THE WEATHERLEY CATCHMENT: SOIL ORGANIC MATTER AND VEGETATION BASELINE STUDY

Report to the

Water Research Commission

by

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WRC Report No. KV 170/05
ISBN No. 1-77005-393-X **NOVEMBER 2005**

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EXECUTIVE SUMMARY

This project was born in 2003 at a meeting of the steering committee for the WRC project K5/1317 titled “The relationship between soil water regime and soil profile morphology in the Weatherley catchment, an afforestation area in the North Eastern Cape”. The 160 ha Weatherley catchment was selected in 1995 for intensive hydrological studies by the school of Bioresources Engineering and Environmental Hydrology of the University of KwaZulu-Natal, in collaboration with North East Cape Forests and Mondi. The study was to be undertaken in two phases. The aim of the first phase was to characterize the hydrology of the catchment over a number of years under its natural grassland vegetation. The plan was to then plant selected species of forest trees on suitable soils in the catchment, and continue the intensive hydrological studies to evaluate the influence of the afforestation on the hydrology. The first phase was undertaken over the seven year period from November 1995 until the spring of 2002. In spring 2002 three species of trees, *Pinus patula, Pinus elliottii and Eucalyptus nitens* were planted. Appropriate soils were selected for each of the species, the total afforested area being about 76 ha or 47% of the catchment, with approximately equal areas of each species.

At the steering committee meeting in 2003, referred to above, Mr Gardiner of Mondi asked if it would be possible to monitor the influence of afforestation on the organic carbon content of the soil. The University of the Free State research team agreed to undertake this task, the results of which are presented in this report.

The main overall objective of the study was to quantify the content of soil organic matter in the different soils to a depth of 1.2 m in each of the tree species areas. This was to provide baseline data against which to compare any changes which may occur as the trees grew to maturity. An additional objective was to characterize the grassland vegetation and its biomass yield.

Using a detailed soil map as basis, 25 sample sites were selected. They were distributed approximately equally over the areas allotted to each tree species. The sites were selected so that the important soils were represented in each of the tree species areas. Two control sites outside the afforested area were also selected. It was hypothesized that it would be possible to identify any freak atmospheric conditions, which might have influenced soil organic matter levels between subsequent sampling dates, via these control sites. For 12 of the sample sites it was found convenient to use sites previously studied for WRC Project K5/1317. Thirteen new sites were selected.

The following were obtained for each sample site: soil profile description and soil classification; vegetation characterization and biomass determination; soil samples for analysis of organic matter in the following soil layers (mm): 0-50; 50-100; 100-150; 150-200; 200-300; and thereafter at 100 mm intervals to 1200 mm. For the five surface layers at each sample site four replicates were

taken of each layer, each replicate consisting of 3 sub-samples mixed together. Single samples were taken of the 100 mm layers below the 300 mm depth. Organic carbon (OC) and total nitrogen (TN) were determined on all the soil samples. The bulk densities of these soil layers were also quantified for every site.

The soils were grouped into four groups with similar properties, viz. group A, excessively drained soils (Hutton and Clovelly forms); group B, moderately well drained soils (Bloemdal and Pinedene forms); group C poorly to very poorly drained soils (Katspruit, Kroonstad, Westleigh, Longlands and Klapmuts forms); group H freely drained soils (Tukulu form). For each soil layer at each sample site the following results are presented in tables and diagrams: OC (%); OC (Mg m^{-3}); TN (%); TN (Mg m^{-3}); C:N ratio; bulk density (Mg m^{-3}). Differences in amounts and distribution of OC and TN are shown to occur between the soil groups. A prominent feature is a similar and almost linear decrease in OC from the surface to a depth of 650 mm, irrespective of the kind of B horizon present. The decrease was from values ranging from around 1.5 to 2.0 Mg m^{-3} x 10^{-2} for the different soil groups, to an average value of around 0.5 Mg m^{-3} x 10^{-2} at 650 mm. This decrease was followed by a much slower decrease to a fairly uniform value of around 0.3 Mg m^{-3} x 10^{-2} at a depth of 1150 mm. The total amounts of OC in a depth of 1200 mm for the different soil groups and tree species areas expressed as Mg ha^{-1} were found to be: 111, 85, 97 and 88 for the soil groups A, B, C and H respectively; and 90, 93, 74 and 75 for the *P. patula*, *P. elliottii*, and *E. nitens* areas, and the control sites, respectively. These amounts are similar to those reported as average world soil values for Ultisols and Entisols.

With regard to TN two observations are significant. Firstly, the decrease in TN with depth was less pronounced than OC, resulting in considerably lower C:N ratios towards the bottom of the profile. Over all the soils, the average decrease in TN from the surface to a depth of 1150 mm was from 1.1 x 10^{-3} to 0.4 Mg m^{-3} x 10^{-3}. The equivalent decrease in the C:N ratio was from 15 to 6. Secondly, relative to the other soils there was an accumulation of TN in the deep layers of the poorly to very poorly drained soils.

An average oven dry biomass yield from grassland cover was 3400 kg ha^{-1} yr^{-1}. Carbon sequestration efficiency by the grassland in the catchment was estimated to be 2.1 kg C ha^{-1} yr^{-1} mm^{-1} rain. It was possible, after making some assumptions, to estimate that the equivalent value for *P. patula* would be around 2.8.

Recommended future research activities included the following: Repeated soil sampling at five year intervals; measurements of the amounts of C in the forest vegetation at five year intervals; measurements of ET from the afforested and remaining grassland areas; soil water content measurements to continue at the same sites and in the same ways as monitored during the grassland phase; calculation of C sequestration efficiencies for the afforested areas and for the grassland control sites for each subsequent five year period.

ACKNOWLEDGEMENTS

This report is the result of research funded by the Water Research Commission with the title:

"THE WEATHERLEY CATCHMENT: SOIL ORGANIC MATTER AND VEGETATION BASELINE STUDY"

The steering committee responsible for the project "The relationship between soil water regime and soil profile morphology in the Weatherley catchment, an afforestation area in the North Eastern Cape" also took responsibility for this one. They were:

Mr R Dube	Water Research Commission (chairman)
Prof. ATP Bennie	University of the Free State
Mr DB Butt	North East Cape Forests
Dr F Ellis	University of Stellenbosch
Prof. MV Fey	University of Stellenbosch
Mr P Gardiner	Mondi-Forests
Mr JJN Lambrechts	University of Stellenbosch
Dr SA Lorentz	University of KwaZulu-Natal
Ms N Ncapayi	Department of Water Affairs
Prof. PJT Roberts	Forestry South Africa
Dr DP Turner	ARC-Institute for Soil, Climate and Water
Mr M Warren	Department of Water Affairs

The research team wishes to thank the following persons and institutions:

i) The Water Research Commission for the trust it put in the research team by awarding this contract.

ii) The members of the steering committee for their time invested, criticism, advice and leadership during the execution of this project.

iii) The management and administration of the University of the Free State without whose contribution, in terms of infrastructure and maintenance, this research would not have been possible.

iv) Mondi (represented by Mr P Gardiner) and North East Cape Forests (represented by Mr D Butt), who made available the research facility.

v) Ms Y Dessels and Mr E Moeti for chemical analyses.

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1. INTRODUCTION

1.1 Background

The following is an extract from the minutes of the steering committee meeting of the Water Research Commission project K5/1317 entitled "The relationship between soil water regime and soil profile morphology in the Weatherley catchment, an afforestation area in the North Eastern Cape" held on 6 June 2003: "Mr Gardiner asked if it would be possible to monitor the influence of the trees on soil organic carbon. Prof du Preez and Mr van Huyssteen agreed to investigate the matter. The chairman explained that the WRC liked to support additional investigations such as this at an already established research site".

The following details about such a project were carefully considered by the project team: the current and future value of the results; how the underlying objectives could be achieved in an efficient and meaningful way; the relationship with the present project. It became clear that this would be a useful study which should yield information that would be valuable for the Department of Water Affairs and Forestry, the forestry industry, ecologists – especially those interested in global warming, botanists and soil scientists. This value is expressed in the motivation which follows.

1.2 Motivation

According to current estimates the output of CO_2 from the world is considerably more than the amount being fixed by photosynthesis. Hence the threat of global warming and the resultant worldwide reaction in the form of efforts to, wherever possible, reduce C emissions and increase C sequestration. Commercial forests generally use more water than grassland under similar conditions, but they also sequester more carbon. This presents an important and complex balance between socio-economic and environmental demands on water, which policy makers will increasingly need to address in the future. They will need quantitative information to be able to make decisions that are best in the long-term. Because of the detailed hydrological data available for the Weatherley catchment under grassland for seven years, and similar data which will become available for the catchment after afforestation, this study offers a golden opportunity to provide a sound foundation for the provision of relevant data. Relatively little data of this sort and quality is currently available in South Africa.

