.3	37		
2557	0-45	36	24	40	10	61	5.8	22.2	56	D112	5ae
	-90	21	14	65	10	66	5.9	16.5	25		
2558	-150				23	66					
	0-45	38	24	38	21	57	12.4	22.0	58	D112	5ase
2559	-90	33	24	43	22	74	18.5	34.3	80		
	0-45	38	32	30	9.0	44	4.0	13.8	46	D112	5ae
2560	-90	43	17	40	11	68	8.3	46.1	115		
	0-45	61	11	28	2.9	37	1.2	6.0	21	C111	5a
2561	-90	61	9	30	11.0	48	4.8	11.2	37		
	0-45	46	21	33	1.3	44	0.55	7.45	23	C212	5a
2562	-90	43	22	35	5.50	56	3.4	16.6	47		
	-150				10	75					
2563	0-45	38	24	38	4.1	56	2.5	16.7	44	D112	5a
	-90	21	19	60	12	71	9.2	21.6	36		
2564	0-45	47	17	36	14	50	7.2	17.2	48	D112	5a
	-90	50	14	36	12	75	7.0	42.6	118		
2565	0-45	40	14	46	0.78	48	0.4	9.2	20	C212	5a
	-90	37	27	36	4.9	67	3.8	16.2	45		
2566	0-45	60	11	29	11	57	7.0	26.6	92	C211	5ae
	-90	52	12	36	10	58	5.4	32.6	97		
2567	-150				4.85	95					
	0-45	65	9	26	3.4	40	1.5	12.5	48	D111	5a
2568	-90	60	14	26	7.0	76	4.9	25.5	98		
	0-45	47	37	16	0.47	22	0.08	1.1	7	C111	6t
2569	-90		gravel								
	0-45	75	9	16	0.88	22	0.22	3.8	24	D111	5a
2570	-90	67	12	21	2.6	54	1.5	11.7	56		
	-150				5.65	74					
2571	0-45	55	16	29	1.7	46	0.69	15.3	36	D111	5a
	-90	48	30	32	1.4	48	0.69	25.3	44		
2572	0-45	50	16	34	16	44	6.3	16.2	48	C212	5a
	-90	35	31	34	1.8	77	1.4	23.8	70		
2573	0-45	70	11	19	0.33	33	0.08	1.5	8	D121	401t
	-90	77	14	9	0.35	36	0.09	0.71	8		
2574	0-45	57	12	31	4.7	48	2.5	14.3	46	D112	5a
	-90	52	12	36	3.3	102	3.6	23.8	66		
2575	-150				4.7	110					
	0-45	52	12	36	5.9	63	3.9	14.5	40	D112	5ae
2576	-90	42	14	44	5.5	80	4.0	27.2	62		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
2593	0-45	49	19	32	14	47	6.0	11.4	36	D112	5ae
	-90	19	34	47	29	77	23.6	50.40	107		
2594	0-45	54	17	29	24	46	12.6	19.40	67	D111	5ase
	-90	57	14	29	52	50	21.8	29.40	101		
2595	0-45	82	6	12	7.90	25	1.75	0.25	2	C221	401t
	-90	69	9	22	1.40	28	0.42	4.78	22		
	-150				11	42					
2596	0-45	74	9	17	0.54	26	0.13	0.67	4	C111	401t
	-90	62	11	27	0.32	34	0.12	1.08	4		
2597	0-45	64	12	24	1.40	37	0.51	5.89	25	C111	5at
	-90	52	11	37	4.75	61	3.04	13.76	37		
2598	0-45	57	11	32	3.00	41	1.04	16.56	52	D112	5a
	-90	69	9	22	10.00	40	3.7	17.9	81		
2599	0-45	57	11	32	15	39	5.6	14.4	45	C212	5ae
	-90	44	14	42	32	61	19.70	38.70	92		
	-150				31	48					
2600	0-45	44	17	39	6.40	51	3.45	14.95	38	C212	5ae
	-90	32	21	47	19	84	13.00	22.20	47		
2601	0-45	39	22	39	5.05	53	2.65	12.55	32	D112	5a
	-90	49	12	39	4.25	77	3.85	18.55	48		
2602	0-45	24	22	54	0.75	53	0.40	9.60	18	C122	4a
	-90	34	17	49	7.25	62	4.20	11.80	24		
2603	0-45	47	14	39	3.55	50	1.75	9.45	24	D112	5a
	-90	34	17	49	11	74	7.60	21.20	43		
	-150				14	57					
2604	0-45	32	19	49	3.30	59	1.90	11.70	24	D112	5a
	-90	32	16	52	11	68	7.15	18.85	36		
2605	0-45	39	19	42	0.53	46	0.25	7.15	17	D112	4ae
	-90	37	16	47	6.55	59	3.90	12.90	27		
2606	0-45	54	12	34	13	49	6.10	11.5	34	D112	5ae
	-90	49	9	42	15	87	13.00	19.4	46		
	-150				5.40	86					
2607	0-45	64	7	29	6.95	39	2.80	12.00	41	D111	5a
	-90	54	14	32	12	58	7.25	28.75	90		
2608	0-45	4	17	79	0.89	64	0.55	6.25	8	D111	3ht
	-90	2	16	82	1.04	68	0.70	8.90	11		
2609	0-45	52	19	29	14	44	5.3	17.9	62	D111	5a
	-90	72	16	12	10	44	3.5	16.10	134		
2610	0-45	77	6	17	3.30	24	0.65	1.75	10	C111	401
	-90	77	6	17	1.30	28	0.40	5.60	33		
	-150				2.20	67					
2611	0-45	52	34	14	3.55	38	1.40	2.80	20	C211	5a
	-90	29	39	32	1.20	77	0.95	22.25	70		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
2612	0-45	29	34	37	1.20	63	0.30	1.30	4	C112	3h
	-90	9	42	49	2.10	68	0.70	0.50	1		
2613	0-45	59	19	22	33	53	22.8	55.60	252	G211	5as
	-90	35	23	42	58	59	14.6	37.80	90		
2614	0-45	24	37	39	0.89	66	0.25	1.75	4	C112	3h
	-90	14	39	47	0.99	66	0.35	1.25	3		
	-150				3.00	71					
2615	0-45	42	29	29	3.50	49	1.70	35.10	121	D111	5a
	-90	44	22	34	11	55	4.10	34.30	101		
2616	0-45	44	22	34	1.25	70	0.70	2.50	7	C112	3ah
	-90	21	30	49	2.50	65	1.60	9.20	19		
2617	0-45	19	25	56	5.90	66	3.15	11.45	20	A112	4a
	-90	6	25	69	1.70	68	1.20	10.40	15		
2618	0-45	31	20	49	2.35	59	1.20	11.60	24	C122	5a
	-90	39	15	46	13	58	5.00	19.00	41		
	-150				2.40	47					
2619	0-45	66	13	21	0.65	24	0.15	1.05	5	C111	4at
	-90	46	18	36	8.15	50	4.05	10.35	29		
2620	0-45	31	28	41	3.35	58	1.80	9.40	23	C122	5a
	-90	19	32	49	1.45	58	0.80	16.00	33		
2621	0-45	11	35	54	1.65	66	0.95	7.85	15	C121	4a
	-90	24	22	54	7.90	56	4.35	15.65	29		
2622	0-45	19	30	51	0.46	60	0.20	1.40	3	C112	3ht
	-90	19	27	54	0.51	58	0.28	5.72	11		
	-150				4.85	67					
2623	0-45	11	40	49	1.50	65	0.65	3.35	7	C112	3h
	-90	9	47	44	0.33	67	0.16	0.64	1		
2624	0-45	29	32	39	0.36	60	0.08	0.72	2	C112	3a
	-90	36	25	39	4.35	58	0.24	9.76	25		
2625	0-45	24	22	54	0.33	55	0.08	0.72	1	C112	3h
	-90	61	8	31	0.31	42	0.06	0.74	2		
2626	0-45	46	25	29	15	51	9.40	45.00	155	D111	5a
	-90	64	22	14	12	56	7.00	68.20	487		
	-150				15	51					
2627	0-45	46	23	31	0.36	35	0.05	1.55	5	D111	4t
	-90	61	20	19	0.31	44	0.10	1.10	6		
2628	0-45	59	10	31	0.44	21	0.05	1.55	5	C112	4t
	-90	39	10	51	1.32	36	0.40	6.00	12		
2629	0-45	46	22	31	10	55	8.00	27.60	89	D112	5a
	-90	61	20	19	19	47	9.90	38.90	204		
2630	0-45	59	10	31	12	51	6.25	18.35	59	D112	5ae
	-90	39	10	51	13	122	13.10	41.30	81		
	-150				4.85	83					

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
2631	0-45	69	12	19	4.05	54	2.23	20.17	100	D111	6at
	-90	76	13	11	2.00	38	0.82	29.58	270		
2632	0-45	69	7	24	3.15	26	0.77	5.63	23	D111	5a
	-90	49	15	36	4.85	73	3.38	17.42	49		
2633	0-45	81	8	11	0.44	25	0.04	0.76	7	D121	401t
	-90	79	7	14	0.78	22	0.15	1.85	13		
2634	0-45	41	18	41	0.72	45	0.25	2.95	7	D122	3ah
	-90	44	15	41	1.85	56	1.00	9.40	23		
2635	0-45	44	22	34	8.8	47	0.15	1.45	4	C112	2t
	-90	46	23	31	0.44	50	0.20	1.60	5		
2636	0-45	24	35	41	0.90	50	0.15	1.05	3	C112	3h
	-90	51	18	31	0.38	53	0.15	1.05	3		
2637	0-45	64	10	26	3.95	39	1.50	9.70	37	D111	6t
	-90	44	12	44	7.00	89	6.45	24.75	56		
2638	0-45	81	8	11	0.32	23	0.05	0.75	7	D121	6at
	-90	79	7	14	2.10	25	0.45	4.35	31		
2639	0-45	46	13	41	5.0	36	4.10	21.50	52	C212	5a
	-90	79	7	14	5.40	68	4.20	8.20	59		
2640	0-45	19	25	56	0.45	52	0.25	3.75	7	A111	3ht
	-90	19	17	64	0.98	56	0.50	9.90	15		
2641	0-45	46	18	36	2.40	48	1.00	9.00	25	D112	5a
	-90	41	18	41	11.0	58	6.10	18.30	45		
2642	0-45	34	24	41	0.54	50	0.10	0.70	2	C112	3h
	-90	36	18	46	0.33	59	0.15	0.65	1		
2643	0-45	23	29	48	0.4	58	0.82	0.38	1	C121	3ht
	-90	33	34	33	1.20	66	0.30	0.90	3		
2644	0-45	30	25	45	2.00	70	0.88	0.72	2	C112	3ah
	-90	35	20	45	4.85	55	2.30	8.10	18		
2645	0-45	40	30	30	3.75	54	1.89	1.31	4	C112	2h
	-90	33	27	40	2.55	60	1.28	1.12	3		
2646	0-45	58	22	20	1.90	37	0.08	0.72	4	C111	1
	-90	40	32	28	0.78	53	0.10	0.70	3		
2647	0-45	30	40	30	1.08	76	0.16	0.84	4	C112	3a.
	-90	38	29	33	4.90	59	2.50	6.30	3		
2648	0-45	40	30	30	0.56	56	0.09	1.11	4	C112	2h
	-90	35	30	35	0.78	56	0.12	1.08	3		
2649	0-45	50	22	28	1.08	49	0.17	1.03	4	C111	1
	-90	48	22	30	3.65	54	0.34	0.86	3		
	-150				1.02	36					

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
2650	0-45	65	12	23	1.75	36	0.06	0.74	3	D121	1
	-90	68	9	23	1.08	40	0.11	0.69	3		
2651	0-45	60	15	25	0.84	35	0.06	0.74	3	C111	3l
	-90	83	7	10	1.25	23	0.09	0.71	7		
2652	0-45	83	7	10	0.66	22	0.04	0.36	4	C221	401t
	-90	85	7	8	0.57	25	0.03	0.37	5		
2653	0-45	30	40	30	1.20	63	0.16	1.04	3	C112	3h
	-90	13	42	45	0.57	75	0.11	1.09	2		
	-150				0.72	36					
2654	0-45	40	25	35	3.50	53	1.32	5.88	17	C111	4a
	-90	55	22	23	0.84	47	0.09	0.71	3		
2655	0-45	40	25	35	0.90	54	0.11	1.19	3	C112	3ah
	-90	30	30	40	1.14	55	0.50	6.70	17		
2656	0-45	58	17	25	0.57	49	0.09	0.71	3	C111	1
	-90	50	22	28	0.96	56	0.13	1.07	4		
2657	0-45	65	15	20	0.78	44	0.09	0.71	4	C111	1
	-90	58	19	23	0.90	48	0.19	1.41	6		
	-150				1.08	54					
2658	0-45	48	27	25	1.02	64	0.10	0.70	3	C111	2h
	-90	30	35	35	1.20	67	0.12	0.68	2		
2659	0-45	18	27	55	0.78	64	0.20	1.20	2	C121	3h
	-90	15	27	58	0.53	64	0.18	2.22	4		
2660	0-45	20	45	35	0.84	62	0.09	0.71	2	C112	2h
	-90	68	12	20	1.20	45	0.10	0.70	4		
2661	0-45	45	25	30	1.14	55	0.10	0.70	2	C111	1
	-90	50	25	25	1.65	45	0.09	0.71	3		
	-150				0.72	50					
2662	0-45	15	20	65	0.45	61	0.07	0.73	1	C121	3h
	-90	40	15	45	0.72	58	0.11	0.69	2		
2663	0-45	23	29	48	4.30	58	1.92	12.08	25	C212	4a
	-90	33	24	43	16	65	10.10	13.10	30		
2664	0-45	35	27	38	6.95	56	3.92	12.88	34	D112	5a
	-90	45	20	35	11	71	8.50	25.50	74		
	-150				6.05	69					
2665	0-45	30	35	35	2.95	53	1.46	8.34	24	D112	5a
	-90	38	27	35	15.0	72	12.0	19.6	56		
2666	0-45	18	27	45	1.14	56	0.70	0.90	2	C112	3h
	-90	23	39	38	2.20	61	0.15	1.45	4		
2667	0-45	53	17	30	0.84	63	0.17	1.03	3	C111	1
	-90	28	57	15	0.57	55	0.02	1.18	8		
2668	0-45	15	26	59	0.96	61	0.09	1.11	2	A111	3h
	-90	22	24	54	0.66	60	0.09	1.11	2		
	-150				0.66	52					
2669	0-45	35	24	41	0.96	53	0.11	0.69	2	C112	3h
	-90	25	24	51	1.02	58	0.33	2.47	5		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
3448	0-45	48	22	30	32	46	14.5	24.5	82	D112	5as
	-90	41	21	38	16	66	10.6	39.0	103		
	-150				18	65					
3449	0-45	48	22	30	16	62	9.2	17.2	57	C212	5as
	-90	38	22	40	32	58	17.4	20.2	50		
3450	0-45	71	16	13	5.60	36	1.80	4.60	35	C211	6at
	-90	63	24	13	5.20	36	1.98	8.42	65		
3451	0-45	66	11	23	19	39	7.20	12.0	52	D111	5as
	-90	48	19	13	16	55	9.10	20.5	158		
3452	0-45	48	32	20	3.45	26	0.91	6.29	31	C211	5ae
	-90	43	12	45	10.0	86	9.5	22.5	50		
	-150				4.8	86					
3453	0-45	48	24	28	67	40	19.0	15.8	56	C211	6ast
	-90	46	24	30	56	37	19.0	29.0	97		
3454	0-45	66	26	8	1.65	20	0.33	1.27	16	C111	6at
	-90	76	9	15	11	41	4.90	12.70	85		
3455	0-45	58	19	23	65	44	29.6	29.6	129	D111	6ast
	-90	58	19	23	92	53	30.8	86.8	377		
3456	0-45	41	19	40	48	39	12.9	26.3	66	D112	6ast
	-90	56	14	30	49	47	14.1	35.5	118		
3457	0-45	43	32	25	12	46	3.8	28.2	113	D111	5as
	-90	41	36	23	86	46	26.8	75.2	326		
3458	0-45	48	24	28	46	44	11.5	17.3	62	D111	5as
	-90	46	24	30	72	47	21.8	57.4	192		
3459	0-45	51	14	35	1.55	48	0.72	9.28	27	D112	5a
	-90	28	32	40	8.30	40	3.00	17.80	44		
	-150				12	49					
3460	0-45	23	39	38	0.92	55	0.41	1.19	3	C112	2h
	-90	26	34	40	0.99	54	0.54	5.06	13		
3461	0-45	71	16	13	14	29	4.36	7.64	59	D111	5a
	-90	51	24	25	32	37	8.58	34.62	138		
3462	0-45	46	34	20	0.52	47	0.24	2.16	11	C111	3a
	-90	76	9	15	1.11	36	0.41	3.59	24		
3463	0-45	23	44	33	0.49	31	0.08	1.52	5	C112	2h
	-90	26	34	40	0.79	57	0.28	2.92	7		
	-150				1.14	56					
3464	0-45	28	52	20	0.44	49	0.12	1.88	9	C111	3a
	-90	36	44	20	1.11	46	0.35	3.65	18		
3465	0-45	31	56	13	36	48	13.4	48.6	374	C211	5as
	-90	42	28	30	15	40	7.4	40.6	135		
3466	0-45	18	44	38	0.72	45	0.23	1.77	44	C112	2h
	-90	53	19	28	0.47	37	0.14	1.06	4		
	-150				1.08	33					