For the discussion which follows the Weatherley catchment will be considered to be an ecosystem, with each similar mapping unit on the soil map (Figure 1.1, Roberts *et al*. 1996), a micro-ecosystem. The vegetation of the Weatherley ecosystem has been composed over a long period of time of a variety of different types of grassveld on the different component micro-ecosystems. It can therefore be assumed that the C cycle in each of the micro-ecosystems has reached a characteristic equilibrium level. These equilibria are at the threshold of a drastic change with three different kinds of trees having been planted towards the end of 2002 on about half of the catchment. A detailed inventory made now of the vegetation and organic matter status of the soils will therefore be valuable – while the trees are still small and have not yet had a significant effect.

The results will provide valuable baseline ecological information against which changes brought about by the growing trees can be compared at suitable intervals in the future. The baseline study will make it possible to characterize the natural micro-ecosystems in terms of vegetation type, biomass yield, and organic matter content of the different soils, wherever possible to a depth of at least 1.2 m. Resampling of the soils at sites very close to those of the baseline study, at say five year intervals, will reveal the extent of changes in organic matter per soil horizon during the elapsed period on each of the different micro-ecosystems. Each of these will now represent a specific tree species/soil combination, with the influence of the natural vegetation gradually decreasing in importance. If the total C production of the trees are also measured after five years it will be possible to calculate the amount of C sequestered during the period on different tree/soil micro-ecosystems. It will be useful to compare this with equivalent values for the natural grassland. Carbon sequestration values for each of the tree/soil micro-ecosystems, and grassland/soil micro-ecosystems, per unit of rain will also be a useful value.

The importance of this project was confirmed at the final meeting of the steering committee held on 31 May 2005 for WRC project K5/1317 mentioned earlier in Section 1.1. It was recommended, as can been seen in the minutes, that sampling be repeated at five year intervals.

With regard to capacity and competency development, there were unfortunately no post-graduate students available for this first, “base-line”, phase of the project. It is hoped however that this will not be a problem for the proposed sampling exercise scheduled for 2009. The project nevertheless has considerable value with regard to other broader aspects of capacity and competency development. This subject covers a wide multidisciplinary field which is currently of great international importance. The study is also of national importance because it is concerned with water and is situated in a critical development area, and will serve to broaden the vision and understanding of all those involved. It will also provide a sound foundation for future studies in this connection.

1.3 Objectives

The objectives of this project were formulated as follow:

- To obtain for each of 27 locations a detailed description of the soil, slope and vegetation; biomass yield; bulk density, organic carbon (OC) and total nitrogen (TN) contents for the 0-50, 50-100, 100-150, 150-200 and 200-300 mm soil layers.

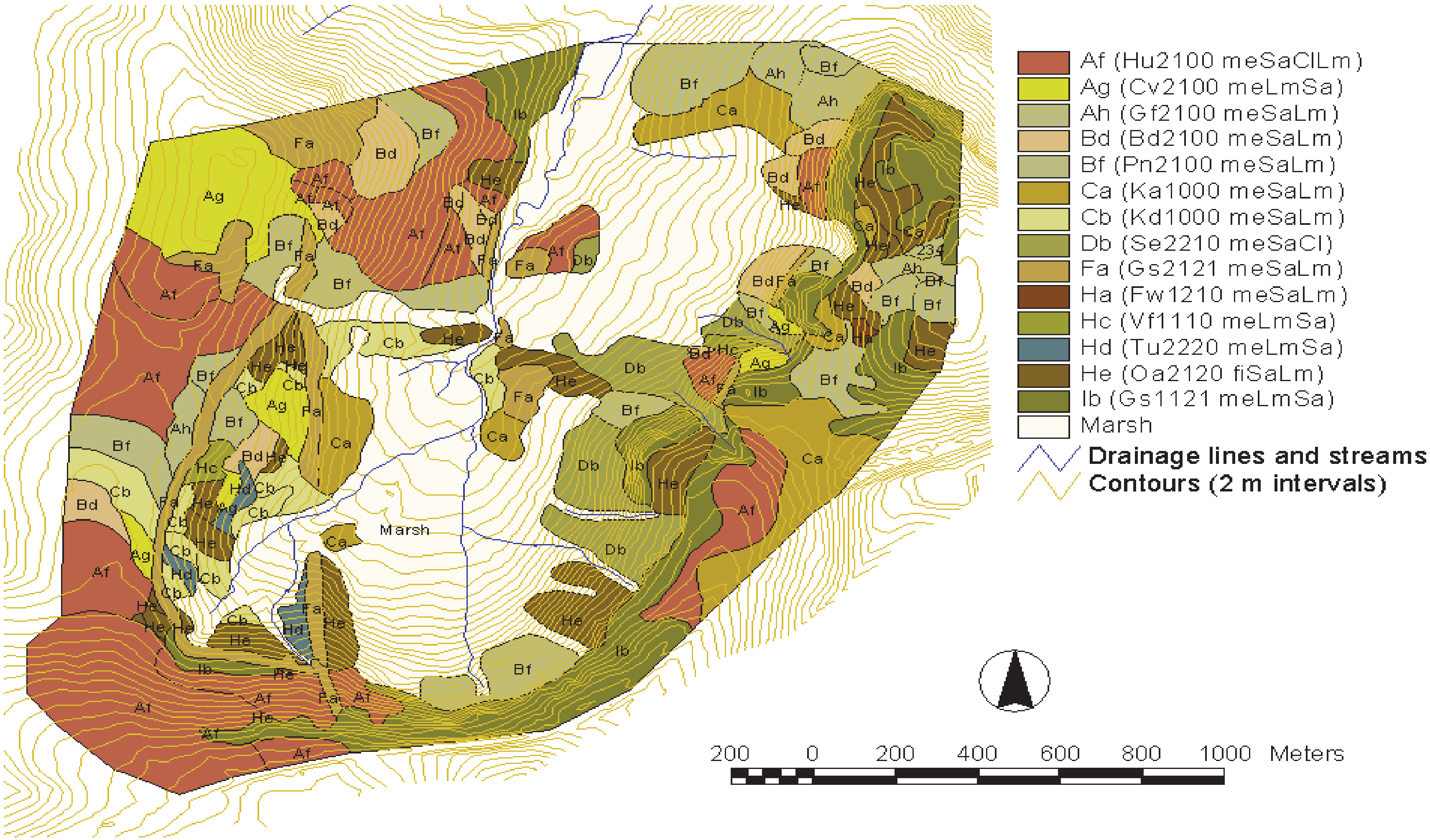

Figure 1.1 Generalised soil patterns according to Roberts *et al.* (1996).

- To obtain OC and TN contents at 100 mm intervals to a depth of 1.2 m for the 14 new soil profiles as for the 13 old soil profiles.
- To obtain the OC and TN contents of each soil layer in the relevant map units expressed as Mg ha^{-1}.

2. CATCHMENT CHARACTERISTICS

2.1 Introduction

The Weatherley study area is situated in one of the most picturesque areas of South Africa, on the footslopes of the Drakensberg mountain range. This region has only recently been deemed suitable for forestry and has been planted since 1989. Weatherley escaped this development and only received attention during 1995 when it was decided to utilise this catchment to monitor the impact of forestry on catchment water yield – after the yield under grassland had been monitored over a number of years. Three tree species, *Pinus patula*, *Pinus elliottii* and *Eucalyptus nitens* were selected for the study. As these species have different soil requirements for optimum growth, specific areas of the catchment were selected for each species. However, the normal criteria were deliberately transgressed at some of the sites in order to study tree-soil interactions. Pitting was done during April 2002 on the areas earmarked for *P. patula* and *P. elliottii* and the area for *E. nitens* was ploughed with a disc plough (Figure 2.1).

2.2 Location

The study catchment is located in the north-eastern corner of the Eastern Cape Province. It occupies approximately 160 ha and constitutes most of the farm Weatherley. It is situated 4 km south-west of Maclear, on the road to Ugie. The study area is located on the 1:50 000 sheet 3128AB Maclear (Chief Director of Surveys and Mapping, 1993).

2.3 Relief

The study area is the upper-most catchment of one of the very small tributaries of the Mooi River. There is therefore no inflow of water into the catchment, which makes it highly attractive for hydrological studies. It drains in a north-easterly direction and is therefore closed on the eastern, southern and western slopes.

The eastern and southern slopes have prominent Molteno sandstone shelves at approximately 1316 – 1318 m above mean sea level. This is largely due to the resistance of Molteno sandstone against weathering. The highest point in the catchment, at 1 352 m, occurs in the south-western corner of the catchment. The stream runs in a north easterly direction and occurs at a height of between 1 254 and 1 286 m (Figure 2.1).