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
3467	0-45	38	22	40	0.65	49	0.25	0.55	1	C112	3ah
	-90	38	17	45	3.15	64	1.84	10.56	23		
3468	0-45	48	29	23	0.57	57	0.14	1.06	5	C111	2t
	-90	63	14	23	0.39	48	0.12	0.68	3		
3469	0-45	63	14	23	1.40	38	0.19	1.01	4	C111	2e
	-90	71	11	18	2.90	31	0.16	0.64	4		
3470	0-45	26	21	53	0.94	57	0.52	8.28	16	C122	5a
	-90	28	19	53	4.70	76	3.20	18.40	35		
3471	0-45	23	19	58	0.49	59	0.15	1.45	3	A111	3ht
	-90	23	19	58	0.47	60	0.23	1.77	3		
3472	0-45	41	29	30	0.72	48	0.85	7.95	27	D112	5a
	-90	38	22	40	1.80	52	12.4	22.8	57		
3473	0-45	73	14	13	1.25	63	0.47	1.93	15	C111	40l
	-90	71	16	13	2.20	60	0.90	3.90	30		
3474	0-45	31	21	48	0.60	59	0.30	2.90	6	C121	3ht
	-90	36	19	45	1.4	69	7.8	6.6	15		
3475	0-45	58	32	10	0.60	59	0.37	2.03	20	C111	4a
	-90	63	27	10	8.05	44	2.62	2.98	30		
3476	0-45	49	21	30	1.75	48	0.17	1.43	5	C112	1
	-90	49	16	35	0.32	46	0.12	1.88	5		
3477	0-45	41	37	22	0.76	44	0.11	1.49	7	C111	1
	-90	39	41	20	0.23	48	0.06	1.14	6		
3478	0-45	21	27	52	0.36	58	0.15	1.05	2	C211	3ht
	-90	26	19	55	0.44	54	0.14	1.46	3		
3479	0-45	74	14	12	0.72	48	2.38	4.82	40	C211	5a
	-90	51	22	27	8.70	38	4.95	15.05	56		
3480	0-45	46	39	15	6.00	55	1.10	1.70	11	C111	4a
	-90	31	39	30	1.95	66	0.36	8.44	28		
3481	0-45	61	12	27	4.75	42	1.68	7.12	26	C211	6t
	-90	61	12	27	22	52	10.2	6.60	24		
3482	0-45	46	17	37	10	35	3.34	26.66	72	D112	6at
	-90	51	22	27	16	41	6.56	15.04	56		
3483	0-45	71	12	17	1.30	31	0.32	0.48	3	D121	40lt
	-90	76	7	17	3.85	64	2.72	2.88	17		
3484	0-45	46	27	27	0.51	48	0.09	1.11	4	C111	5a
	-90	59	26	15	0.53	25	0.12	19.08	127		
3485	0-45	54	24	22	12	39	4.00	16.00	73	C211	5a
	-90	81	7	12	1.82	45	0.56	0.24	2		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
3486	0-45	81	9	10	0.43	25	0.06	0.74	7	C121	5a
	-90	46	24	30	0.37	28	0.07	20.73	69		
	-150				0.40	37					
3487	0-45	31	32	37	10	50	5.0	30.2	82	D112	5a
	-90	46	32	22	12	63	6.15	21.85	99		
3488	0-45	51	32	17	22	44	9.12	21.28	125	D111	5as
	-90	54	16	30	14	43	6.44	13.96	47		
3489	0-45	34	29	37	12	37	4.62	43.58	118	G212	5a
	-90	79	9	12	19	58	11.3	1.90	16		
3490	0-45	89	6	5	0.68	22	0.17	3.83	77	G222	6at
	-90	89	6	5	1.08	23	0.22	0.58	12		
	-150				1.7	26					
3491	0-45	66	19	15	0.52	35	0.09	1.51	10	C111	401
	-90	79	14	7	4.95	36	0.63	1.37	20		
3492	0-45	76	14	10	0.49	35	0.09	2.71	27	C111	401t
	-90	36	42	22	1.55	35	0.26	0.94	4		
3493	0-45	21	44	35	0.39	45	0.11	1.49	4	C112	31t
	-90	50	15	35	0.39	54	0.14	0.66	2		
3494	0-45	84	6	10	0.74	35	0.13	0.27	3	C221	6t
	-90	61	12	27	0.63	23	0.06	1.14	4		
3495	-150				5.45	26				C112	5a
	0-45	56	12	32	0.52	34	0.09	2.71	8		
	-90	56	17	27	0.39	42	0.11	17.89	66		
3496	0-45	51	24	25	36	39	12.0	19.2	77	D111	5as
	-90	59	24	17	14	56	8.7	2.1	12		
3497	0-45	44	36	20	4.25	38	1.38	16.22	81	D111	5a
	-90	66	14	20	14	50	6.10	4.30	22		
	-150				12	46					
3498	0-45	41	32	27	18	36	4.02	19.18	71	D111	5a
	-90	74	9	17	22	48	9.25	0.75	4		
3499	0-45	69	9	22	0.92	23	0.23	2.97	14	C111	2a
	-90	74	6	20	5.6	44	1.16	1.24	6		
3500	0-45	71	7	22	0.68	24	0.15	5.85	27	C211	5a
	-90	61	17	22	8.45	26	1.43	1.77	8		
3501	0-45	56	19	25	0.76	30	0.19	5.01	20	C212	5a
	-90	51	24	25	9.00	26	4.44	12.76	51		
	-150				12	34					
3502	0-45	41	32	27	10	42	3.7	21.9	81	D111	5a
	-90	56	27	17	10	53	4.2	13.4	79		
3503	0-45	61	22	17	0.55	49	0.25	2.15	13	C111	401
	-90	84	6	10	0.62	46	0.23	0.57	6		
3504	0-45	64	24	12	0.52	35	0.13	1.47	12	C111	401
	-90	56	29	15	0.47	43	0.16	2.24	15		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
3505	0-45	59	21	20	0.82	42	0.26	7.74	39	C211	5at
	-90	39	14	47	2.65	42	0.84	4.36	9		
	-150				6.05	53					
3506	0-45	49	14	37	0.47	48	0.18	10.62	29	C211	5at
	-90	39	19	42	4.75	50	2.06	6.74	16		
3507	0-45	26	24	50	0.44	61	0.15	0.65	1	C121	3ah
	-90	39	16	45	6.30	56	2.60	7.40	16		
3508	0-45	36	17	47	0.75	48	0.36	8.04	17	C122	5a
	-90	39	14	47	5.20	65	3.42	16.58	35		
3509	0-45	64	9	27	0.44	40	0.20	0.60	2	C111	3at
	-90	79	6	15	1.55	26	0.33	3.67	24		
	-150				3.05	58					
3510	0-45	36	22	42	1.25	49	0.61	12.19	29	D112	5a
	-90	39	19	42	14.50	66	8.4	14.19	33		
3511	0-45	63	11	25	0.55	41	0.31	0.89	4	C111	40l
	-90	51	17	32	0.64	28	0.18	6.22	19		
3512	0-45	54	24	22	8.85	32	2.72	23.28	115	C111	5a
	-90	46	29	25	8.50	48	4.20	35.80	143		
3513	0-45	36	34	30	1.24	59	0.44	1.16	4	C112	2ht
	-90	19	44	37	1.02	66	0.33	1.27	3		
	-150				3.50	57					
3514	0-45	75	6	19	0.78	20	0.11	1.09	6	C111	40lt
	-90	60	8	32	1.56	23	0.31	5.69	18		
3515	0-45	85	6	9	0.90	24	0.04	0.76	8	C221	6t
	-90	82	6	12	1.20	24	0.12	0.68	6		
3516	0-45	65	9	27	2.28	35	0.66	8.14	30	C211	5a
	-90	60	11	29	6.00	45	2.64	12.56	43		
	-150				4.65	26					
3517	0-45	52	14	34	1.40	41	0.55	7.45	22	C212	5at
	-90	35	18	47	6.25	70	4.38	14.82	32		
3518	0-45	52	21	27	0.66	51	0.09	1.11	4	C111	1
	-90	47	19	34	2.20	51	0.38	1.22	4		
3519	0-45	65	13	22	0.66	50	0.10	0.70	3	C111	2t
	-90	70	13	17	0.52	38	0.07	0.73	4		
3520	0-45	80	6	14	0.84	44	0.08	0.72	5	D121	40l
	-90	52	21	27	0.78	37	0.16	1.44	5		
	-150				0.90	34					
3521	0-45	57	14	29	0.54	21	0.03	0.77	3	C111	4t
	-90	77	9	14	0.51	22	0.03	0.77	6		
3522	0-45	82	6	12	0.66	24	0.04	0.76	6	C111	6t
	-90	75	6	19	0.72	24	0.05	0.75	4		
3523	0-45	50	11	39	2.50	44	2.99	6.21	16	C122	4a
	-90	30	16	54	10.0	55	4.4	12.8	24		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
3524	0-45	55	8	37	0.48	38	0.06	1.54	4	C112	3e
	-90	52	9	39	0.66	42	0.16	1.84	5		
	-150				1.40	49					
3525	0-45	72	6	22	0.49	18	0.03	0.77	4	C111	40lt
	-90	85	6	9	0.50	20	0.03	0.77	9		
3526	0-45	67	9	24	3.10	28	0.88	9.12	38	C211	5a
	-90	72	9	19	5.05	41	2.05	13.95	73		
3527	0-45	17	39	44	0.78	63	0.27	2.13	5	C121	3ah
	-90	25	23	52	0.78	52	0.33	9.27	18		
3528	0-45	10	36	54	0.50	65	0.25	3.35	6	C121	3h
	-90	12	26	62	0.64	57	0.33	8.47	14		
	-150				4.10	33					
3529	0-45	20	23	57	0.72	56	0.39	6.81	12	C121	4a
	-90	22	19	59	1.50	58	0.81	15.19	26		
3530	0-45	42	16	42	1.50	41	0.57	11.03	26	C122	5a
	-90	25	23	52	4.85	60	2.92	25.08	48		
3531	0-45	37	29	34	1.45	40	0.56	7.64	23	C212	5a
	-90	50	11	39	3.55	51	1.72	12.28	31		
3532	0-45	17	24	59	0.55	53	0.24	3.76	6	C121	3ah
	-90	25	21	54	0.55	58	0.32	8.48	16		
	-150				2.90	49					
3533	0-45	30	38	32	0.66	58	0.13	1.07	3	C112	3h
	-90	27	31	42	0.57	63	0.31	2.89	7		
3534	0-45	49	27	24	1.08	55	0.14	0.66	3	C111	2h
	-90	40	28	32	0.78	52	0.34	4.46	14		
3535	0-45	26	28	46	0.72	48	0.29	2.91	6	C121	3ah
	-90	24	22	54	1.10	55	0.58	11.02	20		
	-150				7.90	64					
3536	0-45	25	16	59	0.72	53	0.32	6.08	10	A111	3aht
	-90	20	16	64	2.16	55	0.72	10.48	16		
3537	0-45	50	11	39	1.75	39	0.60	7.20	18	D112	5a
	-90	47	11	42	2.90	59	1.54	14.86	35		
3538	0-45	64	10	26	3.85	26	0.94	5.06	19	D111	5a
	-90	50	16	34	16	44	6.80	14.80	43		
3539	0-45	57	11	32	4.90	48	2.40	14.40	45	D112	5a
	-90	30	26	44	6.20	65	4.06	28.74	65		
	-150				3.20	93					
3540	0-45	32	14	54	0.44	50	0.08	1.52	3	C121	3h
	-90	31	15	54	0.40	56	0.07	0.73	1		
3541	0-45	41	15	44	0.57	50	0.21	2.19	5	C121	3h
	-90	36	15	49	0.78	51	0.31	5.29	11		
3542	0-45	34	15	51	0.54	51	0.23	2.97	6	C121	3ht
	-90	31	15	54	1.14	57	0.68	6.12	11		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
3543	0-45	81	8	11	0.72	20	0.05	0.75	7	C111	401
	-90	74	10	16	0.46	24	0.06	0.74	5		
	-150				0.90	30					
3544	0-45	59	10	31	4.50	36	1.36	9.84	32	C212	5a
	-90	45	11	44	11	60	6.60	17.40	40		
3545	0-45	72	9	19	0.66	20	0.05	1.15	6	C111	401
	-90	75	6	19	0.72	21	0.08	1.12	6		
3546	0-45	62	6	32	2.95	22	0.52	4.68	15	C212	4a
	-90	47	9	44	7.90	46	3.46	10.14	23		
3547	0-45	60	8	32	3.80	36	1.26	7.54	24	C212	4a
	-90	42	14	44	11	56	5.74	8.66	20		
	-150				11.00	70					
3548	0-45	47	11	42	5.20	51	2.94	13.06	31	D112	5a
	-90	35	13	52	17.0	68	10.5	19.1	37		
3549	0-45	52	11	37	2.50	36	0.90	9.90	27	D112	6t
	-90	47	19	34	6.30	53	3.32	24.68	73		
3550	0-45	77	4	19	0.72	19	0.06	1.14	6	C111	401t
	-90	72	6	22	2.15	22	0.21	5.39	25		
3551	0-45	67	9	24	0.84	22	0.16	2.64	11	C111	5a
	-90	42	11	47	4.00	54	2.02	14.38	31		
	-150				6.40	60					
3552	0-45	50	11	39	1.60	41	0.55	5.05	13	C112	4e
	-90	42	11	47	6.55	56	3.22	9.58	20		
3553	0-45	47	11	42	0.84	43	0.32	4.48	11	C112	4e
	-90	45	13	42	5.60	52	2.73	10.07	24		
3554	0-45	65	11	24	1.14	23	0.21	2.99	12	C111	5a
	-90	62	8	30	10	41	3.7	9.9	33		
	-150				11	58					
3555	0-45	77	8	15	1.60	23	0.32	5.08	34	C211	5a
	-90	47	16	37	11.0	47	5.5	16.9	46		
3556	0-45	84	6	10	0.55	19	0.05	0.75	8	C221	6t
	-90	77	6	17	0.51	31	0.05	0.75	4		
3557	0-45	82	6	12	4.15	24	0.18	1.02	9	C111	401
	-90	72	8	20	4.10	24	0.20	1.40	7		
3558	0-45	42	26	32	0.72	45	0.21	2.59	8	C112	4at
	-90	42	18	40	1.45	48	0.68	10.52	26		
	-150				3.90	39					
3559	0-45	47	31	22	0.72	52	0.08	1.52	7	C111	1
	-90	57	21	22	0.45	40	0.06	1.14	5		
3560	0-45	82	6	12	0.78	22	0.04	0.76	6	C111	401
	-90	79	9	12	0.48	23	0.04	0.76	6		
3561	0-45	47	13	40	7.75	48	3.48	14.32	36	C212	5a
	-90	37	21	42	12	59	5.9	15.7	37		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
3562	0-45	24	29	47	0.46	53	0.09	1.51	3	C112	3h
	-90	79	6	15	0.56	22	0.05	1.15	8		
	-150				0.66	25					
3563	0-45	49	14	37	2.30	29	0.62	11.38	31	C212	5a
	-90	29	19	52	6.30	82	5.30	17.90	34		
3564	0-45	52	11	37	13.80	48	6.84	18.76	51	D112	5a
	-90	39	16	45	25.51	58	14.80	28.40	63		
3565	0-45	52	13	35	1.08	39	0.35	3.65	10	C112	4a
	-90	49	14	37	1.80	50	0.78	11.22	30		
3566	0-45	29	31	40	0.96	54	0.43	4.37	11	C121	3ah
	-90	37	18	45	1.75	56	0.84	7.16	16		
	-150				2.70	59					
3567	0-45	27	46	27	0.90	54	0.20	2.20	8	D121	5a
	-90	52	21	27	2.20	44	0.95	9.25	34		
3568	0-45	19	31	50	0.49	67	0.13	1.47	3	A111	3h
	-90	12	23	65	0.42	71	0.19	1.81	3		
3569	0-45	57	18	25	0.78	40	0.15	1.05	4	C111	1
	-90	44	24	32	0.72	52	0.27	2.93	9		
3570	0-45	39	29	32	0.51	52	0.16	1.44	5	C112	3ah
	-90	24	36	40	0.72	60	0.41	7.59	19		
	-150				2.70	63					
3571	0-45	44	26	30	0.57	49	0.20	1.80	6	C112	3ah
	-90	32	23	45	2.00	59	1.12	7.28	16		
	-150				5.15	60					
3572	0-45	74	9	17	0.48	27	0.04	0.76	4	C111	4t
	-90	67	11	22	0.48	26	0.03	0.77	4		
3573	0-45	54	16	30	0.52	40	0.06	0.94	3	C111	4t
	-90	72	13	15	0.45	23	0.03	0.77	5		
	-150				0.47	32					
3574	0-45	17	21	62	0.72	66	0.31	2.09	3	A111	3ht
	-90	19	24	57	5.15	69	2.93	8.27	15		
3575	0-45	2	26	72	0.68	60	0.38	4.82	7	A111	3ah
	-90	37	18	45	11.98	54	5.4	11.4	25		
3576	0-45	12	18	70	4.10	76	2.66	6.14	9	A111	4at
	-90	32	21	47	11	63	6.46	12.74	27		
3577	0-45	22	33	45	1.08	67	0.18	1.02	2	C112	3h
	-90	27	31	42	3.50	64	1.64	5.16	12		
	-150				1.20	55					
3578	0-45	47	31	22	1.45	57	0.26	0.94	4	C111	3a
	-90	39	21	40	3.80	58	1.45	6.55	16		
3579	0-45	14	26	60	0.37	66	0.12	1.48	2	A111	3ht
	-90	22	23	55	1.50	60	0.71	4.09	7		
3580	0-45	62	13	25	0.48	42	0.08	1.12	4	C111	1
	-90	67	16	17	0.44	44	0.08	1.12	7		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
3581	0-45	7	43	50	0.49	74	0.15	1.85	4	C121	3h
	-90	9	44	47	0.78	61	0.18	1.42	3		
	-150				0.78	44					
3582	0-45	37	31	32	2.10	57	0.14	1.06	3	C112	3h
	-90	14	39	47	0.72	77	0.25	1.75	4		
3583	0-45	22	41	37	0.90	70	0.11	1.49	4	C112	2h
	-90	39	26	35	0.51	63	0.08	1.12	3		
3584	0-45	7	36	57	0.66	65	0.28	2.92	5	C121	5a
	-90	27	26	47	6.95	63	4.25	15.75	34		
3585	0-45	32	36	32	0.56	62	0.14	1.46	5	C112	2h
	-90	34	34	32	0.48	55	0.14	1.46	5		
	-150				0.57	48					
3586	0-45	39	31	30	13	65	6.7	11.7	39	C212	5a
	-90	39	29	32	5.20	53	2.65	24.55	77		
3587	0-45	27	21	52	4.90	59	2.00	8.40	16	C122	4at
	-90	27	23	50	2.25	60	0.81	4.79	10		
3588	0-45	44	21	35	0.54	48	0.08	1.12	3	C112	4a
	-90	42	18	40	6.55	53	3.45	13.35	33		
3589	0-45	42	18	40	0.51	46	0.09	2.31	6	C112	3ht
	-90	34	16	50	0.44	55	0.14	2.66	5		
	-150				4.20	59					
3590	0-45	12	28	60	0.41	63	0.11	2.29	4	A111	3ht
	-90	14	26	60	0.39	63	0.15	3.45	6		
3591	0-45	22	21	57	0.96	54	0.46	10.34	18	C122	5ae
	-90	27	31	42	6.65	67	4.35	20.85	50		
3592	0-45	17	28	55	4.70	62	2.60	12.60	23	C122	5ae
	-90	24	31	45	11	70	7.52	28.48	63		
	-150				4.35	76					
3593	0-45	16	46	38	0.78	69	0.16	3.04	8	C112	3ht
	-90	31	21	48	7.60	56	2.94	6.66	14		
3594	0-45	51	23	26	2.40	46	0.88	7.92	30	C211	5a
	-90	46	28	26	0.96	44	0.15	7.05	27		
3595	0-45	61	18	21	1.08	40	0.36	3.24	15	C211	5a
	-90	58	19	23	10	40	4.70	24.10	105		
3596	0-45	41	16	43	0.40	47	0.08	1.52	4	C112	3h
	-90	46	31	23	0.43	45	0.07	1.13	5		
	-150				0.48	52					
3597	0-45	16	24	60	33	60	21.4	4.2	74	C212	5ae
	-90	33	25	58	33	54	16.8	0.4	58		
3598	0-45	28	15	57	24	61	10.7	1.3	37	C212	5ae
	-90	4	20	72	33	76	16.0	4.0	33		
3599	0-45	4	24	72	50	65	14.3	0.4	48	C212	5ae
	-90	6	19	75	61	72	45.0	7.8	88		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
4353	0-45	61	9	30	1.01	35	0.35	4.45	15	C112	4a
	-90	46	12	42	1.65	46	0.75	11.25	27		
	-150				5.00	41					
4354	0-45	48	20	32	2.90	42	1.00	7.80	24	D112	5a
	-90	36	24	40	10	66	5.6	12.8	32		
4355	0-45	73	12	15	0.70	33	0.17	1.03	7	D121	3e
	-90	73	15	12	1.07	34	0.13	1.07	9		
4356	0-45	71	9	20	5.30	30	1.50	8.90	44	C211	5at
	-90	51	27	22	14.0	54	6.3	22.9	57		
4357	0-45	56	22	22	12	37	4.12	11.68	53	D111	5at
	-90	51	24	25	20	47	9.16	22.04	88		
	-150				15	61					
4358	0-45	58	22	20	5.60	36	1.08	2.92	15	C111	401t
	-90	68	17	15	8.05	39	1.46	2.34	15		
4359	0-45	63	20	17	1.65	33	0.25	1.75	10	D121	401t
	-90	66	22	12	11	34	1.36	1.84	15		
4360	0-45	68	15	17	0.99	34	0.30	2.90	17	C212	5a
	-90	68	17	15	2.65	33	0.83	6.37	42		
4361	0-45	51	17	32	1.55	38	0.57	12.23	38	C212	5a
	-90	46	22	32	6.40	48	2.82	15.58	50		
	-150				4.90	44					
4362	0-45	51	17	32	4.00	44	1.93	11.67	37	D112	5a
	-90	58	17	25	22	48	12.0	27.20	109		
4363	0-45	68	10	22	1.95	33	0.62	5.38	24	D111	5at
	-90	36	17	47	17	57	10.3	22.5	48		
4364	0-45	53	17	30	2.2	40	0.70	4.10	14	C112	5ae
	-90	43	12	45	13	58	7.10	17.70	39		
	-150				27	62					
4365	0-45	48	12	40	114	41	33.3	19.5	49	D112	5ase
	-90	31	17	52	98	52	35.4	27.0	52		
4366	0-45	26	37	37	38	58	23.2	42.4	115	C212	5as
	-90	18	37	45	85	59	51.6	14.0	31		
4367	0-45	61	22	17	2.10	44	0.88	10.32	61	C211	5ae
	-90	61	24	15	1.80	42	0.79	16.01	107		
4368	0-45	43	17	40	11	56	6.02	23.58	59	D112	5a
	-90	26	24	50	53	69	29.7	24.70	49		
	-150				41	60					
4369	0-45	16	24	60	33	60	21.4	44.2	74	C212	5ase
	-90	23	25	52	33	56	16.0	30.4	58		
4370	0-45	28	15	57	24	61	10.7	21.3	37	C212	5as
	-90	8	20	72	33	76	16.0	24.0	33		
4371	0-45	4	24	72	50	65	44.8	70.4	98	C212	5as
	-90	6	19	75	61	72	45.0	67.0	89		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
4372	0-45	61	14	25	16	33	3.96	8.84	35	C211	5ast
	-90	51	9	40	33	44	18.10	9.10	23		
	-150				8.20	46					
4373	0-45	61	12	27	1.75	35	0.23	2.17	8	C111	3e
	-90	51	12	37	2.25	38	0.46	3.54	10		
4374	0-45	48	27	25	9.90	45	1.52	11.28	45	C212	5a
	-90	33	37	30	19	58	6.96	13.04	43		
4375	0-45	53	22	25	16	38	4.70	11.30	45	C211	5as
	-90	36	27	37	36	37	9.45	24.15	65		
4376	0-45	73	7	20	1.14	31	0.24	2.96	15	C111	6t
	-90	61	7	32	3.40	41	1.23	7.17	22		
	-150				8.50	46					
4377	0-45	16	27	57	35	61	12.80	20.80	37	C212	5as
	-90	5	21	74	42	73	17.90	18.90	26		
4378	0-45	35	19	46	5.45	53	2.52	11.08	24	D112	5a
	-90	17	19	64	24	81	19.50	36.50	57		
4379	0-45	40	14	46	20	53	7.44	18.16	40	D112	5as
	-90	17	19	64	49	63	21.20	28.40	44		
4380	0-45	35	19	46	11	54	7.30	12.70	28	C212	5a
	-90	17	19	64	55	61	20.60	20.20	32		
	-150				21	76					
4381	0-45	37	17	46	1.45	48	0.53	5.87	13	C112	4a
	-90	30	14	56	5.45	60	3.00	12.20	22		
4382	0-45	50	29	21	7.50	50	3.00	11.40	54	C211	5a
	-90	65	21	14	7.20	47	2.64	8.96	64		
4383	0-45	25	12	63	44	60	21.60	26.40	42	C212	5as
	-90	20	24	56	55	62	23.20	24.80	44		
	-150				18	70					
4384	0-45	32	39	29	71	60	44.90	31.90	110	C211	5as
	-90	22	44	34	16	74	11.10	48.10	142		
4385	0-45	87	7	6	1.08	39	0.34	2.86	48	C222	6at
	-90	gravel									
4386	0-45	12	32	56	34	75	22.50	43.90	78	D112	5as
	-90	5	31	64	11	91	8.20	28.60	45		
4387	0-45	32	22	46	8.4	58	4.35	22.85	50	C212	5ae
	-90	20	19	61	7.8	79	5.90	26.90	44		
	-150				4.25	66					
4388	0-45	40	21	39	12	51	4.59	16.21	42	C212	5a
	-90	17	22	61	11	74	8.5	7.1	12		
4389	0-45	40	21	39	5.40	54	2.36	1.84	5	C112	3ht
	-90	20	30	50	65	75	28.70	7.30	15		
4391	0-45	22	39	39	24	64	8.17	8.23	21	C212	5as
	-90	20	41	39	19	74	18.25	42.15	109		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
4392	0-45	37	24	39	10	48	5.6	14.4	37	C212	5a
	-90	27	34	39	22	63	9.5	21.7	56		
	-150				9.65	60					
4393	0-45	35	36	29	17	59	13.3	26.7	92	C211	5as
	-90	22	39	39	15	68	14.4	27.2	70		
4394	0-45	32	29	39	77	54	52.8	16.0	41	D112	5as
	-90	22	32	46	21	77	15.8	51.4	112		
4395	0-45	45	26	29	12	71	7.10	18.50	64	C211	5a
	-90	45	29	26	20	54	10.30	22.70	87		
4396	0-45	27	42	31	22	42	13.8	3.8	12	C211	5s
	-90	37	19	44	40	63	21.2	12.4	28		
	-150				40	63					
4397	0-45	50	16	34	28	45	10.5	18.30	54	D112	5as
	-90	42	24	34	11	56	6.86	20.34	60		
4398	0-45	45	21	34	11	55	8.80	22.0	65	C212	5a
	-90	30	29	41	22	63	12.00	22.0	54		
4399	0-45	27	54	19	2.20	41	0.72	5.28	28	C211	4ae
	-90	57	24	19	2.50	45	0.79	4.81	25		
4400	0-45	40	21	39	4.35	51	2.42	12.78	33	D112	5ao
	-90	27	19	54	13.0	100	12.5	38.7	72		
	-150				14	78					
4401	0-45	50	26	24	10.0	42	4.0	5.2	22	C211	5a
	-90	35	34	31	8.70	65	4.10	11.90	38		
4402	0-45	55	14	31	0.83	37	0.19	2.01	7	C112	4ae
	-90	45	14	41	7.05	51	3.60	9.60	23		
4403	0-45	60	9	31	1.65	38	0.52	3.88	13	C112	4ae
	-90	52	9	31	12	45	3.94	8.06	26		
4404	0-45	85	6	9	18	50	1.60	13.60	151	C211	5ae
	-90	80	6	14	3.15	51	1.02	18.98	136		
						2.35	45				
4408	0-45	47	14	39	0.64	38	0.24	3.76	10	D122	3ah
	-90	35	14	51	2.75	55	1.31	12.29	24		
4409	0-45	55	19	26	1.55	36	0.36	2.84	11	C111	3e
	-90	55	21	24	3.30	38	0.86	3.54	15		
4410	0-45	72	9	19	0.62	24	0.09	0.71	4	C111	3e
	-90	72	9	19	0.42	27	0.07	0.73	4		
4411	0-45	62	7	31	0.72	35	0.09	0.71	2	C112	3e
	-90	55	9	36	0.44	41	0.21	2.59	7		
	-150				0.90	45					
4412	0-45	45	29	26	23	55	11.00	23.40	90	D111	5as
	-90	47	27	26	11	47	5.40	23.40	90		
4413	0-45	50	29	21	10.0	37	1.8	3.00	14	D111	5a
	-90	40	39	21	15	55	4.3	6.9	33		
4405) 4406) 4407)	Stones + gravel.										

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
4414	0-45	52	14	34	0.52	43	0.11	1.09	3	C112	6t
	-90	72	7	21	0.42	34	0.09	0.71	3		
4415	0-45	65	11	24	1.25	34	0.21	1.39	6	D121	2e
	-90	70	14	16	2.65	37	0.56	1.84	12		
	-150				3.35	29					
4416	0-45	45	29	26	22	48	5.76	9.44	36	D111	5as
	-90	57	24	19	24	49	9.78	9.42	50		
4417	0-45	57	12	31	0.51	35	0.18	1.42	46	C212	5a
	-90	55	9	36	0.72	42	0.26	1.74	48		
4418	0-45	52	17	31	0.72	37	0.23	1.77	6	C112	3e
	-90	52	14	34	19	43	1.62	2.38	7		
4419	0-45	40	19	41	33	49	5.89	11.31	28	C212	5s
	-90	27	22	51	51	55	12.4	9.60	19		
	-150				61	63					
4420	0-45	22	17	61	36	53	10.3	12.5	21	C212	5s
	-90	25	24	51	73	57	18.8	14.0	27		
4421	0-45	87	6	7	0.66	20	0.08	1.12	16	C222	6at
	-90	57	11	32	1.08	47	0.50	10.70	33		
4422	0-45	69	9	22	0.72	23	0.13	1.47	7	D121	5a
	-90	62	14	24	1.08	40	0.40	19.60	82		
4423	0-45	42	14	44	0.88	39	0.34	7.66	17	D112	5a
	-90	72	9	19	3.40	37	1.26	11.54	61		
	-150				4.05	30					
4424	0-45	84	7	9	0.51	20	0.05	0.75	8	C221	6t
	-90	84	7	9	0.72	18	0.12	1.08	12		
4425	0-45	77	9	14	3.00	22	0.69	4.51	32	D111	5a
	-90	59	14	27	7.35	44	3.30	19.50	72		
4426	0-45	52	24	24	2.28	38	0.78	20.42	85	C211	5a
	-90	49	27	24	7.45	48	3.60	25.00	105		
	-150				8.40	50					
4427	0-45	57	19	24	7.90	40	3.00	10.20	43	C211	5a
	-90	52	21	27	28	45	12.70	19.30	71		
4428	0-45	52	11	37	1.68	40	0.60	9.80	27	D112	5a
	-90	39	19	42	3.25	61	2.60	16.34	39		
4429	0-45	39	17	44	1.02	48	0.42	5.98	14	D112	5a
	-90	49	14	37	5.30	51	2.74	18.06	49		
4430	0-45	69	12	19	5.15	35	2.20	13.18	69	D111	5a
	-90	64	12	24	10.0	46	5.60	24.00	100		
	-150				8.50	61					
4431	0-45	34	22	44	2.55	49	1.22	11.58	26	C212	5ae
	-90	42	16	42	11	90	8.50	31.50	75		
4432	0-45	32	24	44	0.90	49	0.42	4.38	10	C112	3ahe
	-90	29	24	47	2.04	50	0.88	11.52	25		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
4433	0-45	32	26	42	0.66	47	0.26	2.94	7	C112	3ahe
	-90	32	21	47	0.80	49	0.37	10.03	22		
4434	0-45	24	27	49	0.51	54	0.25	2.95	6	C112	3h
	-90	29	24	47	0.72	52	0.38	6.82	15		
4435	0-45	32	26	42	1.20	59	0.52	3.08	7	C112	4a
	-90	42	16	42	2.50	55	1.44	11.36	27		
4436	0-45	49	22	29	1.08	46	0.47	5.53	19	D111	5a
	-90	54	14	32	5.40	81	4.05	19.15	60		
4437	0-45	54	12	34	1.45	38	0.51	8.29	24	C212	5a
	-90	34	19	47	4.85	70	3.18	19.22	41		
4438	0-45	82	6	12	0.37	19	0.03	0.77	6	C221	6t
	-90	82	6	12	0.39	20	0.03	0.57	5		
	-150				0.66	16					
4439	0-45	82	6	12	0.66	21	0.11	1.09	9	C212	6at
	-90	72	6	22	1.45	27	0.62	6.98	32		
4440	0-45	67	11	22	10	33	3.38	12.62	57	C211	5a
	-90	59	12	29	21	51	11.10	16.90	58		
4441	0-45	59	12	29	0.84	34	0.22	2.98	10	C111	3a
	-90	52	11	37	1.56	46	0.62	7.78	21		
4442	0-45	84	7	9	0.48	17	0.04	0.16	2	C221	6t
	-90	82	6	12	0.84	19	0.08	0.32	3		
	-150				3.05	25					
4443	0-45	74	7	19	0.90	20	0.16	3.04	16	C211	5at
	-90	57	9	34	2.50	42	0.59	10.61	31		
4444	0-45	42	16	42	2.25	50	0.96	10.84	26	D112	5ae
	-90	37	21	42	16	54	8.9	17.5	42		
4445	0-45	52	11	37	1.08	39	0.39	6.81	18	D112	5ae
	-90	42	11	47	4.50	65	2.54	14.66	31		
4446	0-45	52	19	29	2.40	52	0.91	6.69	23	D111	5a
	-90	57	11	32	5.40	77	4.04	21.56	60		
4447	0-45	24	22	54	0.84	52	0.39	7.21	13	A111	3ah
	-90	24	14	62	3.60	69	1.42	14.18	23		
4448	0-45	27	14	59	1.02	64	0.35	2.85	5	C121	3h
	-90	42	11	47	0.42	58	0.09	0.71	2		
4449	0-45	69	9	22	2.55	34	0.85	6.35	29	C211	5at
	-90	62	9	29	9.95	60	6.23	16.97	88		
4450	0-45	69	12	19	4.95	27	0.83	5.37	28	C211	5at
	-90	57	11	32	11	41	4.21	14.99	47		
4451	0-45	64	14	22	0.66	41	0.24	2.16	10	C111	4at
	-90	64	7	29	2.40	36	0.76	8.04	28		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
4452	0-45	82	6	12	0.52	19	0.10	0.70	6	C111	4a
	-90	79	7	14	2.15	21	0.43	3.57	26		
4453	0-45	84	7	9	0.43	19	0.04	0.36	4	C221	6t
	-90	84	7	9	0.42	19	0.04	0.76	8		
	-150				0.84	24					
4454	0-45	72	6	22	3.05	28	0.91	7.89	36	C211	5at
	-90	39	19	42	11	86	7.80	25.40	60		
4455	0-45	68	12	20	1.75	27	0.28	5.72	28	C211	5ae
	-90	58	15	27	12	52	6.4	13.6	50		
4456	0-45	41	14	45	1.08	45	0.46	9.54	21	C212	5a
	-90	38	15	47	4.30	63	2.50	20.10	43		
4457	0-45	46	19	35	14.0	45	6.2	15.4	44	C212	5a
	-90	43	25	32	15.0	60	9.9	24.5	76		
4458	-150				19	54				C212	5a
	0-45	48	12	40	13	52	6.5	13.5	34		
	-90	31	19	50	5.75	94	5.40	27.40	55		
4459	0-45	51	12	37	0.66	45	0.10	1.10	3	C112	2e
	-90	68	10	22	0.72	34	0.15	0.65	3		
4460	0-45	6	29	65	1.70	66	0.62	3.38	5	C121	3aht
	-90	13	25	62	2.15	68	1.26	10.34	17		
4461	0-45	71	7	22	0.66	32	0.06	0.74	3	C111	1
	-90	71	7	22	0.37	27	0.04	0.76	3		
	-150				0.48	27					
4462	0-45	48	12	40	4.25	42	1.79	8.81	22	C212	5ae
	-90	43	12	45	15	77	12.7	15.7	35		
4463	0-45	61	9	30	1.44	33	0.40	7.60	25	D112	5ae
	-90	56	12	32	3.05	58	1.23	15.57	49		
4464	0-45	43	17	40	5.50	66	3.28	17.52	44	D112	5ae
	-90	48	12	40	2.04	44	0.75	12.05	30		
	-150				2.20	72					
4465	0-45	86	7	7	0.78	19	0.08	0.72	10	C222	6t
	-90	78	7	15	0.90	20	0.17	2.63	17		
4466	0-45	86	7	7	0.45	21	0.04	0.76	11	C221	6t
	-90	83	7	10	0.78	20	0.12	1.08	11		
4467	0-45	83	7	10	1.02	21	0.15	1.45	15	C222	401
	-90	73	10	17	0.90	25	0.14	1.46	9		
4468	0-45	66	9	25	1.08	23	0.21	5.39	22	D111	5a
	-90	46	12	42	4.30	59	2.51	17.49	42		
	-150				4.80	62					
4469	0-45	53	17	30	9.95	52	5.20	30.00	100	D111	5a
	-90	58	17	25	10	65	5.47	40.93	164		
4470	0-45	76	7	17	0.78	24	0.06	1.54	9	C111	401
	-90	80	7	13	0.52	23	0.04	0.76	6		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
4471	0-45	45	17	38	0.66	46	0.17	1.43	4	C112	5a
	-90	43	15	42	4.20	55	2.01	14.79	35		
4472	0-45	83	7	10	0.45	22	0.04	0.76	8	C221	6t
	-90	78	7	15	0.78	20	0.13	1.87	12		
4473	0-45	78	7	15	3.15	29	0.21	2.19	15	D121	5a
	-90	68	10	22	1.20	23	0.37	8.03	36		
4474	0-45	68	10	22	4.00	28	1.12	7.88	36	D111	5a
	-90	48	15	37	15.0	60	9.5	16.1	43		
4475	0-45	68	10	22	1.90	68	1.02	4.18	19	C211	5a
	-90	56	12	32	11	45	5.3	10.3	32		
4476	0-45	48	12	40	0.57	39	0.21	4.59	11	C112	3ahe
	-90	41	14	45	4.25	51	2.10	9.10	20		
4477	0-45	51	12	37	58	37	0.28	4.52	12	C112	4a
	-90	38	15	47	0.84	57	0.97	13.63	30		
4478	0-45	33	15	52	2.10	59	1.09	7.71	15	D122	5at
	-90	51	12	37	7.50	73	5.30	17.10	46		
4479	0-45	8	20	72	3.60	109	0.50	3.50	5	A111	3ht
	-90	11	17	72	1.02	76	0.87	8.73	12		
4480	0-45	31	12	57	2.35	64	1.15	6.25	11	A111	4at
	-90	36	17	47	5.15	64	3.36	13.44	28		
4481	0-45	8	27	65	0.46	62	0.39	6.41	10	A111	3aht
	-90	8	25	67	0.72	77	2.31	13.69	20		
4482	0-45	8	30	62	2.75	72	1.93	12.17	20	C212	5a
	-90	23	22	55	14	63	7.9	16.9	31		
4483	0-45	21	32	47	0.90	62	0.55	9.85	21	C212	5ae
	-90	26	24	50	11	77	9.4	17.8	36		
4484	0-45	31	27	42	12	74	0.20	1.40	3	C121	3h
	-90	21	27	52	0.90	54	0.28	3.72	7		
4485	0-45	78	17	15	1.80	20	0.32	7.28	49	C211	5ae
	-90	53	12	35	4.85	44	2.04	9.96	29		
4486	0-45	38	32	30	1.45	86	0.61	6.19	21	D112	5ae
	-90	53	17	30	4.30	35	3.75	20.25	68		
4487	0-45	71	7	22	4.30	92	1.58	8.42	38	D111	5a
	-90	61	12	27	3.85	53	2.50	21.50	80		
4488	0-45	43	25	32	7.10	71	19.10	33.70	105	C212	5ase
	-90	36	22	42	30	53	23.0	22.60	54		
4489	0-45	48	10	42	0.57	45	0.06	1.14	3	C112	3h
	-90	71	7	22	1.08	27	0.23	2.17	10		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
4490	0-45 -90	63 66	7 7	30 27	0.96 4.85	35 39	0.28 1.85	3.32 10.95	11	D122	5a
4491	0-45 -90 -150	48 63	12 7	40 30	0.45 2.10 7.60	49 39 49	0.10 0.72	1.10 5.68	3 19	D122	3aht
4492	0-45 -90	76 55	7 12	17 33	0.32 0.42	28 36	0.04 0.05	0.96 0.75	6 2	C111	1
4493	0-45 -90	60 55	12 12	28 33	0.46 1.40	39 52	0.19 0.69	2.21 6.91	8 21	D121	3a
4494	0-45 -90	60 60	10 10	30 30	0.42 0.37	34 35	0.06 0.09	0.74 0.71	2 2	D122	1
4495	0-45 -90 -150	73 63	7 12	20 25	0.34 0.28 0.90	33 37 37	0.05 0.06	0.75 0.74	4 3	D121	2t
4496	0-45 -90	58 58	17 12	25 30	5.10 1.60	49 36	2.45 0.54	19.15 6.66	77 23	D111	5a
4497	0-45 -90	75 50	7 15	18 35	3.24 3.80	26 92	0.74 3.40	11.66 1.40	65 4	D111	5a
4498	0-45 -90	60 53	10 12	30 35	0.57 3.30	38 52	0.21 1.82	5.19 16.98	17 48	C212	5a
4499	0-45 -90 -150	38 70	12 7	50 23	0.72 1.08 2.15	51 25 31	0.20 0.20	2.10 2.20	4 10	C112	3h
4500	0-45 -90	78 70	7 7	15 23	0.48 1.20	21 41	0.08 0.51	1.12 7.09	7 31	C111	5a
4501	0-45 -90	73 53	7 19	20 28	0.36 0.35	26 42	0.04 0.06	1.16 1.14	6 4	C111	3e
4502	0-45 -90 -150	53 43	12 17	35 40	21 11 4.85	55 91 66	11.3 11.4	15.9 26.2	45 66	D112	5as
4503	0-45 -90	63 60	14 12	23 28	13 13	40 62	4.4 8.40	17.2 26.00	77 93	D111	5a
4504	0-45 -90	33 45	22 15	45 40	1.35 6.65	73 69	0.88 4.30	4.92 15.10	11 38	C112	5at
4505	0-45 -90 -150	23 25	39 25	38 50	0.39 0.29 0.44	62 61 42	0.06 0.06	1.14 1.14	3 2	C112	3h
4506	0-45 -90	55 45	15 17	30 38	3.05 4.90	42 82	1.32 4.10	8.28 26.30	28 69	D112	5a
4507	0-45 -90 -150	38 40	27 22	35 38	10.0 12.0 6.05	61 75 67	6.6 7.4	14.2 31.0	41 82	D112	5at
4508	0-45 -90	75 58	7 9	18 33	0.54 1.90	35 41	0.11 0.64	1.49 4.56	8 14	C111	401t