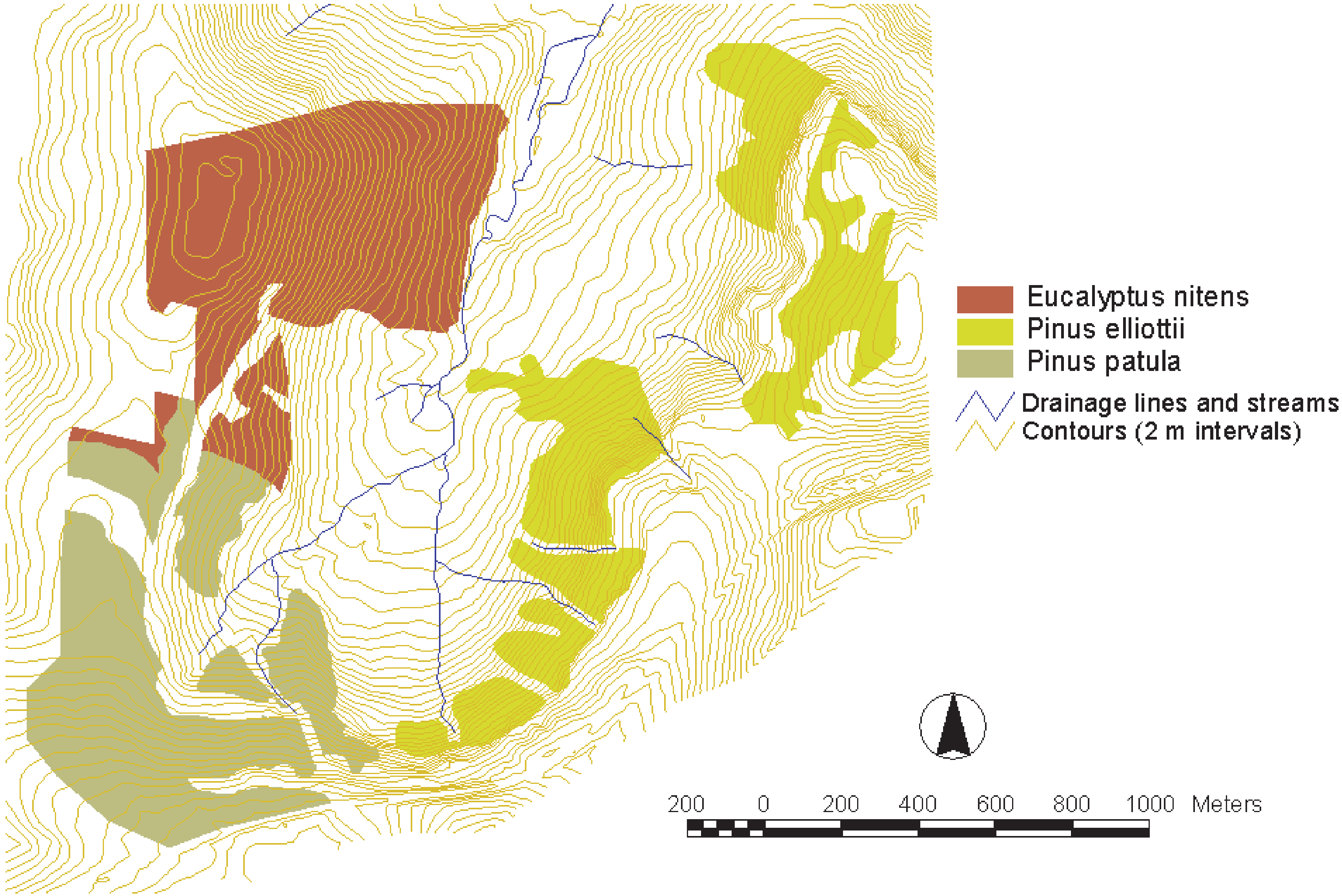

Figure 2.1 Tree species planting strategy in the Weatherley catchment (BEEH, 2003).

Moles and earthworms are very active in the marshy valley bottom area of the catchment. This is probably due to the moist conditions that predominate in the soils. It leads to the formation of many surface mounds, to such an extent that walking becomes difficult. It is possible that macro faunal activity is associated with changing water regimes in the soil. Moles and earthworms will move to drier soil in summer when it rains and back to the wetter soils in the dry winter months.

2.4 Geology

Elliot sandstone and mudstone are found higher than 1 320 m above mean sea level. This covers the upper slopes on the Eastern and Southern slopes (Figure 2.2). Both sandstone and mudstone of the Molteno formation predominate lower than 1 320 m above mean sea level. There are two dolerite dykes in the catchment, both running roughly in a north-south direction, one in the south-western corner and one in the north-eastern corner. The former creates a natural sub-catchment in the south-western part of the catchment.

2.5 Climate

The area has a temperate climate with warm wet summers and cold dry winters. Detailed climate measurement from an automatic weather station in the catchment are available since late 1995. Results are presented in Table 2.1. A characteristic feature of the rainfall during summer months is expressed as short periods with large amounts of rain. This feature has probably contributed to the dominating hydromorphic nature of the soils over such a large proportion of the catchment. It is reflected in the high P/ETo values, ranging from 1.20 to 1.37 for the period December to March (Table 2.1).

Table 2.1 Mean monthly rainfall (P) and reference evapotranspiration (ETo; FAO Penman – Monteith) from 1997 to 2002 in the Weatherley catchment

Month	P (mm)	ETo (mm)	P/ETo
January	195	142	1.37
February	154	121	1.27
March	140	117	1.20
April	62	97	0.64
May	30	84	0.36
June	25	72	0.35
July	15	74	0.20
August	29	98	0.30
September	37	111	0.33
October	65	134	0.49
November	131	137	0.96
December	181	142	1.27
Total	1064	1329	0.80

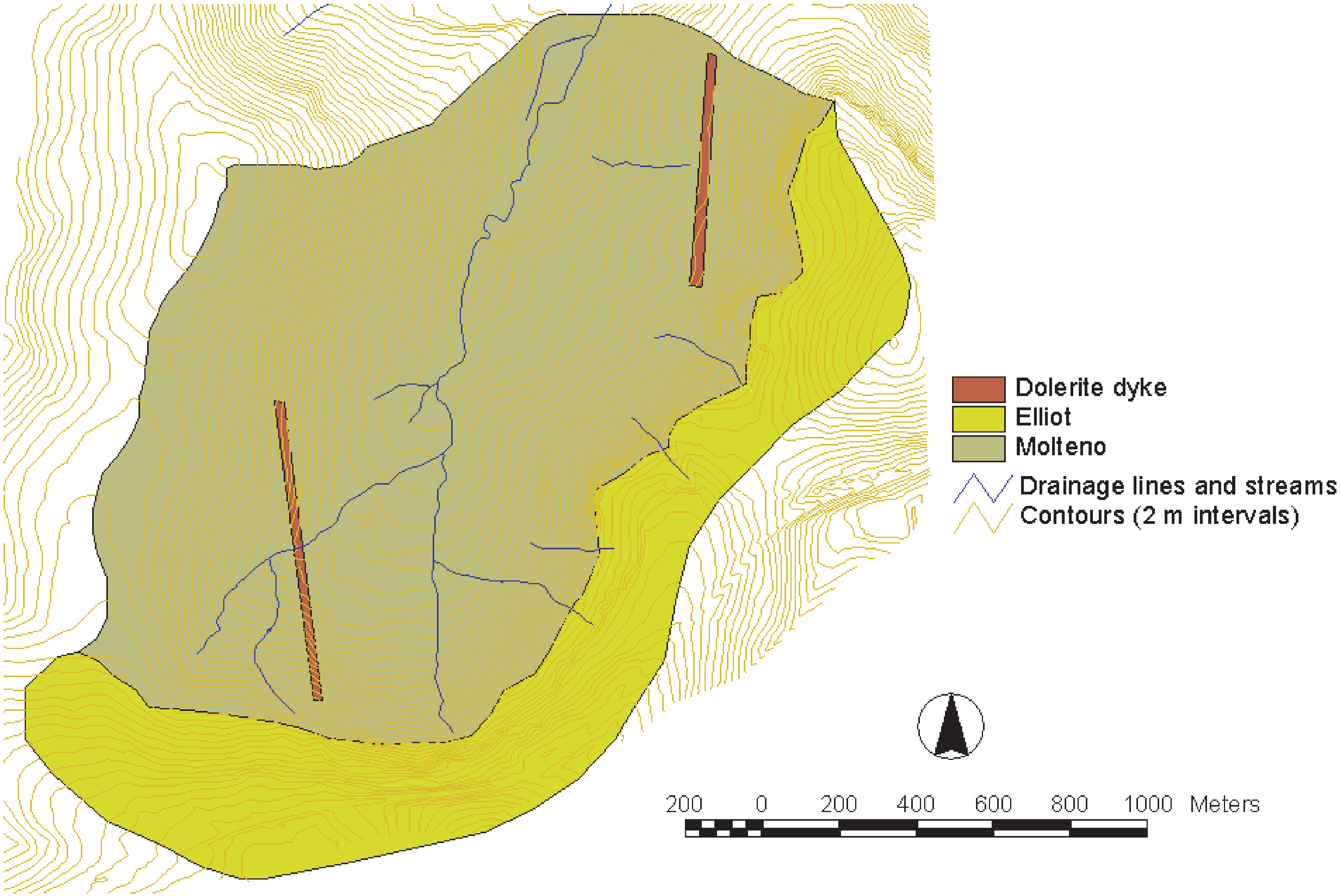

Figure 2.2 Simplified geology of the Weatherley catchment (De Decker, 1981).