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
4509	0-45	80	7	13	1.45	22	0.10	0.70	5	C111	401t
	-90	78	7	15	0.57	24	0.07	0.73	5		
4510	0-45	33	19	48	8.45	71	3.55	1.65	3	C121	3h
	-90	3	47	50	0.36	80	0.12	1.08	2		
	-150				0.57	71					
4511	0-45	23	17	60	0.40	60	0.11	1.09	2	C121	3h
	-90	68	7	25	0.42	27	0.04	0.76	3		
4512	0-45	65	12	23	0.33	32	0.05	0.75	3	C111	2e
	-90	58	14	28	0.66	37	0.07	0.73	3		
4513	0-45	28	31	41	1.02	60	0.13	1.87	5	C112	3ht
	-90	28	34	38	0.48	70	0.11	1.49	4		
4514	0-45	23	29	48	0.90	60	0.30	2.10	4	C112	3ht
	-90	51	21	28	0.90	59	0.28	2.12	8		
	-150				1.75	62					
4515	0-45	68	14	18	0.49	42	0.08	1.12	6	C111	1
	-90	51	21	28	0.54	53	0.11	1.89	7		
4516	0-45	26	43	31	0.57	74	0.19	1.81	6	C112	3h
	-90	16	43	41	1.25	75	0.21	1.39	3		
4517	0-45	26	21	53	1.50	57	0.71	6.49	12	C121	5at
	-90	38	21	41	8.05	57	3.70	11.50	28		
4518	0-45	21	18	61	1.95	48	0.63	5.77	9	A111	3ht
	-90	26	16	58	1.75	66	0.88	5.52	10		
	-150				3.60	59					
4519	0-45	6	16	78	0.48	71	0.15	1.85	2	A111	3ht
	-90	36	18	46	2.80	57	1.00	3.40	7		
4520	0-45	8	49	43	0.90	67	0.17	1.83	4	C121	3ht
	-90	21	21	58	1.75	65	0.78	4.42	8		
4521	0-45	21	36	43	0.54	66	0.13	1.47	2	C121	3he
	-90	23	33	46	0.44	68	0.16	1.44	3		
4522	-150				0.78	61				C112	2h
	0-45	23	41	36	0.96	69	0.14	1.06	3		
4523	0-45	58	14	28	0.51	40	0.05	6.35	23	C111	4au
	-90	43	19	38	0.34	68	0.07	0.73	2		
4524	0-45	21	36	43	0.50	73	0.12	1.08	3	C121	3h
	-90	18	36	46	0.44	59	0.12	1.48	3		
4525	0-45	11	36	53	0.57	66	0.12	1.48	3	C121	3hte
	-90	13	14	53	0.49	66	0.15	1.85	3		
	-150				1.60	56					
4526	0-45	26	21	53	0.53	56	0.13	1.47	5	C121	3hte
	-90	26	18	58	0.78	58	0.30	3.30	6		
4527	0-45	56	13	31	0.96	36	0.13	1.47	2	D122	1
	-90	63	16	21	0.96	41	0.25	1.35	14		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
4528	0-45	11	23	66	0.52	72	0.14	1.46	2	C121	3hte
	-90	41	18	41	2.40	56	0.98	5.82	14		
4529	0-45	8	26	66	0.66	68	0.22	2.18	3	C121	3hte
	-90	38	21	41	6.65	58	3.56	8.04	2		
4530	-150				4.80	66				C121	3aht
	0-45	18	24	58	0.84	60	0.39	4.81	8		
	-90	33	21	46	4.25	57	2.21	9.39	20		
4531	0-45	11	36	53	0.84	69	0.14	1.46	3	C121	3he
	-90	21	31	48	0.48	68	0.14	1.06	2		
4532	0-45	38	29	33	0.96	60	0.11	0.69	2	C112	3h
	-90	33	26	41	0.48	56	0.09	1.11	3		
4533	-150				0.96	65				C112	3h
	0-45	38	26	36	0.66	60	0.09	0.71	2		
	-90	23	31	46	0.55	68	0.18	1.42	3		
4534	0-45	43	24	33	0.78	55	0.15	1.25	4	C112	2h
	-90	38	26	36	3.80	55	1.58	4.82	13		
4535	0-45	11	28	61	0.57	71	0.18	1.42	2	C121	3aht
	-90	23	26	51	7.30	53	2.78	12.42	24		
4536	0-45	61	13	26	0.57	47	0.08	0.72	3	C111	2t
	-90	66	11	23	0.43	49	0.07	0.73	3		
4537	0-45	41	26	33	0.45	39	0.06	0.74	2	C112	2h
	-90	46	21	33	0.40	53	0.11	0.69	2		
4538	-150				0.84	53				C111	1
	0-45	71	11	18	0.55	39	0.06	0.74	4		
	-90	58	19	13	0.44	41	0.09	1.11	9		
4539	0-45	53	16	31	0.96	48	0.10	1.10	4	C112	1
	-90	56	16	28	0.44	48	0.05	1.15	4		
4540	0-45	51	13	36	0.52	50	0.07	1.13	3	C112	2h
	-90	38	26	36	0.84	59	0.11	1.29	4		
4541	-150				2.15	75				C112	3h
	0-45	41	18	41	0.57	56	0.06	1.14	3		
	-90	36	28	36	0.47	53	0.07	1.13	3		
4542	0-45	16	36	48	0.90	65	0.12	1.48	3	C121	3h
	-90	18	29	53	1.20	71	0.30	1.70	3		
4543	0-45	11	28	61	0.72	71	0.14	1.46	2	C121	3h
	-90	26	21	53	0.66	64	0.11	1.09	2		
4544	-150				1.95	56				C121	3hte
	0-45	38	16	46	2.50	56	0.87	0.33	1		
	-90	33	19	48	2.15	59	0.19	1.01	2		
4545	0-45	33	14	53	0.72	58	0.12	1.08	2	C121	3ht
	-90	33	14	53	1.20	63	0.31	1.29	2		
4546	0-45	71	8	21	0.42	33	0.06	0.74	14	C111	2te
	-90	81	6	13	0.57	65	0.35	1.65	13		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
4547	0-45	23	41	36	0.96	44	0.11	1.09	3	C121	3hte
	-90	26	28	46	0.39	62	0.16	1.84	4		
4548	0-45	56	23	21	0.52	44	0.18	1.82	9	C111	3ae
	-90	51	13	36	1.02	45	0.42	8.78	24		
	-150				4.95	63					
4549	0-45	36	22	41	6.65	53	3.32	18.68	46	C212	5ae
	-90	18	46	36	12.00	65	6.83	23.57	65		
4550	0-45	63	16	21	2.40	32	0.30	2.50	12	C111	6k
	-90	gravel			4.75	60	2.70	14.10	30		
4551	0-45	61	13	26	0.39	35	0.04	1.56	6	C111	6k
	-90	gravel			6.10	53	3.38	9.00	21		
4552	0-45	58	24	18	1.14	32	0.17	2.23	12	D121	5t
	-90	40	27	33	8.30	47	3.53	9.27	28		
4553	0-45	60	20	20	0.57	34	0.09	2.31	12	C111	6k
	-90	gravel			0.43	64	0.16	1.40	3		
4554	0-45	40	12	48	0.72	52	0.34	4.86	10	C121	4ae
	-90	28	17	55	4.25	63	2.60	15.80	29		
	-150				13	83					
4555	0-45	30	35	35	1.14	53	0.43	1.97	6	C112	3h
	-90	20	35	45	0.72	59	0.37	5.23	12		
4556	0-45	45	17	38	1.14	43	0.11	5.49	14	C112	2ah
	-90	73	7	20	0.51	22	0.04	0.76	4		
4557	0-45	53	19	28	0.48	37	0.03	1.17	4	D121	3e
	-90	58	19	23	0.43	27	0.03	0.77	3		
4558	0-45	3	32	65	0.57	72	0.15	1.85	3	C121	3hte
	-90	20	27	53	3.20	62	1.55	7.25	14		
	-150				2.15	72					
4559	0-45	15	27	58	0.90	66	0.11	1.49	3	C121	3hte
	-90	33	32	35	0.46	62	0.09	1.51	4		
4560	0-45	23	24	53	0.49	57	0.06	1.54	3	C121	3hte
	-90	20	20	60	0.40	63	0.09	1.51	3		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
5485	0-45	37	22	41	1.80	35	0.61	4.99	12	C112	3h
	-90	32	19	49	6.10	66	3.80	6.60	13		
	-150				11	65					
5486	0-45	46	14	40	1.55	49	0.74	7.26	18	D112	4a.
	-90	34	19	47	8.05	75	6.20	6.40	14		
5487	0-45	41	12	47	1.80	42	0.74	12.86	27	D112	4ae
	-90	46	14	40	6.00	77	4.04	10.36	26		
5488	0-45	29	26	45	0.84	44	0.33	10.87	24	C212	4ae
	-90	29	24	47	4.75	60	2.70	14.10	30		
5489	0-45	64	19	17	1.55	34	0.34	2.46	14	C111	401t
	-90	46	12	42	6.10	53	3.38	9.02	21		
	-150				6.05	58					
5490	0-45	39	21	40	28	57	7.8	18.8	47	C212	5as
	-90	29	24	47	36	71	18.7	18.5	39		
5491	0-45	41	19	40	0.42	51	0.19	1.41	4	C121	3h
	-90	34	14	52	0.43	62	0.16	1.44	3		
5492	0-45	14	31	55	0.80	69	0.43	0.77	1	C121	3h
	-90	14	34	52	0.41	64	0.24	1.36	3		
5493	0-45	14	34	52	0.92	63	0.63	7.37	14	A121	4ae
	-90	11	32	57	6.80	84	5.35	16.65	29		
	-150				9.10	72					
5494	0-45	21	17	62	1.02	55	0.55	6.65	11	A121	3aht
	-90	21	14	65	2.50	71	1.78	15.82	24		
5495	0-45	26	22	52	0.98	50	0.50	7.10	14	A121	4at
	-90	24	21	55	5.05	71	3.82	16.18	29		
5496	0-45	46	12	42	1.50	49	0.86	11.34	27	C212	5ae
	-90	44	11	45	4.35	70	2.98	24.42	54		
5497	0-45	21	27	52	0.37	56	0.21	3.39	7	A111	3hte
	-90	21	22	57	0.53	64	0.32	5.68	10		
	-150				38	55					
5498	0-45	36	24	40	0.82	50	0.38	14.02	35	C212	5ae
	-90	41	29	30	17.00	53	9.0	21.80	73		
5499	0-45	41	24	35	1.04	42	0.32	2.88	9	C112	3h
	-90	29	29	42	0.71	50	0.25	2.15	5		
5500	0-45	34	21	45	24.00	54	12.0	39.2	87	D112	5as
	-90	28	24	48	59.00	55	31.0	36.2	75		
5501	0-45	31	34	35	28.00	53	13.9	38.9	111	C212	5ase
	-90	26	34	40	23.00	55	13.4	19.4	48		
	-150				35	48					
5502	0-45	36	24	40	145.00	44	48.5	21.9	55	D112	5as
	-90	32	19	49	69.00	50	34.6	18.2	37		
5503	0-45	21	39	40	9.25	50	4.56	16.24	41	D112	5ae
	-90	31	22	47	24.00	62	14.0	53.20	113		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
5504	0-45	46	17	37	2.20	44	0.93	6.27	17	D112	5ae
	-90	34	24	42	5.20	64	3.52	18.08	43		
	-150										
5505	0-45	41	24	35	0.87	39	0.29	4.91	14	C212	5ae
	-90	31	27	42	4.00	53	2.25	13.55	32		
5506	0-45	51	34	15	0.44	46	0.12	1.08	7	C111	2ht
	-90	34	39	27	0.61	51	0.19	1.41	5		
5507	0-45	64	21	15	0.35	48	0.12	1.08	7	C111	2h
	-90	39	34	27	0.39	51	0.19	1.41	5		
5508	0-45	36	24	40	0.38	49	0.25	15.75	39	D112	5ae
	-90	29	23	48	3.55	58	2.39	25.41	53		
	-150				3.75	45					
5509	0-45	16	57	27	0.49	42	0.21	2.99	11	C111	5ae
	-90	16	47	37	2.50	63	1.42	11.38	31		
5510	0-45	31	47	22	1.95	45	0.45	1.95	9	C111	5a
	-90	29	34	37	49.00	50	18.50	16.70	45		
5511	0-45	34	24	42	0.62	48	0.30	1.30	3	C112	2h
	-90	21	39	40	0.44	56	0.21	1.39	3		
5512	0-45	34	31	35	6.95	51	3.58	17.22	49	C212	5a
	-90	16	42	42	23.00	62	13.90	26.10	62		
	-150				19	63					
5513	0-45	29	34	37	19.00	50	9.0	24.6	67	C212	5as
	-90	9	41	50	32.00	60	20.3	35.7	71		
	-150										
5514	0-45	39	19	42	10.00	67	6.36	14.04	33	C112	5ae
	-90	28	21	51	32.00	59	18.4	34.8	68		
5515	0-45	29	39	32	1.55	41	0.62	4.18	13	D122	3ae
	-90	36	27	37	1.04	42	0.37	6.83	18		
5516	0-45	51	7	32	0.74	37	0.28	3.32	10	C112	3h
	-90	34	21	45	0.78	45	0.34	5.66	13		
	-150				2.40	56					
5517	0-45	66	14	20	0.39	23	0.09	1.11	6	C111	1.
	-90	66	12	20	0.57	26	0.07	1.13	6		
5518	0-45	69	19	12	4.00	39	0.68	2.52	21	D111	401
	-90	66	17	17	1.55	38	0.38	2.02	12		
5519	0-45	31	27	42	13	49	6.38	22.42	53	D112	5ae
	-90	34	26	40	24	60	14.4	49.6	124		
5520	0-45	31	29	40	10	55	5.2	22.0	55	D112	5a
	-90	19	44	37	16	65	10.2	29.2	79		
	-150				4.10	35					
5521	0-45	31	37	32	48	53	17.2	14.8	47	D112	5ase
	-90	41	27	32	48	53	17.2	15.6	48		
5522	0-45	21	47	32	1.55	51	0.77	7.23	23	D112	5ae
	-90	24	36	40	13	70	8.9	20.7	52		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
5523	0-45	39	49	12	0.64	55	0.28	1.72	14	C111	2ah
	-90	26	57	17	0.91	53	0.46	1.94	11		
	-150				0.84	49					
5524	0-45	21	39	40	0.68	46	0.23	7.77	19	C212	5a
	-90	9	44	47	3.00	62	1.86	17.34	37		
5525	0-45	41	32	27	0.72	44	0.22	2.18	8	D121	3hte
	-90	36	32	42	0.61	50	0.25	3.75	9		
5526	0-45	16	37	47	0.57	48	0.24	2.96	6	C121	3aht
	-90	11	32	57	1.80	65	1.14	10.66	19		
5527	0-45	31	37	32	0.85	42	0.32	6.08	19	D112	5ae
	-90	28	27	45	3.40	61	2.14	19.26	43		
	-150				18	56					
5528	0-45	31	27	42	1.42	41	0.62	12.18	29	D112	5a
	-90	56	17	27	12	44	5.06	23.74	88		
5529	0-45	16	34	50	0.74	49	0.37	3.63	7	C121	3aht
	-90	8	37	55	0.88	51	0.54	10.66	19		
5530	0-45	26	34	40	0.63	42	0.26	5.74	14	C112	3ah
	-90	23	30	47	1.24	57	0.71	11.29	24		
5531	0-45	58	15	27	17	36	5.7	20.3	75	D111	5ase
	-90	33	30	37	13	71	9.6	49.6	134		
	-150				4.25	77					
5532	0-45	31	27	42	2.10	53	1.19	10.61	25	D112	5a
	-90	16	27	57	10.00	76	7.05	32.15	56		
5533	0-45	16	34	50	0.84	59	0.30	2.10	4	D122	3h
	-90	31	24	45	0.39	46	0.17	1.43	3		
5534	0-45	18	50	32	0.43	64	0.24	1.36	4	C112	3h
	-90	6	37	57	0.49	62	0.31	2.09	4		
5535	0-45	43	27	30	0.91	37	0.32	2.88	10	D121	5a
	-90	23	35	42	5.30	68	3.74	24.26	59		
	-150				4.35	86					
5536	0-45	23	32	45	4.38	56	2.66	24.94	55	D112	5ae
	-90	33	30	37	19	52	10.1	29.10	79		
5537	0-45	73	10	17	0.32	34	0.09	1.91	11	C111	401t
	-90	81	7	12	0.25	21	0.05	1.55	13		
5538	0-45	56	19	25	0.55	46	0.23	0.97	4	C111	1
	-90	56	24	20	0.38	41	0.10	0.90	5		
5539	0-45	28	37	35	0.28	48	0.12	1.08	3	C112	4t
	-90	56	14	30	0.28	35	0.09	1.51	5		
	-150				0.90	27					
5540	0-45	21	44	35	0.42	49	0.18	1.42	4	C112	4t
	-90	71	12	17	0.28	28	0.07	0.73	4		
5541	0-45	48	20	32	1.55	38	0.57	8.23	26	C212	5a
	-90	33	20	47	11	59	6.8	22.4	48		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
5542	0-45	56	22	22	0.48	32	0.16	1.44	7	C111	4t
	-90	66	14	20	1.25	31	0.23	0.97	5		
5543	0-45	36	34	30	0.47	43	0.22	2.98	10	D122	5ae
	-90	31	27	42	5.75	56	2.80	14.00	33		
5544	0-45	51	37	12	1.12	65	0.23	0.97	8	C111	4ae
	-90	58	17	25	0.35	41	0.15	0.65	26		
5545	0-45	76	9	15	0.38	21	0.05	0.75	5	C111	401t
	-90	83	7	10	0.64	20	0.10	1.50	15		
5546	0-45	28	42	30	0.47	52	0.26	4.54	15	D112	5ae
	-90	41	29	30	3.15	49	1.35	18.65	62		
5547	0-45	76	9	15	0.78	29	0.18	1.42	9	C111	5a
	-90	78	7	15	6.00	19	1.14	8.06	54		
5548	0-45	26	29	45	12	61	6.5	18.3	41	D112	5a
	-90	51	19	30	24	44	16.5	31.50	105		
5549	0-45	33	27	40	3.00	41	1.23	10.77	27	D112	5ae
	-90	48	22	30	10	42	3.8	21.0	70		
5550	0-45	56	12	32	1.25	37	0.46	4.74	15	C112	5at
	-90	71	12	17	3.10	22	0.72	15.68	92		
5551	0-45	66	17	17	0.66	30	0.19	1.01	6	C111	401t
	-90	66	14	20	0.37	41	0.15	0.65	3		
5552	0-45	61	17	22	0.57	42	0.90	5.50	25	C211	5a
	-90	48	20	32	2.50	36	3.12	20.08	65		
5553	0-45	26	42	32	1.11	47	0.53	1.07	3	C112	4t
	-90	48	27	25	1.55	36	0.54	1.46	6		
5554	0-45	78	7	15	0.46	19	0.10	0.30	2	C111	4e
	-90	81	7	12	0.44	19	0.10	0.70	6		
5555	0-45	73	7	20	2.20	22	0.49	5.91	30	C211	5a
	-90	71	7	22	6.95	27	2.03	12.37	56		
5556	0-45	66	12	22	8.15	38	3.33	18.27	83	D111	5at
	-90	68	10	22	43	38	19	38.6	176		
5557	0-45	71	14	15	0.50	39	0.20	1.20	8	C111	401t
	-90	81	7	12	0.68	40	0.25	0.95	8		
5558	0-45	43	27	30	0.57	41	0.26	1.34	4	C112	2t
	-90	33	35	32	1.12	46	0.29	1.31	4		
5559	0-45	41	32	27	0.48	45	0.17	1.43	5	C111	2h
	-90	41	27	32	0.42	43	0.16	1.04	3		
5560	0-45	28	35	37	2.10	50	0.44	0.76	2	C112	2h
	-90	46	17	37	1.01	44	0.10	1.10	3		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
5561	0-45	78	7	15	0.72	22	0.17	0.63	4	C111	401t
	-90	71	7	22	1.80	25	0.47	5.93	27		
5562	0-45	51	19	30	8.15	46	4.02	31.98	107	D111	5ae
	-90	63	17	20	16	46	8.3	8.5	42		
	-150				10	56					
5563	0-45	68	17	15	4.50	39	1.95	15.65	104	C211	5a
	-90	66	12	22	4.25	34	1.44	13.76	62		
5564	0-45	73	15	12	36	42	21.4	34.60	290	C211	5ase
	-90	41	29	30	56	39	25.6	11.2	37		
5565	0-45	29	46	25	12	42	7.25	31.75	127	D111	5ae
	-90	49	26	25	19	47	9.2	20.0	80		
5566	0-45	39	34	27	6.30	50	3.38	22.22	82	D111	5ae
	-90	39	36	25	10	52	3.00	30.7	123		
5567	0-45	49	19	32	3.30	46	1.49	17.71	55	D112	5ae
	-90	46	24	30	8.05	49	4.04	15.96	53		
5568	0-45	69	9	22	5.45	38	2.09	13.11	60	C211	5at
	-90	76	7	17	1.14	31	0.35	3.85	23		
5569	0-45	51	19	30	0.39	41	0.15	1.25	4	C111	2t
	-90	74	9	17	0.57	35	0.22	0.58	3		
5570	0-45	36	34	30	17	50	9.75	28.65	96	D111	5ase
	-90	41	29	30	84	47	51.00	48.20	161		
5571	0-45	39	21	40	1.15	44	0.55	5.85	15	D122	5a
	-90	31	22	47	3.65	59	2.29	14.51	31		
	-150				11	44					
5572	0-45	21	47	32	12	57	6.72	30.88	97	D112	5ae
	-90	41	37	22	76	56	47.9	72.10	328		
5573	0-45	55	6	39	1.02	31	0.26	4.94	13	C112	5a
	-90	47	9	44	4.85	49	2.26	14.54	33		
5574	0-45	67	14	19	1.65	34	0.51	6.69	35	D111	5ate
	-90	62	12	26	10	40	3.7	13.90	53		
5575	0-45	50	11	39	3.15	46	1.44	12.96	33	D112	5at
	-90	50	11	39	16	48	8.88	15.12	39		
	-150				17	56					
5576	0-45	65	6	29	0.78	34	0.25	5.35	18	C211	5ate
	-90	55	14	31	13	43	4.95	11.85	38		
5577	0-45	82	4	14	0.66	21	0.06	0.74	5	D121	5t
	-90	77	7	16	0.72	22	0.15	2.65	17		
5578	0-45	75	6	19	0.57	27	0.09	0.91	5	D121	3e
	-90	70	36	24	0.48	28	0.05	0.95	4		
5579	0-45	72	7	21	1.35	25	0.16	5.84	28	C211	5ate
	-90	65	6	29	12	37	4.30	13.70	47		
	-150				8.20	51					