2.6 Soils

Due to the high rainfall and the siliceous lithology, the soils in the catchment are highly acidic. The soils also have a very low cation exchange capacity. A soil survey was done by Roberts *et al*. (1996), using “Soil Classification- A Taxonomic System for South Africa” (Soil Classification Working Group, 1991) and grouped according to FSC (1995). Generalized soil patterns are shown in Figure 1.1. The soils range from very poorly drained hydromorphic (Katspruit form), to excessively drained without any hydromorphy (Hutton and Oakleaf forms). Most of the soils do, however, show clear signs of hydromorphy. These signs range from faint mottles to grey zones characterised by clay depletion, often referred to as silans (Le Roux *et al.,* 2003). Duplex soils with strongly structured B horizons also occur on the northwest facing slopes in the southern part of the catchment (Figure 1.1). Detailed information about the soils is presented in Van Huyssteen *et al*. (2005).

2.7 Hydrology

Runoff is measured at two crump weirs in the Weatherley catchment (Figure 3.1). Some data for the lower weir during the period before afforestation, is given in Figure 2.3. It is clear that runoff is concentrated during the summer months and that runoff normally occurs as peaks after large rain storms, and that there is little low flow. The large variation in annual runoff is also apparent in the graph.

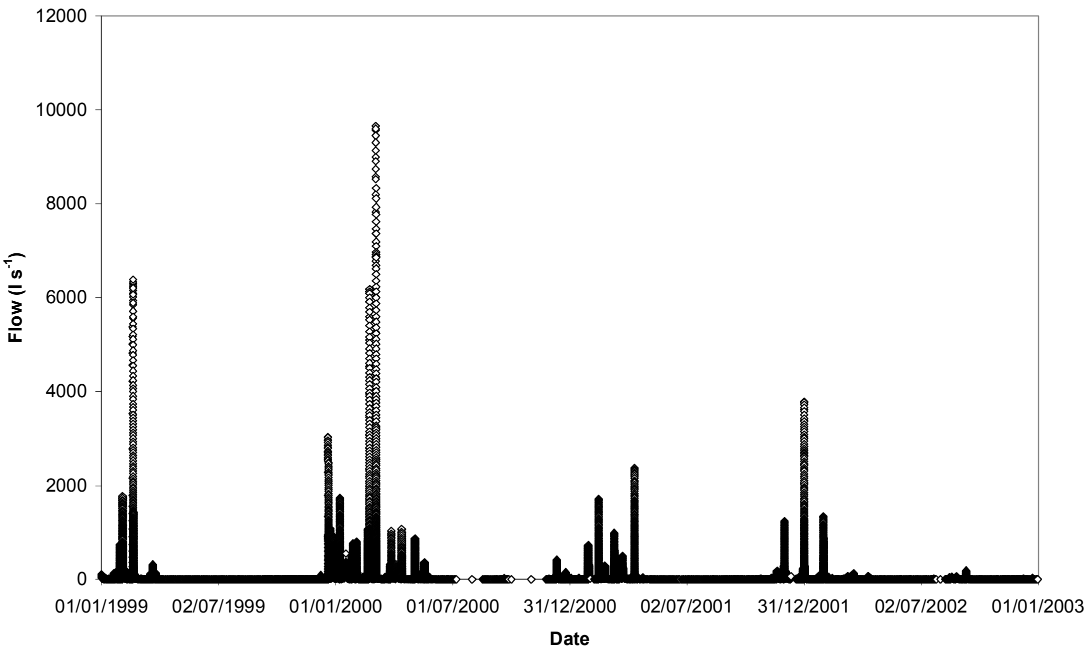

Figure 2.3 Hydrograph, showing runoff at the lower weir in the Weatherley catchment (BEEH, 2003).

3. MATERIALS AND METHODS

3.1 Sample site selection

As mentioned in Section 1.2 a soil map of the Weatherley catchment was compiled by Roberts *et al*. (1996). The map units are shown in Figure 1.1, and the tree planting plan in Figure 2.1. There are five broad soil groups in the catchment which could be used for afforestation. Each group with their map unit subdivisions and relevant total areas in the catchment are listed in Table 3.1. The areas of each of these groups actually planted to the different tree species are given in Table 3.3.

In the selection of sampling sites (Figure 3.1) an attempt was made to select replicates from every broad soil group allocated to each of the tree species. Details are presented in Table 3.2. A total of 25 sites were selected, ten for the *Pinus elliottii* area, eight for the *Pinus patula* area, and seven for the *Eucalyptus nitens* area. In accordance with a request made by Mr Gardiner (Mondi-Forests) to Dr Mkhize (WRC), two additional control sites have been identified at which trees will not be planted. Monitoring the change in soil organic matter at these sites will provide information about any freak atmospheric occurrence which could have influenced C sequestration, over and above that resulting from tree growth.

Table 3.1 Areas of soils which could be used for afforestation in the Weatherley catchment according to the survey by Roberts *et al*. (1996)

Soil groups, map units and soil forms	Area (ha)
Group A: Apedal mesotrophic soils	
Af: Hutton	38
Ag: Clovelly and some Griffin	8
Ah: Hutton/Clovelly/Griffin	4
Group B: Plinthic mesotrophic soils	
Bd: Bloemdal	6
Bf: Pinedene and some Avalon	16
Group C: Undifferentiated hydromorphic soils	
Ca: Westleigh, Katspruit, Longlands	10
Cb: Kroonstad, Longlands	7
Group D: Non-red duplex soils	
Db: Sepane and some Escourt	8
Group H: Mostly neocutanic B horizons	
Ha: Pale topsoil sands	<1
Hc: Vilafontes	1
Hd: Tukulu	1
He: Tukulu, Oakleaf	13
Total	112

The sampling site selection resulted in only 13 of the 28 soil profiles studied by Van Huyssteen *et al*. (2005) for project K5/1317 being included in this study. They described these 13 soil profiles (all numbers 235 and lower) in great detail. The other 14 soil profiles (numbers 240 and higher) were described by this project team but in lesser detail using the procedure of Turner (1991).

The areas of each soil group that have been planted with the three tree species are given in Table 3.3. Both the Sepane and Estcourt soils in the Db map unit used for *P. elliottii* are poorly drained with strong hydromorphic features and have been therefore included in group C. These soil group areas were calculated from the soil map unit areas of Roberts *et al*. (1996) and do not necessarily correspond to the tree species areas presented in Figure 2.1. A simple GPS boundary survey of each of the tree species areas is needed to clarify the situation.

Table 3.2 Soil map units selected for the establishment of three tree species

Soil map unit	Profile No	Soil form*
Pinus elliottii area		
Ah4	250	Pinedene (Pn)
Af13	251	Clovelly (Cv)
Bf16	201	Longlands (Lo)
Bf15	202	Pinedene (Pn)
Ca5	232	Westleigh (We)
Ca5	249	Kroonstad (Kd)
Db3	252	Kroonstad (Kd)
Db5	253	Klapmuts (Km)
He18	203	Tukulu (Tu)
He17	233	Pinedene (Pn)
Pinus patula area		
Af10	240	Hutton (Hu)
Af10	254	Hutton (Hu)
Bf6	245	Pinedene (Pn)
Bd7	244	Pinedene (Pn)
Cb12b	241	Longlands (Lo)
Cb12a	242	Longlands (Lo)
He11	212	Tukulu (Tu)
He8	243	Tukulu (Tu)
Eucalyptus nitens area		
Af4	221	Hutton (Hu)
Af9	246	Pinedene (Pn)
Bd2	220	Bloemdal (Bd)
Bd4	222	Tukulu (Tu)
He1	248	Tukulu (Tu)
He3	210	Bloemdal (Bd)
Bf3	247	Pinedene (Pn)
Control sites		
Cb2	209	Katspruit (Ka)
Marsh	235	Katspruit (Ka)

*Soil Classification Working Group (1991).