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
5580	0-45	82	7	11	0.54	23	0.08	2.32	21	C211	401t
	-90	82	7	11	0.66	23	0.15	0.65	6		
5581	0-45	65	6	29	10	42	4.6	11.6	39	D111	5a
	-90	52	14	34	19	80	11.8	37.8	111		
5582	0-45	67	7	26	0.84	31	0.16	1.44	6	C111	4a
	-90	62	9	29	2.00	34	0.61	7.39	25		
	-150				3.60	45					
5583	0-45	65	9	26	5.10	59	2.95	19.85	76	D111	5a
	-90	57	9	34	4.30	100	4.00	29.20	86		
5584	0-45	57	14	29	5.10	42	1.94	11.86	41	D111	5a
	-90	68	10	22	4.40	49	2.04	22.54	102		
5585	0-45	38	32	30	0.72	49	0.32	4.88	16	C212	5a
	-90	26	34	40	1.45	57	0.78	15.22	38		
5586	0-45	78	7	15	0.55	22	0.09	0.71	5	C111	4a
	-90	78	7	15	0.98	24	0.23	3.77	5		
	-150				3.00	29					
5587	0-45	71	9	20	6.05	43	2.58	12.62	63	D111	5ae
	-90	63	15	22	13	56	7.1	24.1	109		
5588	0-45	16	44	40	0.54	62	0.14	2.26	6	D111	3at
	-90	71	12	17	0.34	64	0.16	2.64	16		
5589	0-45	26	42	32	0.54	61	0.08	1.52	5	C112	3h
	-90	11	37	52	0.33	63	0.06	1.14	2		
5590	0-45	66	12	22	1.50	33	0.46	5.94	27	D111	5ae
	-90	63	10	27	10.0	58	5.40	21.20	79		
	-150				4.1	70					
5591	0-45	58	10	32	2.04	36	0.60	10.60	33	D112	5ae
	-90	43	20	37	4.55	68	2.89	27.11	73		
5592	0-45	76	7	17	0.72	41	0.09	1.11	7	C111	401t
	-90	71	7	22	0.51	34	0.05	1.55	9		
5593	0-45	78	7	15	0.39	35	0.07	0.73	5	C111	401
	-90	76	7	17	0.52	37	0.15	1.45	9		
5594	0-45	61	12	27	4.85	44	2.04	20.36	75	D111	5ae
	-90	43	27	30	12	60	6.5	44.7	153		
	-150				12	54					
5595	0-45	81	7	12	0.52	33	0.09	1.51	13	C211	401t
	-90	81	7	12	0.72	32	0.06	0.74	6		
5596	0-45	26	37	37	0.78	55	0.29	3.51	9	C112	4ae
	-90	21	32	47	1.56	60	0.78	13.42	29		
5597	0-45	11	37	52	0.84	67	0.12	1.08	2	C112	3he
	-90	38	27	35	0.34	56	0.06	0.74	2		
5598	0-45	8	35	57	0.43	67	0.08	1.12	2	C121	3he
	-90	8	30	62	0.52	70	0.09	1.11	2		
	-150				1.80	67					

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
5599	0-45 -90	18 18	27 25	55 57	0.72 1.65	53 63	0.32 0.79	3.68 13.21	7 23	A111	3ahe
5600	0-45 -90	43 50	12 13	45 37	11 3.60	63 73	6.9 2.56	18.7 22.24	42 61	C212	5a
5601	0-45 -90	25 48	47 24	28 28	0.72 0.71	53 27	0.09 0.04	1.51 1.56	5 6	C111	2h
5602	0-45 -90	33 25	27 22	40 53	2.45 6.05	33 42	0.07 0.22	7.93 16.58	20 31	C212	5ae
5603	0-45 -90	25 15	27 30	48 55	2.95 13	56 77	1.47 9.05	11.33 20.95	24 38	C212	5a
5604	0-45 -90	28 25	24 15	48 60	0.48 0.35	51 77	0.06 0.06	1.54 1.14	3 2	C121	3h
5605	0-45 -90 -150	25 28	22 22	53 50	2.60 10 4.20	37 64 64	0.83 5.4	10.87 15.4	20 31	C122	5ae
5606	0-45 -90	15 13	20 22	65 65	0.66 4.65	40 77	0.21 2.98	5.99 12.02	9 18	A121	3ahe
5607	0-45 -90	18 20	24 22	58 58	0.90 4.95	55 73	0.41 3.66	8.39 19.54	14 34	A121	5ae
5608	0-45 -90	18 18	37 27	45 55	0.41 0.47	34 57	0.04 0.09	1.56 2.31	3 4	C121	3he
5609	0-45 -90 -150	5 5	52 42	43 53	0.96 0.44 0.84	39 49 69	0.08 0.05	1.12 1.15	3 2	C112	3h
5610	0-45 -90	53 73	12 7	35 20	0.72 0.40	28 23	0.05 0.04	1.15 1.16	3 6	C112	1
5611	0-45 -90	20 18	27 24	53 58	0.44 0.57	37 36	0.09 0.15	2.31 4.65	4 8	C121	3hte
5612	0-45 -90	50 70	17 10	33 20	0.48 0.35	42 26	0.06 0.03	1.54 1.37	5 7	C112	1
5613	0-45 -90 -150	73 83	12 7	15 10	0.57 0.84 3.80	23 20 39	0.06 0.15	1.54 4.65	10 47	C111	5a
5614	0-45 -90	78 65	7 7	15 28	0.54 0.39	23 26	0.03 0.06	1.17 1.54	8 6	D121	2e
5615	0-45 -90	50 75	15 7	35 18	1.02 2.90	35 35	0.26 0.84	2.94 9.16	8 51	C111	5a
5616	0-45 -90	20 40	22 20	58 40	0.72 4.85	68 55	0.11 1.79	1.09 6.21	2 16	C121	3aht
5617	0-45 -90 -150	8 13	34 24	58 63	0.78 2.75 7.0	65 70 71	0.26 1.44	2.94 8.96	5 14	A111	3hte

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
5618	0-45	10	32	58	0.51	67	0.14	1.66	3	A111	3hte
	-90	10	27	63	0.46	65	0.24	4.56	7		
5619	0-45	60	12	28	0.36	41	0.04	0.76	3	C111	2h
	-90	45	15	40	0.29	47	0.04	0.76	2		
5620	0-45	20	22	58	0.34	64	0.09	1.51	3	A121	3hte
	-90	20	22	58	0.38	62	0.13	1.87	3		
	-150				1.25	39					
5621	0-45	28	22	50	0.46	63	0.11	1.49	3	A121	3hte
	-90	25	20	55	0.72	64	0.17	1.83	3		
5622	0-45	80	7	13	0.34	26	0.02	0.78	6	C111	40lt
	-90	75	7	18	0.39	23	0.03	0.77	4		
5623	0-45	68	14	18	0.55	27	0.05	1.15	6	C111	40lt
	-90	75	10	15	2.50	32	0.16	1.04	7		
6433	0-45	29	29	42	4.30	36	2.25	16.15	38	C212	5ht
	-90	26	34	40	4.30	37	2.40	27.4	60		
6434	0-45	46	14	40	3.30	47	1.76	12.6	38	C212	5ht
	-90	44	14	42	3.30	37	2.10	17.5	43		
6435	0-45	64	9	27	3.30	38	1.50	8.5	31	C211	5ht
	-90	39	16	45	3.30	36	13.4	22.4	50		
6436	0-45	54	26	20	6.65	35	0.64	1.11	6	A121	4ht
	-90	44	19	17	4.75	31	0.50	2.3	14		
6437	0-45	31	34	35	11	48	5.52	21.6	62	C212	5ht
	-90	14	41	45	24	61	16.8	20.8	46		
6438	0-45	51	34	15	0.79	45	0.34	1.6	11	C111	1
	-90	44	34	22	0.51	46	0.23	1.7	8		
6439	0-45	64	24	12	0.82	44	0.11	1.0	9	C111	40lt
	-90	66	19	15	0.62	44	0.17	1.4	10		
6440	0-45	39	41	20	0.84	47	0.24	1.3	7	C111	40lt
	-90	29	44	27	0.79	48	0.30	4.5	17		
6441	0-45	43	24	27	32.00	44	10.9	13.1	49	C211	5ht
	-90	66	17	17	14.00	34	4.0	8.8	52		
6442	0-45	29	29	42	3.05	52	1.82	14.9	36	C212	3ht
	-90	41	32	27	24	68	17.9	49.3	183		
	-150				8.60	83					
6443	0-45	11	42	47	6.65	43	2.16	5.6	13	C212	5ht
	-90	39	34	27	14.00	50	3.50	5.7	21		
6444	0-45	56	27	17	1.25	40	0.30	1.7	10	C111	40lt
	-90	61	22	17	0.56	38	0.10	7.3	8		
6445	0-45	46	19	35	16.00	46	6.44	17.3	34	C212	5ht
	-90	54	19	27	12.00	44	4.08	16.7	62		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
6427	0-45	34	26	40	12	52	6.50	31.9	80	D112	5ae
	-90	31	49	20	12	59	7.80	29.8	149		
6428	0-45	29	31	40	21	53	10.30	22.5	56	D112	5as
	-90	16	29	55	22	72	18.90	24.3	44		
6429	-150				3.45	77				D112	5a
	0-45	59	6	35	3.10	37	1.21	9.99	28		
	-90	56	9	35	6.00	47	3.23	11.97	34		
6430	0-45	54	14	32	10	50	5.5	12.9	40	D112	6at
	-90	41	19	40	12	63	6.4	28.8	72		
6431	0-45	69	9	22	11	32	3.80	9.0	41	C211	6at
	-90	51	12	37	12	73	9.10	26.9	73		
6432	-150				4.85	100				C111	3a
	0-45	64	11	25	1.40	31	0.39	2.81	11		
	-90	51	12	37	4.10	47	1.76	8.24	22		
6433	-150				12	44				C212	5ate
	0-45	29	29	42	4.50	50	2.25	16.15	38		
	-90	26	34	40	16	57	9.40	27.4	69		
6434	0-45	46	14	40	3.30	47	1.76	12.64	32	D112	5a
	-90	44	14	42	13	57	7.10	17.9	43		
6435	-150				8.70	71				D111	5a
	0-45	64	9	27	5.20	38	1.90	8.5	31		
	-90	39	16	45	13	88	13.6	22.4	50		
6436	0-45	54	26	20	6.65	35	0.44	1.16	6	D121	4t
	-90	64	19	17	2.75	31	0.50	2.30	14		
6437	0-45	31	34	35	11	48	5.52	21.68	62	C212	5at
	-90	14	41	45	24	61	16.8	20.80	46		
6438	0-45	51	34	15	0.79	45	0.34	1.66	11	C111	1
	-90	44	34	22	0.51	46	0.23	1.77	8		
6439	0-45	64	24	12	0.82	44	0.11	1.09	9	C111	40lt
	-90	66	19	15	0.62	44	0.11	1.49	10		
6440	0-45	39	41	20	0.84	47	0.24	1.36	7	C111	40lt
	-90	29	44	27	0.79	48	0.30	4.50	17		
6441	-150				3.60	59				C211	5ast
	0-45	49	24	27	32.00	44	10.9	13.1	49		
	-90	66	17	17	14.00	34	4.0	8.8	52		
6442	0-45	29	29	42	3.85	52	1.82	14.98	36	C212	5at
	-90	41	32	27	24	68	17.9	49.30	183		
6443	-150				8.60	83				C112	5t
	0-45	11	42	47	6.65	43	2.16	5.64	13		
	-90	39	34	27	14.00	50	3.50	5.70	21		
6444	0-45	56	27	17	1.25	40	0.30	1.70	10	C111	40lt
	-90	61	22	17	0.56	38	0.10	1.30	8		
6445	0-45	46	19	35	16.00	46	6.44	11.96	34	C212	5at
	-90	54	19	27	12.00	44	4.08	16.72	62		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
6446	0-45	39	31	30	16.00	54	6.1	7.9	26	D111	5ast
	-90	31	39	30	16.00	50	5.50	11.30	38		
	-150				17	55					
6447	0-45	44	31	25	21.00	51	5.86	9.34	37	D111	5as
	-90	41	34	25	20.00	54	5.40	8.20	33		
6448	0-45	26	22	52	0.98	55	0.55	5.85	11	A121	3aht
	-90	24	19	57	3.85	66	1.90	9.30	16		
6449	0-45 -90	69 gravel	11	20	0.75	32	0.12	0.68	3	C111	40lt
6450	0-45	26	39	35	29.00	41	9.84	21.36	61	D112	5ast
	-90	19	39	42	33.00	61	14.2	18.20	43		
	-150				38	76					
6451	0-45	44	29	27	11.00	45	3.38	8.22	30	D111	5at
	-90	36	34	30	24.00	51	5.10	6.90	23		
6452	0-45	24	21	55	12.00	46	3.68	8.32	15	D112	5at
	-90	41	19	40	40.00	57	16.6	13.0	33		
6453	0-45	41	22	37	2.10	53	1.13	9.27	25	D112	5at
	-90	19	31	50	12.00	57	5.84	26.96	54		
6454	0-45	76	7	17	0.68	40	0.20	1.0	6	C111	40lt
	-90	81	7	12	0.53	25	0.06	0.74	6		
6455	0-45	76	7	17	0.55	24	0.06	0.74	4	C111	40lt
	-90	84	9	7	0.51	27	0.07	0.73	10		
6456	-150				3.50	77				C221	5e
	0-45	86	7	7	0.62	26	0.10	0.70	10		
	-90	86	7	7	0.52	25	0.06	1.14	16		
6457	0-45	26	37	37	12.00	58	9.30	21.1	57	C212	5ae
	-90	29	41	30	36.00	56	17.50	18.9	63		
	-150				3.70	77					
6458	0-45	41	24	35	5.45	44	2.31	28.09	80	D112	5ae
	-90	24	29	47	18.00	60	10.2	28.20	60		
6459	0-45	29	29	42	173.00	45	57.0	51.8	123	D112	5ast
	-90	29	34	37	58.00	56	32.8	69.6	188		
6460	0-45	36	39	25	0.78	46	0.46	5.94	24	D111	5a
	-90	41	24	35	3.65	64	1.73	21.47	61		
6461	0-45	41	9	50	0.91	57	0.57	5.03	10	C121	3hte
	-90	29	19	52	0.95	55	0.55	7.45	14		
	-150				1.50	61					
6462	0-45	41	37	22	1.40	45	0.34	2.86	13	C111	2at
	-90	64	16	20	0.33	38	0.14	1.46	7		
6463	0-45	41	34	25	1.40	43	0.22	1.38	6	C111	2e
	-90	61	24	15	0.67	39	0.15	2.05	14		
6464	0-45	6	59	35	0.49	60	0.15	1.85	5	C112	3ht
	-90	9	36	55	0.42	60	0.23	2.57	5		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
6465	0-45	16	52	32	0.63	54	0.14	1.46	5	C112	3ht
	-90	16	44	40	0.43	56	0.21	1.39	3		
	-150				0.66	59					
6466	0-45	14	43	43	0.23	52	0.31	1.47	3	C121	3h
	-90	19	33	48	0.60	56	0.28	3.32	7		
6467	0-45	26	39	35	0.37	47	0.12	1.08	3	C112	2h
	-90	51	29	20	0.32	40	0.05	1.15	6		
6468	0-45	74	8	18	0.93	40	0.10	1.10	6	C111	40lt
	-90	66	6	18	0.28	40	0.10	1.90	11		
6469	0-45	16	29	55	0.60	56	0.28	5.12	9	A121	3ht
	-90	16	24	60	1.04	60	0.60	9.20	15		
	-150				4.85	76					
6470	0-45	21	34	45	1.40	53	0.66	11.34	25	C122	5a
	-90	9	33	58	4.75	63	3.15	24.45	42		
6471	0-45	81	6	13	1.40	23	0.23	0.97	7	C111	40lt
	-90	66	9	25	1.02	40	0.35	6.05	24		
6472	0-45	59	11	30	3.00	35	1.01	8.59	29	C211	5at
	-90	46	24	30	14	47	6.10	17.10	57		
	-150				5.55	36					
6473	0-45	51	19	30	0.68	32	0.20	7.0	23	C211	6t
	-90	51	16	33	8.05	57	3.56	9.24	28		
6474	0-45	51	21	28	0.52	33	0.17	3.43	12	C111	6t
	-90	46	26	28	8.05	42	1.68	4.32	15		
6475	0-45 -90	86 6	6	8	0.60	33	0.17	1.03	13	C221	6t
6476	0-45	44	21	35	5.60	40	2.40	11.6	33	C212	5a
	-90	34	31	35	13	55	6.90	17.9	51		
	-150				9.10	61					
6477	0-45	56	21	23	16	41	6.56	20.64	90	D111	5as
	-90	39	31	30	22	48	11.2	27.20	91		
6478	0-45	34	38	38	4.0	36	1.35	5.05	13	C112	5ae
	-90	31	19	50	14	63	9.45	23.35	47		
6479	0-45	64	11	25	0.64	28	0.14	0.66	3	C111	4e
	-90	53	12	35	11	36	3.24	7.96	23		
6480	0-45	56	9	35	0.63	33	0.17	3.03	9	C112	3h
	-90	43	14	43	0.67	39	0.24	6.16	14		
	-150				5.00	48					
6481	0-45	69	6	25	0.71	31	0.16	1.44	6	C111	2e
	-90	63	12	25	0.47	33	0.12	3.48	14		
6482	0-45	38	24	38	14	45	6.2	17.8	47	D112	5ae
	-90	33	32	35	19	53	9.40	18.60	53		
6483	0-45	41	31	28	7.34	43	3.06	12.94	46	C211	5ae
	-90	48	29	23	14	74	9.25	11.35	49		
	-150				18	71					

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
6484	0-45	56	16	28	9.65	31	2.33	2.07	7	C111	4e
	-90	48	17	35	6.65	40	2.05	5.15	15		
6485	0-45	53	22	25	5.20	37	1.34	3.86	15	C111	4e
	-90	46	29	25	14	42	4.00	4.00	16		
6486	0-45	63	17	20	5.30	32	1.36	3.44	17	C212	5ate
	-90	38	29	33	16	44	7.28	20.72	63		
6487	0-45	83	7	10	0.72	20	0.10	0.70	7	C221	401t
	-90	81	4	15	0.72	23	0.14	1.86	12		
6488	-150				1.40	30				D111	401t
	0-45	73	9	18	6.10	26	1.69	8.21	46		
6489	-90	31	24	45	11.00	72	9.5	21.7	48	C112	3ht
	0-45	28	27	45	7.20	81	0.26	2.14	5		
6490	-90	36	19	45	6.10	53	0.27	1.33	3	C111	401t
	0-45	68	14	18	1.11	25	0.16	1.44	8		
6491	-90	73	12	15	2.50	28	0.28	0.92	6	D112	5ae
	0-45	33	32	35	14	66	9.2	36.8	105		
6492	-90	28	42	30	32	51	23.0	5.00	17	D112	5a
	0-45	48	22	30	12	39	4.77	9.63	32		
6493	-150				14	49				D111	5a
	0-45	31	31	38	14	49	7.4	23.8	63		
6494	-150				7.20	66				D112	5at
	0-45	66	14	20	5.45	29	1.56	4.84	24		
6495	-90	41	21	38	7.35	51	3.96	16.44	43	D112	5at
	0-45	36	31	33	10	64	4.4	16.0	49		
6496	-90	56	16	28	16	48	7.56	18.84	67	D121	4e
	0-45	51	19	30	0.74	32	0.24	3.76	13		
6497	-90	56	11	33	6.55	39	1.95	6.05	18	D111	5ase
	0-45	41	39	20	48	39	22.6	37.4	187		
6498	-90	43	34	23	22	44	12.0	47.2	205	D111	5ae
	0-45	41	31	28	7.45	45	3.54	27.66	100		
6499	-150				16	44				A121	3aht
	0-45	43	32	25	16	44	7.74	41.86	170		
6500	-90	8	22	70	0.51	66	0.33	4.47	6	A121	3aht
	0-45	26	19	55	2.50	63	1.89	6.91	13		
6501	-90	11	19	70	0.70	66	0.17	7.03	10	A121	4at
	0-45	16	16	68	2.36	62	1.40	10.80	16		
6502	-150				4.64	64				A121	3aht
	0-45	18	32	50	0.53	57	0.28	4.72	9		
6503	-90	16	29	55	2.24	67	1.34	13.06	24	A121	4at
	0-45	6	14	80	0.47	69	0.35	5.65	8		
6504	-90	28	27	45	11	56	6.2	13.8	30	A121	3ht
	0-45	8	27	65	0.47	66	0.33	3.27	5		
6505	-90	7	27	66	0.52	64	0.32	4.88	7	A121	3ht
	0-45	8	27	65	0.47	66	0.33	3.27	5		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
6503	0-45	15	34	51	0.42	56	0.21	4.99	10	A121	3aht
	-90	12	29	59	1.02	60	0.60	9.40	16		
6504	0-45	12	29	59	1.55	39	0.39	2.01	3	C121	3ah
	-90	57	14	29	10	44	3.41	4.99	17		
6505	-150				4.7	68					
	0-45	50	14	36	4.65	50	2.06	8.54	24	D121	4at
	-90	52	14	34	0.93	42	0.37	3.23	10		
6506	-150				7.40	56					
	0-45	61	12	27	5.40	36	1.98	13.22	49	C211	5a
	-90	56	17	27	16	57	9.40	23.40	87		
6507	0-45	36	29	35	1.55	54	0.88	1.12	3	C112	2h
	-90	21	42	37	0.39	66	0.25	0.95	3		
6508	0-45	23	20	57	0.84	58	0.36	6.04	11	A121	3aht
	-90	23	17	60	2.00	61	1.07	11.73	20		
	-150				5.45	71					
6509	0-45	48	17	35	2.20	40	0.76	9.24	26	G212	5a
	-90	36	24	40	10	57	5.84	18.16	45		
	-150				7.70	54					
6510	0-45	76	7	17	1.25	26	0.30	3.30	19	D111	5at
	-90	73	7	20	4.30	49	2.02	10.78	54		
6511	0-45	76	7	17	42	24	9.15	10.65	63	D111	5as
	-90	73	7	20	91	27	19.4	13.0	65		
	-150				40	38					
6512	0-45	56	12	32	2.50	43	1.29	10.71	33	D111	5a
	-90	73	15	12	14	43	5.5	13.7	114		
6513	0-45	61	9	30	1.92	35	0.53	7.07	24	D111	5a
	-90	61	12	27	4.90	45	2.25	9.35	35		
6514	0-45	83	7	10	0.57	19	0.05	0.75	8	C211	401t
	-90	81	7	12	0.84	21	0.13	0.67	6		
6515	-150				6.90	31					
	0-45	51	12	37	1.20	42	0.44	8.36	23	D112	5a
	-90	38	15	47	3.70	67	2.35	17.45	37		
6516	-150				3.15	84					
	0-45	51	12	37	1.90	42	0.68	10.52	28	C212	5a
	-90	31	19	50	4.70	79	3.30	21.50	43		
6517	-150				3.15	84					
	0-45	26	19	55	0.96	35	0.27	5.33	10	G121	3aht
	-90	23	17	60	2.75	63	1.78	14.62	24		
6518	0-45	18	32	50	0.90	67	0.20	1.00	2	C112	3h
	-90	8	32	60	0.49	75	0.15	1.45	2		
6519	0-45	18	32	50	0.84	75	0.21	0.99	2	C121	3h
	-90	21	32	47	0.40	64	0.09	0.71	2		
6520	0-45	11	22	67	0.57	67	0.29	4.51	7	A121	3ht
	-90	11	19	70	0.46	64	0.22	10.18	15		
	-150				3.00	74					
6521	0-45	41	14	45	6.80	34	2.38	17.42	39	D112	5a
	-90	41	19	40	11	38	5.60	26.40	66		
	-150				8.80	57					

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
6522	0-45	38	17	45	11	37	3.62	22.78	51	C212	5a
	-90	31	14	55	16	73	12.4	26.00	47		
6523	0-45	73	7	20	1.20	27	0.12	1.08	5	D121	2e
	-90	70	7	23	0.44	28	0.04	0.76	3		
6524	0-45	83	7	10	0.49	19	0.03	0.77	8	C221	6t
	-90	80	7	13	0.66	21	0.08	1.12	9		
6525	0-45	83	7	10	0.51	20	0.03	0.77	8	C221	6t
	-90	80	7	13	0.57	23	0.06	0.74	6		
6526	0-45	68	12	20	1.90	29	0.26	0.54	3	C111	4e
	-90	67	15	18	3.05	37	0.51	0.29	2		
6527	0-45	62	20	18	15	44	7.04	28.96	161	D111	5ao
	-90	36	30	34	16.0	48	7.84	44.16			
6528	0-45	82	8	10	0.44	21	0.04	1.36	14	C221	6t
	-90	77	8	15	0.57	39	0.13	1.07	7		
	-150				0.12	39					
6529	0-45	82	8	10	3.20	25	0.50	0.70	7	C221	6t
	-90	80	7	13	5.40	21	0.42	1.58	12		
	-150				4.85	35					
6530	0-45	77	5	18	0.44	21	0.03	1.17	7	C111	401t
	-90	80	7	13	0.38	23	0.03	0.77	6		
6531	0-45	61	11	28	4.95	32	1.52	8.08	29	D111	5at
	-90	51	16	33	13	64	7.44	22.96	70		
	-150				20	73					
6532	0-45	26	21	53	0.48	60	0.11	1.49	3	D122	3h
	-90	26	19	55	0.45	66	0.13	1.47	3		
6533	0-45	79	6	15	0.66	20	0.12	3.48	23	D111	5at
	-90	81	6	13	1.71	23	0.39	8.01	62		
6534	0-45	61	11	28	5.20	45	2.93	11.27	40	C211	5a
	-90	71	9	20	7.45	36	2.70	10.90	54		
6535	0-45	16	46	38	1.08	66	0.17	1.43	4	C112	3ah
	-90	21	34	45	4.25	66	2.15	7.85	17		
6536	0-45	34	33	33	0.84	66	0.18	1.82	6	C112	2ht
	-90	44	28	28	0.46	57	0.14	1.86	7		
	-150				1.75	63					
6537	0-45	61	19	20	1.50	42	0.16	1.04	5	C111	2t
	-90	79	6	15	0.66	39	0.12	0.68	5		
6538	0-45	9	41	50	0.53	69	0.12	1.08	2	C112	3ht
	-90	24	41	35	0.42	66	0.12	1.48	4		
6539	0-45	29	23	48	0.78	56	0.17	1.03	2	C112	3ht
	-90	21	34	45	1.75	66	0.92	4.68	10		
	-150				0.72	49					
6540	0-45	36	26	38	0.48	59	0.15	1.65	4	C112	3ht
	-90	29	23	48	0.90	59	0.43	5.17	11		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
6541	0-45	29	23	48	0.53	52	0.23	2.97	6	C121	3aht
	-90	39	21	40	2.85	57	1.43	7.37	18		
6542	0-45	54	23	23	0.78	45	0.07	1.13	5	C111	2t
	-90	76	6	18	0.34	42	0.06	0.74	4		
6543	0-45	66	16	18	0.56	46	0.06	0.74	4	C111	1
	-90	74	11	15	0.33	42	0.06	0.74	5		
6544	0-45	9	33	58	0.46	60	0.10	1.50	3	C121	3ht
	-90	29	23	48	2.25	60	0.96	4.64	10		
6545	0-45	59	11	30	0.43	37	0.04	1.16	4	C111	1
	-90	76	6	18	0.44	24	0.03	0.77	4		
6546	0-45	71	9	20	0.43	24	0.03	0.77	4	C111	401t
	-90	81	6	13	0.38	21	0.02	0.78	6		
	-150				0.57	41					
6547	0-45	26	21	53	3.70	66	1.98	9.22	17	C122	4aht
	-90	31	21	48	3.00	60	1.43	6.57	14		
6548	0-45	36	14	50	1.25	56	0.42	3.58	7	C121	3ht
	-90	49	11	40	0.36	49	0.05	1.15	3		
6549	0-45	39	28	33	1.02	59	0.44	3.16	10	C112	3a
	-90	36	29	35	1.20	59	0.66	7.34	21		
6550	0-45	49	23	28	0.48	42	0.09	1.11	4	C111	1
	-90	71	9	20	0.53	49	0.09	0.71	4		
	-150				1.25	33					
6551	0-45	44	33	23	2.75	56	0.42	1.18	5	C111	2ht
	-90	41	26	33	1.75	57	0.63	2.57	8		
6552	0-45	66	14	20	0.48	39	0.06	0.74	4	C111	1
	-90	66	16	18	0.38	36	0.05	1.15	6		
6553	0-45	69	13	8	0.47	37	0.06	0.74	9	C111	2l
	-90	54	21	25	0.45	46	0.07	0.73	3		
6554	0-45	54	18	28	0.84	54	0.07	0.73	3	C111	3h
	-90	21	36	43	0.72	67	0.25	1.35	3		
6555	0-45	36	36	28	1.08	69	0.16	1.04	4	C111	2ht
	-90	34	33	33	1.35	61	0.23	1.37	4		
	-150				2.40	51					
6556	0-45	59	18	23	1.08	51	0.09	0.71	3	C111	2t
	-90	64	13	23	0.66	44	0.06	0.74	3		
6557	0-45	16	49	35	1.08	71	0.18	1.02	3	C112	3h
	-90	26	34	40	0.47	66	0.10	0.70	2		
6558	0-45	26	31	43	0.66	62	0.09	0.71	2	C112	3h
	-90	59	16	25	0.57	48	0.09	0.71	3		
6559	0-45	21	46	33	0.84	67	0.25	1.35	4	C112	2h
	-90	59	18	23	1.08	48	0.30	0.50	2		
	-150				0.52	32					