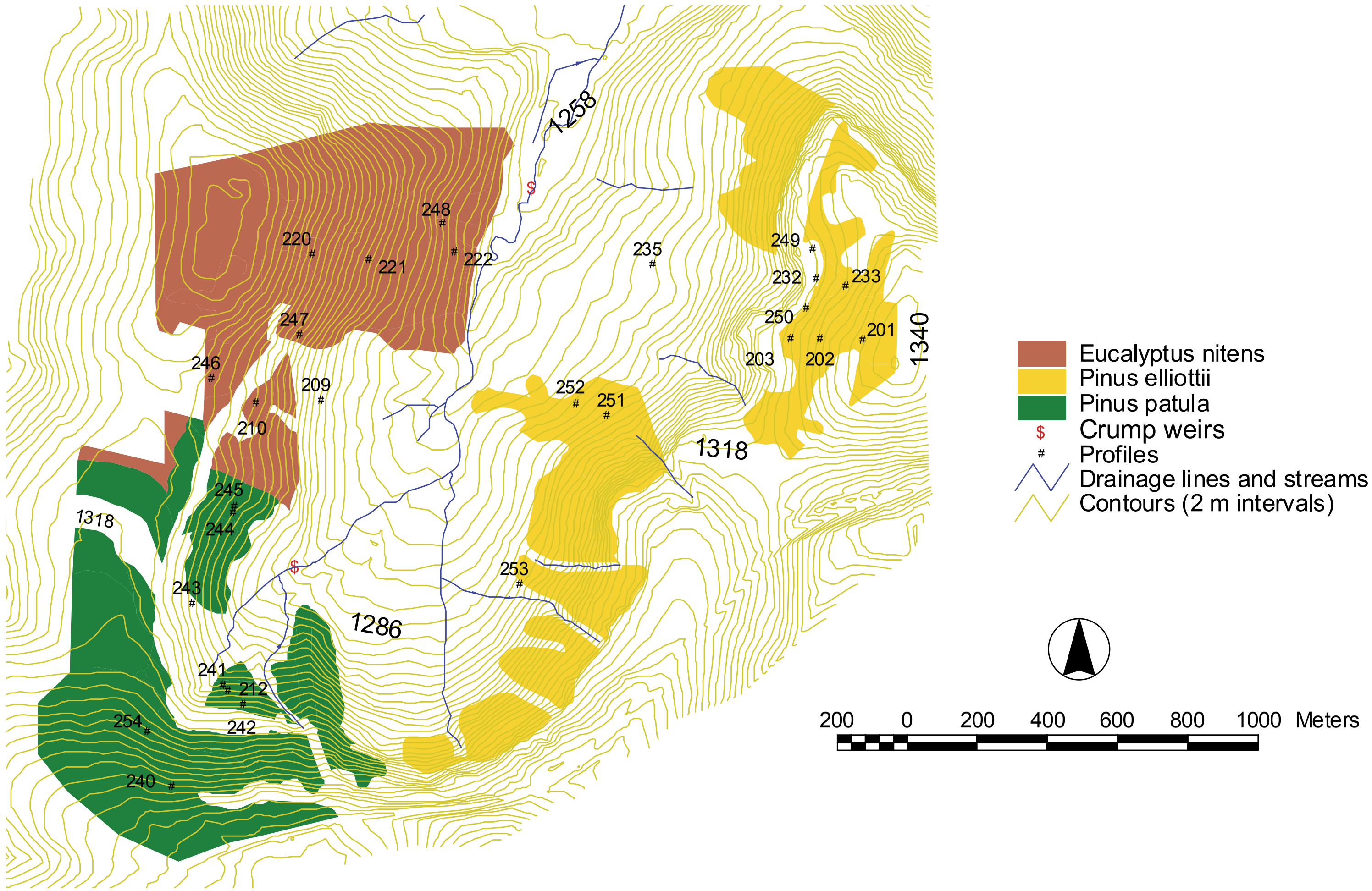

Figure 3.1 Distribution of the 27 sampling sites for this project.

The selection of soil types for the establishment of the three tree species was done by forestry experts. Their preference of group A soils for *P. patula* and *E. nitens* is clearly demonstrated in Table 3.3. The species *P. elliottii* is known for its ability to cope with poorly drained soils. This justifies the choice of groups B, C and H soils, which are dominant on the eastern side of the catchment, for this tree species area (Figure 2.1).

Table 3.3 Areas of the different groups of similar soils in each tree species area

Tree species	Soil groups and areas (ha)				Total (ha)
	A	B	C	H	
P. elliottii	4.2	7.6	6.6	7.9	26.3
P. patula	18.4	3.3	0.2	5.0	26.9
E. nitens	15.0	7.2	0	0.6	22.8
Total (ha)	37.6	18.1	6.8	13.5	76.0

3.2 Vegetation survey

A vegetation survey was done in the Weatherley catchment during 2003. It was logical to focus with this survey on the sites selected for soil sampling as this would expose any marked influence of different kinds of vegetation on the organic matter contents of the soils.

The Braun-Blanquet method of the Zurich-Montpellier (Z-M) school as described by Werger (1974) was applied for the analytical phase of this vegetation survey. This method has become the standardised one for syntaxonomical and synecological studies in South Africa and has long been recognised as such (Scheepers, 1983).

The first major step in the field technique is the choice of a uniform area for description. The field description consists of a relevé (or sample plot) in which all species present are noted and assigned a cover-abundance scale. The order in which the species are listed in the results describes the order of their abundance. Relevés should be subjectively chosen to be representative and uniform of the vegetation being sampled. The stand should also be uniform with regard to the physical environmental conditions, as far as it was possible to judge in the veld.

To ensure uniformity within relevés, plot sizes were chosen to be 4 m^2, with the exception of relevé 2 for which the plot size was 3 m^2. A plant list comprising of all species present within the relevé was compiled for each relevé, during which the general quantitative relations of the species became apparent. After all species are recorded an estimate of cover-abundance is assigned to each species (Mueller-Dombois & Ellenberg, 1974).

In addition the above-ground biomass yield for the 2003/04 growing season was also measured. At each sampling site the above-ground plant material of a 2m x 2m area was cut and thoroughly raked in winter. A year later a portion of this prepared area was randomly selected by throwing a metal square (1m x 1m) on it. The plant material in the square was cut with scissors, collected, dried and weighed. Some ad hoc measurements of biomass yield were also made during the previous growing season, however, without any preparation as described. This data may be useful and is therefore also included.

3.3 Bulk density measurements

For the preceding WRC project on the soils of Weatherley (Project K5/1317) 86 bulk density (Db) determinations were made in duplicate with the core method (Blake & Hartge, 1986), as well as a large number of determinations with a CPN density probe (Reginato, 1974). All these determinations were made over a wide range of depths at all of the 28 soil profile sites selected for that project. The focus of these Db determinations was to improve neutron water meter calibrations and to characterize specific diagnostic horizons or specific 300 mm depth portions of these horizons. For the 13 sites of this study taken from Project K5/1317, the Db values reported by Van Huyssteen *et al*. (2005) were used for all layers deeper than 300 mm. The large number of determinations of that study made it possible to obtain representative Db values for different subsoil horizons in the catchment. These representative values were used for the soil layers deeper than 300 mm at the remaining 12 new sites. Research on soil organic matter (SOM) in grasslands in South Africa has shown that there is generally a relatively rapid decline in OM concentration with depth within the 0-300 mm soil layer (Du Toit, *et al*. 1994; Lobe, *et al*. 2001; Birru, 2002). In order to quantify this gradient in the Weatherley soils under grassland vegetation, expressed as amount of OM (Mg^3 ha^{-1}), it was necessary to have reliable Db values for each of the 0-50 mm or 0-100 mm layers selected for the 0-300 mm soil sampling routine. Duplicate Db determinations were therefore made for these layers at all the sample sites.

Detailed bulk density (Db) sampling of the topsoil was carried out at the 27 sites selected for this study during December 2003 and March 2004. Two sets of Db samples were taken at each site, namely, one set from under a grass tuft and another from a nearby bare area between tufts. The reason for this was the hypothesis that the OM content below the tufts was expected to be higher than that below the bare areas between tufts. Sampling depths were 0-50, 50-100, 100-150, 150-200, and 200-300 mm below the soil surface. Sampling was carried out using an undisturbed core sampler. For the topmost four depths a core size of 334.6 cm^3 was used, whereas for the 200-300 mm depth a larger core of 644 cm^3 was used. The core diameter was 103.2 mm. For the 50 mm intervals a depth of 40 mm was sampled and for the 100 mm interval a depth of 77 mm was sampled. After sampling each layer a smooth soil surface was prepared for the next sample.

3.4 Organic matter measurements

For the map units where test holes had already been dug, profiles described, and samples collected and analysed for project K5/1317, the available results for 100 mm layers to 1.2 m depth were used. There are 13 of these (all numbers 235 and lower). At all the other locations (all numbers 240 and higher) it was necessary to dig profile pits, describe the soils and collect samples for 100 mm layers to 1.2 m depth.

In addition, at each of the 27 sample locations samples were taken at 5 depths in the topsoil viz. 0-50 mm, 50-100 mm, 100-150 mm, 150-200 mm and 200-300 mm. At each sample site 3 sub-samples were taken at each depth and mixed together to give a composite sample. This procedure has proved necessary in recent SOM studies. This procedure was replicated 4 times at each site to give soil samples to represent each depth at each of the sample locations, and therefore 20 topsoil samples per location, making a total of 540 samples, plus 168 samples from the twelve 100 mm depth intervals of the 14 new profiles, for analysis. In order to be able to convert the OM concentration in the samples to an amount, and finally to the Mg ha^{-1} value now internationally used in C sequestration studies, it was necessary to have an appropriate bulk density (Db) value for each soil layer.

The samples were dried at room temperature, crushed, sieved to pass a 2 mm screen and stored until analyzed. All these samples were analyzed for organic C (OC) and total N (TN) as indices of organic matter. Organic C and total N were determined by Mebius (Nelson & Sommers, 1982) and Kjeldahl (Bremner & Mulvaney, 1982) procedures, respectively.

4. Results and discussion

4.1 Soils

As indicated earlier in Section 3.1 a total of 10 soil forms (Table 3.2) were included in this study. They were grouped according to their morphological features into five broad groups (Table 3.1). A concise description of the soil at each sampling site is presented in Appendix 1.

4.2 Vegetation

The native vegetation at Weatherley is known as moist upland grassland which is typical of veld type 42 (Low & Rebelo, 1996). This veld type occurs between 600 and 1400 m above mean sea level and is most commonly found in the Drakensberg foothills of the Eastern Cape and KwaZulu-Natal provinces.

Detailed results of the vegetation survey and biomass yield production for every site are presented in Appendix 1. As mentioned earlier the order in which the species are listed describes the order of their abundance.

The vegetation is a dense, sour grassland with *Themeda triandra* (Redgrass), *Heteropogon contortus* (Speargrass), *Tristachya leucothrix* (Hairy Tridentgrass), *Eragrostis curvula, Elionurus muticus, Digitaria setifera* and *Andropogon appendiculatus* as the dominant species. Diagnostic species include hardy forbs such as *Walafrida densiflora, Cucumis zeyheri (*Spiky Cucumber), C. *ahirsutus* (Wild Cucumber), *Berkheya onopordifolia, Spermacoce natalensis, Kohautia cynanchica, Tephrosia macropoda, T. multijuga, Conyza obscura, Corchorus confuses, Phyllanthus glaucophyllus, Richardia brasiliensis, Gomphrena celosioides, Aster bakerianus, Alysicarpus rugosus, Helichrysum coriaceum and H. rugulosum.* Overgrazing encourages unpalatable *Elionurus muticus* (Wire Grass) and herbaceous weeds such as *Senecio retrorsus* (Staggersweed) and *Helichrysum argyrophyllum* (Doll rose) (Low & Rebelo, 1996).

The already named dominant species in Weatherley are common (i.e. they are present in a relatively large number of relevés), and are also present in large numbers (i.e. a large number of individual specimens are present). Other species with high frequencies of occurrence but that do not necessarily occur in large numbers are *Alloteropsis semialata, Aristida Junciformis, Blepharis integrifolia, Bulbostylis schoenoides, Helichrysum aureonitens, and Zornia capensis.*

The biomass yield at the various sites for the 2003/04 growing season as given in Appendix 1 was used to calculate for each group of similar soils a mean biomass yield. They are as follow for the four soil groups: A = 4070; B = 2670; C = 4020; H = 2850; giving an estimated overall mean for the afforested area of 3400 kg ha^{-1} yr^{-1}.

4.3 Bulk density

Results for samples taken under the tufts and under bare soil are presented in Appendix 2. As they did not differ significantly average values were used. Average values of the 5 surface layers and single values for the remaining nine 100 mm layers to a depth of 1200 mm are presented in Appendix 3, and diagrams showing variations with depth in Appendix 4.

Mean Db values for different depths have been calculated for each group of similar soils in an attempt to identify any characteristic pattern at different depths, and any significant differences between groups. Results are presented in Table 4.1. The following characteristics are revealed by the data.

- In the top three layers, 0-50 mm, 50-100 mm and 100-150 mm, there is a marked similarity in the mean Db values of soil groups A, B and H, with Db increasing from around 1.39 to 1.56 Mg m^{-3}. These are all portions of orthic A horizons overlying either red or yellow-brown apedal or neocutanic B horizons. The equivalent values in the poorly drained strongly hydromorphic soils of group C have considerably lower mean Db values increasing from 1.28 to 1.47 Mg m^{-3}. This indicates that the wetter soil water regime of the orthic A horizons of the latter group has promoted plant growth and also suppressed oxidation of organic matter. If differences in organic matter content had been the main factor governing Db in these three surface 50 mm layers then one would expect the OC content of these layers in the A, B and H groups to be similar, with higher values in the C group. This is not the case as shown by the results in Table 4.2. The mean OC content of the A group is highest, decreasing from 1.98 to 1.84 Mg m^{-3} x 10^{-2} over the top three layers, with the C group next in line with the equivalent decrease being 1.73 to 1.54 Mg m^{-3} x 10^{-2}, followed by the B and H groups with similar values, decreasing from around 1.58 to 1.47 Mg m^{-3} x 10^{-2}. It is clear that there are factors other than organic matter content influencing Db.

- In all the groups there is a gradual increase in Db with depth. In each group, however, the pattern is slightly different. In the A group Db stays fairly constant between 150 mm and 600 mm at about 1.58 Mg m^{-3}, and then again fairly constant from 600-1200 mm at about 1.65 Mg m^{-3}. In the B and C groups the increase continues gradually from 1.59 to 1.70 Mg m^{-3}, and 1.53 to 1.70 Mg m^{-3}, respectively, between 150 and 1200 mm. In the H group the increase is from 1.58 to 1.67 Mg m^{-3} between 150 and 500 mm, whereafter Db remains fairly constant at 1.67 Mg m^{-3} up to 1200 mm. However, although there are differences in Db between the groups below 150 mm depth, they are small and may not be significant. An explanation for the differences is not available at present. There are nevertheless indications that hydromorphic horizons tend to have higher Db values than non-hydromorphic ones.

4.4 Organic matter

Analytical results of the replicated samples for the 0-50 mm, 50-100 mm, 100-150 mm, 150-200 mm and 200-300 mm layers at each test site are presented in Appendix 2; mean values for these layers and single values for the remaining nine 100 mm layers in Appendix 3; and diagrams showing changes with depth in Appendix 4. In view of the objectives of this project report, detailed discussion of the results in the Appendices will not be done. Some characteristics regarding OC and TN contents of the groups of similar soils will be considered.

To study the pedological significance of the data, mean values for each depth for each of the four groups of similar soils have been calculated and expressed on a volume basis as Mg m^{-3} in Table 4.2. This is considered to be expedient as one perceives organic matter visually in the soil on a volume basis, and not on a gravimetric basis. For convenience results have been multiplied by 10^2 and expressed as Mg m^{-3} 10^{-2}. They are also presented graphically in Figures 4.1 and 4.2 to demonstrate an important concept relevant to these soils.

Table 4.1 Mean bulk density (Db) values (Mg m^{-3}) for all the soils in each of the groups of similar soils in the afforested area of the Weatherley catchment. Two control sites outside the afforested area are included. Sampling was early in 2004 or earlier, representing grassland vegetation

Depth (mm)	Db (Mg m^{-3})			
	Group A Hu, Cv	Goup B Pn, Bd	Group C Lo, Ka, Kd, Km, We	Group H Tu
0-50	1.38	1.39	1.28	1.39
50-100	1.45	1.53	1.42	1.49
100-150	1.54	1.56	1.47	1.58
150-200	1.59	1.59	1.53	1.56
200-300	1.58	1.62	1.57	1.59
300-400	1.56	1.63	1.62	1.63
400-500	1.57	1.63	1.63	1.67
500-600	1.58	1.64	1.65	1.67
600-700	1.65	1.66	1.68	1.66
700-800	1.65	1.66	1.68	1.65
800-900	1.65	1.67	1.68	1.66
900-1000	1.64	1.68	1.72	1.67
1000-1100	1.64	1.69	1.70	1.67
1100-1200	1.64	1.70	1.70	1.67

For certain purposes in this study expressing OC and TN content as Mg m^{-3} is advantageous compared to Mg ha^{-1}. The former units allow comparisons between layers of different depths to be made easily, e.g. in Table 4.2 and in all the diagrams in Appendix 4. This is not possible when using Mg ha^{-1}. The latter units have value for other purposes, e.g. they can be added together to give amounts for the whole profile, or specific parts of a profile, as in Tables 4.3 and 4.4.