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
6560	0-45	36	16	48	0.66	50	0.23	2.17	5	C112	3ah
	-90	79	6	15	0.78	39	0.28	2.52	17		
6561	0-45	9	33	58	0.51	71	0.20	1.40	2	C121	3aht
	-90	21	26	53	6.05	65	3.25	8.55	16		
6562	0-45	71	11	18	0.72	42	0.09	0.71	4	C111	401t
	-90	51	21	28	0.72	52	0.33	2.87	10		
6563	0-45	29	26	35	0.78	55	0.12	0.68	2	C112	2t
	-90	34	31	35	0.48	58	0.07	0.73	2		
6564	-150				0.90	41					
	0-45	80	6	14	0.72	29	0.04	1.56	11	C111	401t
-90	82	7	11	0.31	39	0.07	0.73	7			
6565	0-45	45	26	29	0.66	52	0.08	1.12	4	C111	2t
	-90	55	19	26	0.42	39	0.08	1.12	4		
6566	0-45	27	32	41	0.54	61	0.11	1.49	4	C112	3h
	-90	40	29	31	0.51	57	0.11	1.49	5		
6567	0-45	22	22	56	0.49	59	0.16	1.44	3	C121	3ht
	-90	35	24	41	2.25	55	0.84	3.96	10		
6568	-150				4.85	66					
	0-45	50	19	31	0.96	47	0.07	0.73	2	C112	2t
-90	45	24	31	0.39	59	0.07	0.73	2			
6569	0-45	27	27	46	2.70	57	1.14	4.06	9	C112	3ht
	-90	27	24	49	4.25	53	1.79	6.61	14		
6570	-150				2.85	69					
	0-45	57	17	26	0.90	42	0.12	1.08	4	C111	1
-90	52	17	31	0.46	47	0.08	1.12	4			
6571	0-45	20	39	41	2.80	64	0.52	1.48	4	C112	3aht
	-90	10	44	46	6.55	74	4.44	10.76	23		
6572	0-45	7	32	51	1.85	72	0.22	0.98	2	C121	3ht
	-90	15	34	51	2.00	72	0.36	1.64	3		
6573	0-45	25	19	56	2.00	63	0.84	4.36	8	A111	3ht
	-90	22	29	49	4.80	65	2.52	6.28	13		
6574	0-45	52	19	29	10	62	5.0	11.8	40	C211	5at
	-90	22	24	54	4.90	59	2.22	4.98	90		
6575	-150				3.70	69					
	0-45	30	24	46	3.80	56	1.51	3.29	7	C112	5a
-90	30	31	39	4.50	60	2.70	16.50	42			
6576	0-45				5.30	49	2.21	5.79		C111	3a
	-90	42	29	29	6.30	50	2.76	5.24	18		
6577	-150				3.20	61					
	0-45	40	29	31	1.25	53	0.16	0.64	2	C112	2h
-90	37	29	34	1.14	58	0.26	1.34	4			
6578	0-45	15	29	56	3.55	66	1.12	5.28	9	C112	3ht
	-90	55	16	29	2.55	47	0.32	0.88	3		

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
6579	0-45	10	29	61	1.20	69	0.30	1.70	3	A111	3ht
	-90	20	21	59	2.70	61	1.22	5.18	9		
6579A	0-45	45	11	44	0.38	50	0.07	0.73	2	C112	3ht
	-90	67	9	24	0.37	27	0.04	0.76	3		
6580	0-45	62	23	15	9.10	34	0.77	1.23	8	C111	6t
	-90	gravel									
6581	0-45	75	9	16	0.57	21	0.04	0.76	5	C111	5t
	-90	75	9	16	0.43	24	0.06	0.74	5		
6582	0-45	17	37	46	1.02	66	0.12	0.68	1	C112	3ht
	-90	23	36	39	0.40	64	0.10	0.70	2		
6583	0-45	12	42	46	0.46	59	0.07	0.73	2	C121	3ht
	-90	12	44	44	0.34	69	0.10	0.70	2		
6584	0-45	67	19	14	14	24	1.44	1.76	13	C111	6t
	-90	75	11	14	19	28	2.80	1.60	11		
6585	0-45	72	9	19	0.57	25	0.05	0.75	4	C111	5e
	-90	gravel									
6586	0-45	67	9	24	0.40	28	0.03	0.77	3	D121	5e
	-90	65	16	19	0.43	32	0.06	0.74	4		
6587	0-45	70	14	16	0.43	25	0.03	0.77	5	D121	5e
	-90	60	24	16	1.20	21	0.04	0.76	5		
6588	0-45	32	17	51	0.39	60	0.09	0.71	1	A121	3ht
	-90	32	12	56	0.39	58	0.13	1.47	3		
	-150				1.90	65					
6589	0-45	82	7	11	0.90	23	0.03	0.77	7	C221	5e
	-90	77	7	16	0.40	26	0.04	0.76	5		
6590	0-45	75	6	19	0.39	25	0.02	0.78	4	C111	3t
	-90	75	6	19	0.37	26	0.03	0.77	4		
6591	0-45	82	7	11	0.78	24	0.10	0.70	6	C221	5e
	-90	80	6	14	1.75	26	0.18	1.02	7		
6592	0-45	62	14	24	6.95	33	1.24	2.36	10	C111	5e
	-90	55	21	24	19	36	3.60	4.00	17		
6593	0-45	55	19	26	0.57	39	0.05	0.75	3	C111	6t
	-90	67	12	21	0.42	27	0.06	0.74	4		
	-150				0.90	40					
6594	0-45	32	14	54	0.51	57	0.06	0.74	1	D122	3h
	-90										
6595	0-45	30	16	54	0.46	63	0.09	1.11	2	A111	3ht
	-90	30	16	54	0.35	63	0.14	1.46	3		
	-150				2.15	70					

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
6596	0-45 -90	75 gravel	6	19	0.46	39	0.05	0.75	4	C111	Gk.
6597	0-45 -90	62 gravel	17	21	2.5	34	1.7	2.1	6	C111	Gk
6598	0-45 -90	52 gravel	24	24	16	39	4.0	6.4	26	C111	Gk

Pit No.	Depth (cm)	pH 1:5	pH Paste	E.C. mmhos/cm at 25°C.	Sat %	Mechanical Analysis				Sol. Na. Meq. 100g.	Ex. Na Meq. 100g.	C.E.C.	E.S.P.
						Sand		Silt 0.02-0.002 mm	Clay 0.002 mm				
						CS 2.0-0.2 mm	FS 0.2-0.02 mm						
2520	0-20	8.9	7.6	32.00	47	4	42	33	21	12.40	21.20	41	52
	20-190	9.5	8.2	6.30	44	10	33	37	20	2.64	28.56	49	58
	190-200	9.7	9.0	0.52	45	2	82	6	10	0.23	11.77	22	54
2523	0-15	9.9	9.0	1.65	34	27	29	19	25	0.51	12.29	30	41
	15-60	9.4	7.9	8.15	31	42	29	9	20	2.33	10.87	18	60
	60-140	9.7	8.3	6.30	32	39	17	19	25	2.00	9.60	18	53
2544	0-20	9.0	8.0	170.00	47	8	15	33	44	61.2	38.00	48	79
	20-95	9.8	8.8	108.00	39	22	28	15	35	45.8	32.60	36	91
	95-130	10.1	8.8	37.00	43	26	26	19	29	16.2	30.20	33	91
2562	130-200	10.2	9.0	17.00	34	25	51	9	15	6.1	28.30	30	94
	0-45	9.5	8.2	3.50	53	9	30	19	42	28.64	9.34	40	23
	45-75	8.2	7.5	83.00	49	9	25	19	47	682.00	17.00	42	40
2583	75-115	9.7	8.1	13.00	57	14	27	19	40	122.00	16.67	35	48
	115-200	10.1	9.0	3.50	89	9	30	16	45	31.68	28.44	34	84
	0-25	10.1	8.8	5.30	51	28	30	5	37	2.64	10.96	30	36
2592	25-75	9.6	8.5	9.95	79	13	24	12	51	7.70	30.70	44	70
	75-105	10.1	8.7	6.80	45	13	61	7	19	3.10	16.10	18	89
	105-200	9.7	8.7	12.00	86	4	15	36	45	10.8	48.40	54	90
2594	0-75	9.3	8.1	5.60	62	7	15	29	49	3.10	16.10	50	32
	75-160	9.1	7.9	11.00	61	10	24	25	41	6.50	25.50	42	61
	160-200	8.8	7.7	9.50	55	11	28	17	44	5.10	14.90	44	34
2594	0-25	9.7	8.2	12.00	41	17	45	14	24	8.00	12.80	26	49
	25-70	9.5	8.7	44.00	53	10	39	19	32	24.6	47.40	34	140
	70-110	9.9	8.7	38.00	54	7	47	17	29	24.3	35.70	35	102
2594	110-140	10.0	8.4	22.00	53	13	48	8	31	12.7	25.70	32	80
	140-210	9.6	8.5	11.00	94	6	10	23	51	9.60	39.20	49	80

Pit No.	Depth (cm)	pH 1:5	pH Paste	E.C. mmhos/cm at 25°C.	Sat %	Mechanical Analysis				Sol. Na. Meq. 100g.	Ex. Na Meq. 100g.	C.E.C.	E.S.P.
						Sand		Silt 0.02-0.002 mm	Clay 0.002 mm				
						CS 2.0-0.2 mm	FS 0.2-0.02 mm						
2595	0-20	8.7	7.8	0.96	22	42	50	3	5	0.17	0.63	7	9
	20-50	9.4	8.1	1.95	23	49	22	13	16	0.40	3.20	14	23
	50-110	9.6	8.1	4.35	38	33	45	7	15	1.43	6.97	14	50
	110-190	9.4	8.0	15.00	45	25	39	9	27	8.16	16.64	20	83
2604	0-35	9.2	8.2	2.20	54	9	24	19	48	1.22	9.58	38	25
	35-85	8.9	7.9	11.00	71	8	19	20	53	7.63	20.77	44	47
	85-190	9.2	8.1	15.00	80	8	21	20	51	11.60	25.60	44	58
2605	0-40	9.4	8.6	0.55	44	12	29	15	44	0.22	5.18	38	14
	40-90	8.8	7.9	6.65	57	10	27	15	48	3.00	12.20	38	32
	90-135	9.4	8.1	9.80	62	8	21	15	56	8.20	23.80	42	57
	135-195	9.4	8.3	8.30	53	5	22	14	59	4.78	32.82	45	73
2609	0-60	9.4	8.0	13.00	47	17	37	17	29	5.90	18.90	32	59
	60-125	9.5	8.1	4.75	42	9	62	15	14	2.00	12.40	32	39
	125-200	9.2	8.0	1.55	42	9	76	7	9	0.68	6.12	30	20
2625	0-70	8.0	7.2	0.33	33	9	32	14	45	0.04	0.76	36	2
	70-175	8.5	7.7	0.31	28	31	45	7	17	0.04	0.76	20	4
	175-205	8.7	7.6	0.41	25	36	39	12	13	0.05	0.75	13	6
2650	0-40	8.6	7.6	0.90	29	32	34	12	22	1.08	0.25	20	1
	40-70	8.9	7.8	0.60	32	29	39	10	22	1.08	0.25	23	1
	70-150	8.8	7.8	0.70	33	30	28	15	27	1.41	0.30	22	1
	150-200	Rock - No sample											
2661	0-25	8.0	7.3	0.78	57	2	41	22	35	0.09	0.71	41	2
	25-65	8.6	7.8	0.66	30	2	42	29	27	0.04	0.76	38	2
	65-200	8.6	7.9	0.52	29	2	26	42	30	0.04	0.96	38	3

Pit No.	Depth (cm)	pH 1:5	pH Paste	E.C. mmhos/cm at 25°C.	Sat %	Mechanical Analysis				Sol. Na. Meq. 100g.	Ex. Na. Meq. 100g.	C.E.C.	E.S.P.
						Sand		Silt 0.02-0.002 mm	Clay 0.002 mm				
						CS 2.0-0.2 mm	FS 0.2-0.02 mm						
2681	0-50	7.7	7.1	1.08	39	9	33	11	47	0.06	0.74	40	2
	50-65	8.3	7.3	0.72	47	33	40	9	18	0.08	0.32	19	2
	65-100	8.4	7.2	2.20	46	20	25	9	46	0.16	0.64	34	2
	100-130	8.7	7.1	4.25	39	33	50	4	13	0.65	1.35	9	15
	130-200	8.7	7.3	5.00	34	34	40	7	19	1.06	2.54	14	18
3480	0-100	8.0	7.1	0.54	47	1	15	58	22	0.24	2.96	38	8
	100-200	9.2	8.2	3.00	55	2	9	48	41	1.65	9.55	48	20
3487	0-95	9.5	8.4	6.55	49	14	24	26	36	3.18	18.02	36	50
	95-200	9.7	8.3	6.80	58	16	26	29	29	3.92	7.28	30	24
3496	0-16	9.4	8.3	3.80	24	28	34	14	24	26.04	2.44	22	11
	16-183	9.5	8.2	12.00	43	21	29	21	29	137.00	14.95	30	50
	183-200	9.8	8.5	5.20	30	15	61	12	12	47.76	13.52	30	45
3540	0-55	8.6	7.8	0.44	53	14	14	25	47	0.08	1.12	40	3
	55-165	8.8	7.9	0.37	48	26	26	12	36	0.06	4.74	28	17
	165-200	8.7	7.7	0.66	47	12	24	36	40	0.09	1.11	40	3
3549	0-40	9.5	8.5	1.25	24	3	67	9	21	0.28	2.52	15	17
	40-200	10.2	9.0	6.65	52	13	39	19	29	3.44	22.96	30	76
3579	0-65	8.9	8.0	0.70	59	4	12	24	60	1.95	1.27	38	3
	65-175	9.0	7.9	2.50	61	8	15	25	52	17.58	4.23	48	9
	175-200	9.3	8.0	2.70	62	8	36	18	38	21.70	5.88	37	16
3596	0-40	8.5	7.7	0.54	55	2	25	32	41	0.11	2.09	38	6
	40-200	8.5	7.7	0.72	53	1	30	40	29	0.09	1.91	36	5

Subtotal

Pit No.	Depth (cm)	pH 1:5	pH Paste	E.C. mmhos/cm at 25°C.	Sat %	Mechanical Analysis				Sol. Na. Meq. 100g.	Ex. Na Meq. 100g.	C.E.C.	E.S.P.
						Sand		Silt 0.02-0.002 mm	Clay 0.002 mm				
						CS 2.0-0.2 mm	FS 0.2-0.02 mm						
4365	0-20	8.0	7.2	133.00	37	23	32	10	35	28.60	9.00	30	30
	20-80	7.9	7.1	117.00	54	10	16	15	59	36.40	26.00	53	47
	80-135	8.3	7.3	65.00	51	14	26	22	38	20.60	29.80	40	75
	135-200	9.0	7.6	39.00	35	26	45	12	17	14.00	10.80	23	47
4389	0-45	8.3	7.8	5.60	55	5	24	28	43	1.93	6.07	52	12
	45-155	8.4	7.9	4.25	52	4	23	31	42	1.17	4.43	50	9
	155-200	9.0	8.4	28.00	88	6	8	23	63	28.20	35.80	58	62
4390	0-15	Gravel: No samples taken.											
	15-35	9.2	8.1	1.10	21	33	52	6	9	0.16	2.24	12	19
4415	0-10	9.0	8.1	0.67	32	20	39	11	30	0.12	1.48	36	4
	10-40	9.3	7.8	2.35	30	58	13	14	15	0.49	2.71	26	10
	40-140	9.2	7.8	4.00	38	4	39	30	27	1.09	4.51	30	15
	140-200	9.5	8.3	3.30	50	13	22	20	45	1.63	11.17	38	29
4444	0-50	9.2	8.1	11.00	68	6	20	23	51	7.30	23.10	38	61
	50-95	9.4	8.3	9.50	96	8	11	15	56	9.00	30.20	56	54
	95-200	9.5	8.5	0.70	20	45	35	7	13	2.39	0.23	10	2
4467	0-35	9.6	8.3	1.00	24	27	43	12	18	8.03	1.62	21	8
	35-75	10.0	8.5	1.10	30	18	34	16	32	8.46	6.02	22	27
	75-180	9.8	8.3	5.20	59	13	17	22	48	58.16	13.93	40	35
	180-200	10.0	9.3	26.90	53	13	20	29	38	326.00	36.98	48	77
4488	0-50	10.2	9.7	3.90	86	8	12	22	58	36.90	38.37	39	98
	50-115	10.2	9.2	3.50	70	8	32	30	30	31.68	38.13	45	85
	115-165	10.0	9.1	2.90	44	12	48	17	23	29.08	27.93	37	75
	165-200												
5518	0-80	8.6	7.8	1.80	59	37	24	24	15	0.54	2.65	28	10
	80-135	8.8	8.3	1.25	24	57	14	14	15	0.43	2.77	18	15
	135-200	9.7	8.8	1.94	44	10	39	24	19	0.61	18.59	16	12