4.4.1 Organic C

A horizons are recognised by darkening caused by the accumulation of organic matter in the form of humus. The relatively homogenous fairly dark colour of topsoils, and frequently also relatively homogenous other coloured second horizons, creates the impression that the distribution pattern of OC in the A horizons and the underlying horizon should be different. A fairly sharp decrease in OC content at the transition from the A to the underlying horizon is therefore expected. This proves to be not the case for the Weatherley soils. The results in Figure 4.1 show that in all the soil groups there is an almost linear decrease from an average of around 1.7 Mg m^{-3} x 10^{-2} in the top 50 mm layer to around 0.5 Mg m^{-3} x 10^{-2} in the 600-700 mm layer. This is a decrease of approximately 0.17 Mg m^{-3} x 10^{-2} per 100 mm layer, irrespective of the nature of the second horizon. A soil feature which accentuates this linear decrease in OC expressed as Mg m^{-3} is the characteristic almost linear increase in Db with depth in these soils (Table 4.1). The linear portion of the OC graph (Figure 4.1) is followed by a curved portion describing a slowing down of the rate of decrease up to the 800-900 mm layer, where the OC content of all the groups is virtually equal at 0.37 Mg m^{-3} x 10^{-2} (Table 4.2). This curved portion of the graph describes an average decease in OC of 0.07 Mg m^{-3} x 10^{-2} per 100 mm layer. Between the 800-900 mm layer and the 1100-1200 mm layer the decrease is again almost linear at the very slow rate of only 0.04 Mg m^{-3} x 10^{-2} per 100 mm layer, ending up at an average OC value over all the groups of 0.25 Mg m^{-3} x 10^{-2} in the 1100-1200 mm layer (Figure 4.1).

In the grassland soils organic matter accumulation is expected to be at a maximum in the topsoil. Under afforestation the accumulation may be considerably different. Because tree roots penetrate deeply, organic matter may be increased in subsoil layers. Data is presented in Tables 4.3 and 4.4 to show the relationship between OC, expressed as Mg ha^{-1}, in the topsoil (0-300 mm) and subsoil (300-1200 mm) under grassland vegetation. In all the groups, with the exception of the strongly hydromorphic group (group C) there is little difference between the two values. The tendency for maximum deposition in the topsoil is clearly demonstrated. Anaerobic conditions in the subsoil layers of the soils of group C, maintained over relatively long periods each year, probably suppress oxidation of the organic matter to a significant extent compared to the other soils.

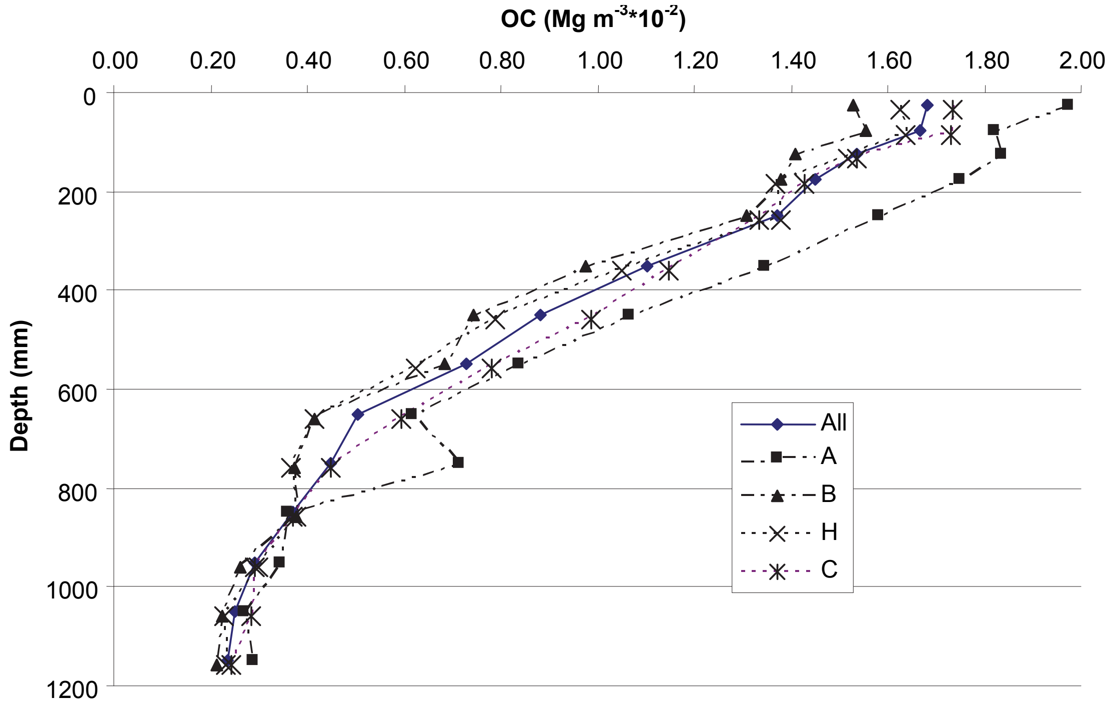

Figure 4.1 Organic carbon content (Mg m^{-3}*10^{-2}) of different soil layers for each of the groups of similar soils in the afforested area of the Weatherley catchment.

There is a marked similarity in the OC content of the different layers between groups B and H (Figure 4.1). The pedological characteristics of the soils in these groups are also similar, the B group having red or yellow-brown apedal B horizons and the H group having neocutanic B horizons, with signs of wetness in both cases below the B horizons at approximately the same depth. The similarity in OC distribution is therefore not surprising. The similarity between these two groups in terms of the total OC in the topsoil and subsoil is also clearly demonstrated by the results in Table 4.3.

In Table 4.4 average OC (Mg ha^{-1}) for the 0-300 mm and 300-1200 mm layers, obtained from all the profiles in each of the tree species areas, and the two control sites, are shown. There is little difference between the values for the three tree species areas. This is considered to be advantageous as it provides what appears to be an unbiased starting point for each of the tree species against which to compare results from later samplings. The very low C:N ratio of 6.9 for the 300-1200 mm layer of the very poorly drained, strongly hydromorphic soils (both Katspruit form) of the control sites is further evidence for the relevant process already discussed.

In Table 4.5 average OC contents (Mg ha^{-1}) for the different soils in each tree species area are presented. There is considerable variation between the same kinds of soil in the different tree areas. This is greatest in the very poorly drained soil group C, the total OC in 0-1200 mm varying from 75 Mg ha^{-1} in the control sites, to 82 Mg ha^{-1} in the *P. patula* area to 112 Mg ha^{-1} in the *P. elliottii* area. No explanation for this is available at present. However, it is reassuring to some extent that over all the different soils in each tree area, excluding the control sites, there is relatively little variation in the OC content (Table 4.4). The variations which occur accentuate the need for replicated samples to eliminate as much sampling error as is feasible within our capability.

The results in Table 4.5 are intended to fulfil the requirements of the third objective. Its wording was poorly chosen. To calculate the OC content of each map unit in each tree species area would not be meaningful. The plan is to resample at the same sites at each new sampling date at five year intervals. Presentation of the results as in Table 4.5 is therefore the logical procedure. This will expose any tree species/soil type interaction.