Pit No.	Depth (cm)	pH 1:5	pH Paste	E.C. mmhos/cm at 25°C.	Sat %	Mechanical Analysis				Sol. Na. Meq. 100g.	Ex. Na Meq. 100g.	C.E.C.	E.S.P.
						Sand			Clay 0.002 mm				
						CS 2.0-0.2 mm	FS 0.2-0.02 mm	Silt 0.02-0.002 mm					
4505	0-70	8.4	7.8	0.46	62	3	9	40	48	0.15	1.05	43	2
	70-125	8.4	7.6	1.20	42	17	28	10	45	0.25	0.95	32	3
	125-200	8.8	7.7	1.60	26	30	45	7	18	0.36	2.04	28	7
4521	0-50	8.2	7.8	0.72	57	2	21	37	40	0.13	1.47	46	3
	50-110	8.4	7.7	0.78	63	2	18	34	48	0.32	1.28	46	3
	110-160	8.6	7.6	0.72	54	2	37	25	35	0.30	2.50	40	6
4557	160-200	8.8	7.8	1.60	59	2	31	27	40	0.81	6.39	46	14
	0-15	9.0	8.1	0.50	35	18	18	27	37	0.65	0.33	38	1
	15-35	9.2	8.4	0.40	26	17	55	8	20	0.76	0.33	21	2
5508	35-200	9.3	8.5	0.60	27	41	20	18	21	1.41	0.31	18	2
	0-38	9.5	8.4	1.65	46	5	26	29	40	0.69	14.51	44	33
	38-90	9.7	8.6	4.75	56	6	18	31	45	2.66	24.54	42	58
5509	90-160	9.8	8.8	7.60	40	46	23	11	20	3.00	16.20	20	81
	160-200	9.8	9.3	9.50	51	46	15	14	25	4.78	27.22	27	101
	0-80	9.3	8.2	1.30	48	3	8	57	32	8.68	3.84	56	7
5510	80-120	9.6	8.3	5.80	61	2	11	43	44	50.36	18.14	53	34
	120-190	10.1	8.6	6.40	55	4	28	31	37	66.84	37.08	62	60
	0-30	8.4	7.8	1.65	46	17	15	56	28	0.46	1.94	48	4
5511	30-70	9.0	8.3	1.01	53	12	7	58	34	0.53	9.67	52	19
	70-120	9.3	8.3	3.00	59	8	18	31	43	1.77	19.03	45	42
	0-20	8.2	7.8	0.84	51	3	25	46	18	0.19	1.81	44	4
5518	20-120	8.2	7.7	0.42	52	2	16	49	33	0.13	1.47	50	3
	120-200	8.4	7.7	0.37	56	18	8	44	30	0.14	1.86	46	4
	0-80	8.4	7.8	1.80	39	37	24	24	15	0.54	2.66	28	10
	80-115	8.8	8.3	1.25	34	57	14	14	15	0.43	2.77	18	15
	115-200	9.7	8.8	1.40	44	18	39	24	19	0.61	18.59	36	52

Pit No.	Depth (cm)	pH 1:5	pH Paste	E.C. mmhos/cm at 25°C.	Sat %	Mechanical Analysis				Sol. Na. Meq. 100g.	Ex. Na Meq. 100g.	C.E.C.	E.S.P.
						Sand		Silt 0.02-0.002 mm	Clay 0.002 mm				
						CS 2.0-0.2 mm	FS 0.2-0.02 mm						
5519	0-16	9.6	8.4	0.80	31	20	29	21	30	0.19	2.61	24	11
	16-36	9.6	8.6	6.30	46	11	20	29	40	2.88	18.72	34	55
	36-110	9.1	8.2	24.00	58	3	8	44	45	13.40	48.20	40	121
	110-200	9.6	8.7	11.00	23	36	47	7	10	2.47	11.13	10	111
5520	0-20	9.9	8.6	4.20	54	14	32	21	33	38.62	6.60	30	22
	20-55	9.3	8.5	21.60	56	6	10	45	39	250.00	27.00	48	56
	55-125	9.4	8.2	13.50	53	8	15	42	35	135.00	16.74	48	35
	125-200	10.0	8.9	4.30	42	17	64	6	13	43.84	6.24	16	39
5521	0-15	8.8	7.8	22.00	45	12	26	24	38	9.00	21.40	38	56
	15-30	7.9	7.5	63.00	52	8	23	24	45	23.40	12.60	38	33
	30-90	7.6	7.3	47.00	53	7	16	27	50	19.90	8.10	42	19
	90-165	7.9	7.4	36.00	55	13	13	34	40	13.60	16.80	42	40
5527	165-200	8.1	7.2	36.00	56	9	4	42	45	14.60	17.00	46	37
	0-16	8.5	8.0	0.70	44	3	18	29	50	0.28	4.12	42	10
	16-45	9.2	8.6	1.34	38	9	20	31	40	0.48	11.92	36	33
	45-100	9.7	8.9	7.35	70	31	20	14	35	5.08	20.52	26	79
5528	100-200	9.6	8.7	22.00	62	29	24	12	35	10.60	27.00	33	82
	0-26	9.4	8.7	1.50	44	10	20	26	44	0.66	15.94	44	40
	26-55	9.2	8.2	8.85	43	17	24	36	23	2.76	19.44	33	59
	55-115	9.5	8.3	12.00	47	22	30	19	29	5.05	21.35	30	71
5529	115-200	8.7	7.6	19.00	49	24	18	27	31	7.60	13.20	36	37
	0-20	9.1	8.1	0.51	49	4	9	45	42	0.25	2.95	48	6
	20-100	9.5	8.3	1.25	50	4	12	35	49	0.63	10.97	50	22
	100-150	9.3	8.0	9.80	92	2	1	62	35	8.95	24.65	48	51
5592	150-200	9.1	8.0	11.00	70	8	10	53	29	5.00	3.00	46	7
	165-200	8.9	8.1	8.80	44	21	14	32	33	2.48	6.55	36	2

Pit No.	Depth (cm)	pH 1:5	pH Paste	E.C. mmhos/cm at 25°C.	Sat %	Mechanical Analysis				Sol. Na. Meq. 100g.	Ex. Na Meq. 100g.	C.E.C.	E.S.P.
						Sand			Clay 0.002 mm				
						CS 2.0-0.2 mm	FS 0.2-0.02 mm	Silt 0.02-0.002 mm					
5546	0-50	9.2	8.1	0.75	47	14	28	24	34	0.35	23.65	42	56
	50-75	10.0	8.5	5.60	60	10	18	22	50	3.30	35.90	35	103
	75-160	9.9	8.5	13.00	62	4	20	28	48	7.75	26.65	40	67
	160-200	9.9	8.7	5.60	73	12	14	42	32	4.10	7.90	43	18
5556	0-20	9.9	8.6	16.00	40	16	6	48	30	6.40	32.00	28	114
	20-55	10.1	8.4	53.00	36	18	10	45	27	19.8	10.60	22	48
	55-135	9.8	8.7	13.00	45	19	15	45	21	6.52	45.88	27	170
	135-200	9.8	8.8	12.00	40	23	26	31	19	5.40	26.20	26	101
5588	0-10	8.1	7.6	0.96	71	5	8	43	48	0.22	1.78	48	4
	10-80	8.2	7.7	0.48	63	1	7	44	48	0.16	1.46	48	3
	80-135	8.8	8.0	0.53	69	1	5	41	52	0.35	5.25	46	11
	135-170	9.6	8.7	2.04	55	12	15	26	47	0.99	16.61	34	49
5589	170-200	9.9	8.9	4.10	67	16	25	20	39	2.64	24.56	35	70
	0-45	8.8	8.1	0.80	56	1	7	49	43	1.08	0.64	46	1
	45-160	8.7	7.9	0.40	61	1	12	32	55	0.98	0.64	52	1
	160-200	9.0	8.2	0.40	41	5	47	16	32	1.74	0.56	25	2
5590	0-18	9.1	8.1	0.90	38	27	38	12	23	0.27	2.13	20	11
	18-55	9.9	8.6	1.95	37	26	33	8	33	0.72	10.48	20	52
	55-120	10.3	9.2	7.75	60	11	33	14	42	4.50	22.70	32	68
	120-200	10.3	9.2	4.25	66	6	50	9	35	2.80	26.20	31	85
5591	0-10	9.7	8.6	1.35	38	15	44	11	31	0.51	7.49	26	29
	10-45	9.5	8.6	4.65	69	5	22	29	44	3.19	30.41	42	72
	45-200	10.1	9.1	3.85	77	7	18	32	43	2.90	51.50	48	107
5592	0-70	9.3	8.2	0.70	22	43	27	9	21	3.26	0.52	18	3
	70-160	9.2	8.1	0.60	23	47	25	8	20	1.63	0.24	19	1
	160-190	8.9	8.1	0.80	44	21	14	32	33	2.48	0.55	36	2

Pit No.	Depth (cm)	pH 1:5	pH Paste	E.C. mmhos/cm at 25°C.	Sat %	Mechanical Analysis				Sol. Na. Meq. 100g.	Ex. Na Meq. 100g.	C.E.C.	E.S.P.
						Sand		Silt 0.02-0.002 mm	Clay 0.002 mm				
						CS 2.0-0.2 mm	FS 0.2-0.02 mm						
5608	0-45	8.8	7.9	0.50	49	3	12	35	50	0.98	0.58	44	1
	45-130	8.7	7.9	0.50	55	4	11	27	58	1.30	0.63	42	2
	130-200	8.6	7.7	0.70	51	4	26	20	50	2.01	0.73	44	2
5620	0-18	8.7	7.9	0.40	57	2	11	24	63	0.76	0.52	47	1
	18-50	8.9	7.9	0.40	51	8	10	24	58	1.14	0.57	38	2
	50-110	8.7	7.8	0.50	56	6	12	22	60	0.76	1.01	44	2
	110-160	9.0	7.9	0.60	40	30	27	13	30	1.79	0.35	21	2
	160-200	9.0	7.8	0.48	23	48	30	7	15	0.04	0.76	8	10
	6594	0-25	9.0	7.9	2.65	23	52	20	6	22	0.37	1.63	15
6435	25-90	9.7	8.0	10.00	73	22	14	46	18	7.50	20.50	38	57
	90-145	9.8	8.4	9.50	51	18	33	20	29	3.64	24.36	30	81
	145-200	10.0	8.5	9.10	43	8	57	11	24	3.66	15.54	22	71
6461	0-40	9.3	8.3	0.76	50	2	11	39	48	0.38	4.42	48	9
	40-150	9.5	8.3	2.10	60	4	23	19	54	1.05	8.95	50	18
	150-170	9.2	7.9	5.60	51	9	14	32	45	2.80	10.40	42	25
6488	170-200	9.5	8.1	2.10	39	7	55	19	19	0.78	5.62	36	16
	0-30	9.7	8.5	1.20	27	38	30	14	18	0.30	3.10	12	26
	30-90	9.4	8.2	7.75	64	12	20	24	44	4.80	10.20	41	47
6523	90-200	9.3	8.2	7.35	69	14	16	24	46	5.00	19.00	46	41
	0-25	9.0	8.0	0.57	21	41	19	15	25	0.03	0.77	19	4
	25-155	8.8	7.8	0.37	29	37	25	11	27	0.04	0.76	15	5
6548	155-200	8.8	7.7	0.29	36	21	46	9	24	0.04	0.76	15	5
	0-55	8.5	7.4	2.40	60	18	18	14	50	1.02	6.58	46	14
	55-90	8.3	7.5	0.42	55	20	29	11	40	0.06	0.74	42	2
	90-200	8.4	7.6	0.45	38	20	51	10	18	0.08	0.72	24	3

Pit No.	Depth (cm)	pH 1:5	pH Paste	E.C. mmhos/cm at 25°C.	Sat %	Mechanical Analysis					Sol. Na. Meq. 100g.	Ex. Na Meq. 100g.	C.E.C.	E.S.P.
						Sand		Silt 0.02-0.002 mm	Clay 0.002 mm					
						CS 2.0-0.2 mm	FS 0.2-0.02 mm							
6570	0-50	8.5	7.7	0.78	45	2	48	20	30	0.09	1.11	32	3	
	50-110	8.6	7.7	0.52	53	9	12	42	37	0.16	1.44	38	4	
	110-200	8.8	7.7	4.25	56	13	15	22	50	2.17	9.23	42	22	
6575	0-60	8.5	7.7	3.90	50	2	28	32	38	1.69	66.11	38	16	
	60-110	10.0	9.0	3.75	54	3	35	27	35	2.02	26.78	34	79	
	110-160	10.1	9.0	3.40	51	2	9	47	42	2.10	28.30	42	67	
	160-200	10.1	9.0	1.30	42	3	65	14	18	0.52	14.68	22	67	
6594	0-30	8.6	7.5	0.50	87	8	20	14	58	0.65	0.43	44	1	
	30-95	9.0	7.9	0.60	23	48	25	7	20	2.07	0.30	20	2	
	95-130	9.1	7.9	0.70	36	32	31	9	28	1.96	0.35	29	1	
	130-200	9.2	8.1	1.10	33	43	20	19	18	2.39	0.41	16	4	

Sample No.	Depth (cm)	Moisture (%)	Organic Matter (%)	pH	W.C. Capacity (%)	Set. %	Sol. Ka Neg 100 G.	Exch. Ka Neg 100 G.	E.S.P.	Soil Class.	Land Class.
4420	0-15	22	42	55	1.25	58	0.19	1.41	3	A111	
	15-30	18	35	48	1.85	53	2.32	6.88	18		
	30-45	16	28	38	2.75	51	2.23	7.37	19		
	45-60	12	20	32	3.20	52	1.28	4.72	9		
	60-75	10	15	28	3.55	45	1.44	7.36	18		
	75-90	8	10	25	4.25	56	1.75	6.65	13		
4421	0-15	14	15	38	0.40	37	0.07	1.13	2	D123	
	15-30	16	8	32	0.85	35	0.04	0.76	2		
	30-45	14	12	28	0.95	39	0.50	3.10	9		
	45-60	16	18	25	0.74	35	0.03	1.17	7		
	60-75	11	8	24	0.39	36	0.04	0.76	3		
	75-90	7	5	24	0.26	25	0.07	0.73	4		
4422	0-15	13	18	35	0.37	40	0.05	0.75	2	D121	
	15-30	15	12	30	0.44	34	0.03	0.77	3		
	30-45	16	15	28	0.75	36	0.05	0.75	3		
	45-60	16	17	28	0.39	42	0.05	0.75	3		
	60-75	23	28	25	0.57	37	0.14	1.06	4		
	75-90	14	15	27	0.45	46	0.09	1.11	4		
APPENDIX 3.4											
4423	0-15	19	25	50	1.60	64	0.10	1.50	3	A121	
	15-30	24	31	50	1.60	60	0.78	4.02	8		
	30-45	26	31	53	0.94	60	0.35	3.65	7		
	45-60	34	31	53	0.94	60	1.75	7.65	17		
	60-75	3	21	50	1.60	60	0.85	2.75	27		
	75-90	21	26	53	0.39	62	0.10	2.4	4		

**LABORATORY ANALYSES
OF 15 cms DEPTH SAMPLES**

Site No.	Depth (cm.)	Mechanical Analysis			E.C. mmhos/cm at 25°C.	Sat. %	Sol. Na Meq 100 g.	Exch. Na Meq 100 g.	E.S.P.	Soil Class	Land Class
		Sand 2.0-0.02 mm.	Silt 0.02-0.002 mm.	Clay 0.002 mm.							
2681	0-15	23	22	55	1.35	58	0.19	1.41	3	All1	
	15-30	35	17	48	4.85	53	2.32	8.88	18		
	30-45	38	24	38	4.70	51	2.23	7.37	19		
	45-60	35	15	50	3.20	51	1.28	4.72	9		
	60-75	45	15	40	3.55	46	1.44	7.36	18		
	75-90	30	20	50	4.70	56	1.75	6.65	13		
6594	0-15	34	11	55	0.47	57	0.07	1.13	2	D122	
	15-30	56	9	35	0.42	35	0.04	0.76	2		
	30-45	54	11	35	2.00	39	0.50	3.10	9		
	45-60	76	16	18	0.34	15	0.03	1.17	7		
	60-75	61	9	30	0.39	36	0.04	0.76	3		
	75-90	74	6	20	0.96	25	0.07	0.73	4		
4557	0-15	43	22	35	0.51	40	0.05	0.75	2	D121	
	15-30	53	17	30	0.46	34	0.03	0.77	3		
	30-45	60	15	25	0.39	46	0.05	0.75	3		
	45-60	58	17	25	0.39	42	0.05	0.75	3		
	60-75	55	20	25	0.57	37	0.14	1.06	4		
	75-90	56	16	28	0.45	46	0.09	1.11	4		
5620	0-15	19	23	58	0.51	64	0.10	1.50	3	A121	
	15-30	29	21	50	1.60	60	0.78	4.02	8		
	30-45	26	21	53	0.96	60	0.35	3.65	7		
	45-60	36	19	45	3.35	56	1.75	7.65	17		
	60-75	34	18	48	3.00	56	0.85	12.75	27		
	75-90	21	26	53	0.39	62	0.10	2.4	4		

SHEET NO. 2

AREA 4b. THE NILE FROM
KHARTOUM TO KAREIMA