Table 4.2 Mean values of OC and TN (Mg m^{-3} x 10^{-2}) at each depth, and C:N ratios, for the four groups of similar soils in the afforested area of the Weatherley catchment. (For convenience results have been multiplied by 10^{2}). Two control sites outside the afforested area are included. Sampling early in 2004 or earlier, representing grassland vegetation

Depth (mm)	Group A Hu, Cv (Mg m^{-3} x 10^{-2})			Group B Bd, Pn (Mg m^{-3} x 10^{-2})			Group C Lo, Ka, Kd, Km, We (Mg m^{-3} x 10^{-2})			Group H Tu (Mg m^{-3} x 10^{-2})		
	C	N	C:N	C	N	C:N	C	N	C:N	C	N	C:N
0-50	1.98	0.132	15.0	1.53	0.097	15.8	1.73	0.113	15.3	1.62	0.106	15.3
50-100	1.82	0.126	14.4	1.56	0.099	15.8	1.73	0.114	15.2	1.64	0.105	15.6
100-150	1.84	0.123	15.0	1.41	0.092	15.3	1.54	0.108	14.3	1.52	0.096	15.8
150-200	1.75	0.111	15.8	1.38	0.084	16.4	1.43	0.106	13.5	1.37	0.092	14.9
200-300	1.58	0.107	14.8	1.31	0.086	15.2	1.34	0.104	12.9	1.38	0.092	15.0
300-400	1.35	0.081	16.7	0.97	0.067	14.5	1.15	0.094	12.2	1.05	0.069	15.2
400-500	1.07	0.074	14.5	0.74	0.057	13.0	0.99	0.087	11.4	0.79	0.065	12.2
500-600	0.84	0.067	12.5	0.68	0.049	13.9	0.78	0.083	9.4	0.63	0.059	10.7
600-700	0.62	0.047	13.2	0.42	0.043	9.8	0.59	0.069	8.6	0.41	0.048	8.5
700-800	0.71	0.053	13.4	0.37	0.040	9.3	0.45	0.062	7.3	0.36	0.038	9.5
800-900	0.36	0.040	9.0	0.38	0.035	10.9	0.37	0.053	7.0	0.38	0.041	9.3
900-1000	0.35	0.048	7.3	0.26	0.033	7.9	0.29	0.049	5.9	0.30	0.040	7.5
1000-1100	0.27	0.049	5.5	0.23	0.029	7.9	0.29	0.052	5.6	0.23	0.036	6.4
1100-1200	0.29	0.049	5.9	0.21	0.030	7.0	0.24	0.048	5.0	0.23	0.036	6.4

Table 4.3 Mean values of OC and TN (Mg ha^{-1}) in topsoils (0-300 mm) and subsoils (300-1200 mm) of the four groups of similar soils in the afforested area of the Weatherley catchment. Two control sites outside the afforested area are included. Sampling early in 2004 or earlier, representing grassland vegetation

Depth (mm)	Group A Hu, Cv			Group B Bd, Pn			Group C Lo, Ka, Kd, Km, We			Group H Tu		
	(Mg ha^{-1} per layer)			(Mg ha^{-1} per layer)			(Mg ha^{-1} per layer)			(Mg ha^{-1} per layer)		
	C	N	C:N	C	N	C:N	C	N	C:N	C	N	C:N
0-300	52.7	3.53	15.0	42.5	2.71	15.6	45.5	3.24	14.0	44.5	2.92	15.3
300-1200	58.4	5.09	11.5	42.7	3.84	11.1	51.5	5.97	8.63	43.8	4.31	10.2
0-1200	111.1	8.62	12.9	85.1	6.55	13.0	97.0	9.21	10.5	88.3	7.23	12.2

Table 4.4 Mean values of OC and TN (Mg ha^{-1} per layer) in topsoils (0-300 mm) and subsoils (300-1200 mm) in the areas planted to *P. patula*, *P. elliottii* and *E. nitens*; and two control sites. Sampling in 2004 or earlier, representing grassland vegetation

Depth (mm)	*P. patula* area			*P. elliottii* area			*E. nitens* area			2 control sites		
	(Mg ha^{-1} per layer)			(Mg ha^{-1} per layer)			(Mg ha^{-1} per layer)			(Mg ha^{-1} per layer)		
	C	N	C:N	C	N	C:N	C	N	C:N	C	N	C:N
0-300	43.3	2.81	15.4	45.8	3.16	14.5	35.5	3.13	11.4	42.0	3.16	13.2
300-1200	46.8	4.39	10.7	47.6	5.29	9.0	38.6	4.57	8.44	33.3	4.96	6.72
0-1200	90.1	7.20	12.5	97.3	8.45	11.1	74.1	7.70	9.62	75.3	8.12	9.28

4.4.2 Total N

Results are presented as for OC in Appendices 2, 3 and 4, and in Tables 4.2, 4.3 and 4.4. Average values of TN content for the different groups of soils at each depth are shown graphically in Figure 4.2. The distribution pattern with depth for groups B and H is, as in the case of OC, again very similar. The amounts of TN in the topsoil and subsoil of these two groups (Table 4.3) is also similar, and also different from the freely drained soils (group A) and the strongly hydromorphic soils (group C).

The TN content in the five topsoil samples of group A is by far the highest (3.53 Mg ha^{-1} for the 0-300 mm layer) followed by equivalent values of 3.24 for group C and a mean value of 2.82 for the B and H groups (Table 4.3 and Figure 4.2). Below 300 mm the pattern changes, with the group C having the highest values (Figure 4.2).

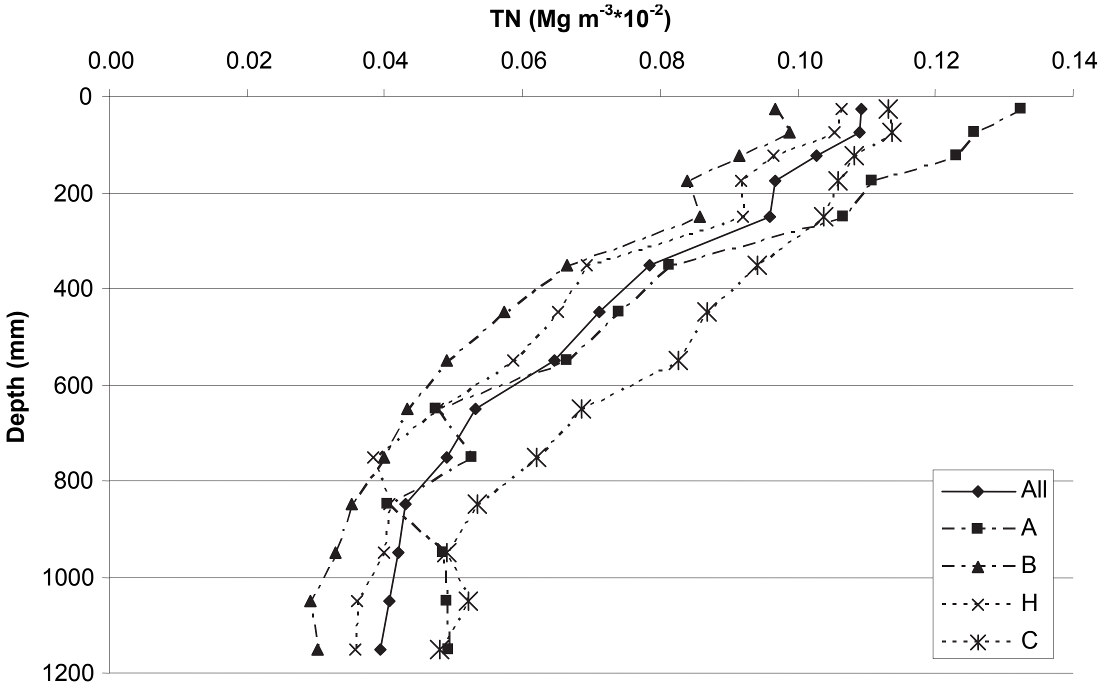

Figure 4.2 Total N content (Mg m^{-3}*10^{-2}) of different soil layers for each of the groups of similar soils in the afforested area of the Weatherley catchment.

4.4.3 C:N ratios

Details for each profile are presented in Appendices 2, 3 and 4. Mean values for the four groups of similar soils at each depth, and totals for the topsoil and subsoil, are presented in Tables 4.2 and 4.3 respectively. As expected there is again a marked similarity between groups B and H, with a C:N value of around 15.6 in the 0-150 mm layer which decreases gradually to around 13 in the 500-600 mm layer, followed by a slower decrease to around 7 at about 1000 mm (Table 4.2). In group A and C the C:N ratio is also around 15 in the 0-150 mm layer. In group A the value then decreases gradually to around 13 at a depth of 700-800 mm, where after there is a sharp decrease to 9 and then decreasing more gradually to end at about 6 at 1200 mm. The pattern is very different in group C.

Table 4.5 Organic carbon contents (Mg ha^{-1}) per 50 mm layer from 0-200 mm depth, and per 100 mm layer from 200 mm to 1200 mm, for the sample sites of each soil group in each of the tree species areas (See Table 3.2 for details), and in the grassland control area

Depth	*Pinus Patula* area				*Pinus elliottii* area				*Eucalyptus nitens* area			Grassland control area
	Soil group				Soil group				Soil group			Soil group
(mm)	A	B	C	H	A	B	C	H	A	B	H	C
0-50	10.72	8.15	8.38	8.13	10.00	7.12	8.64	6.60	8.06	7.77	8.88	9.01
50-100	9.43	7.09	6.89	8.33	9.54	7.46	9.64	6.66	7.99	8.36	8.81	7.98
100-150	9.44	5.96	6.28	7.08	9.21	7.06	8.54	6.80	8.64	7.57	8.48	6.98
150-200	9.32	5.75	5.57	6.38	8.55	6.86	8.24	6.39	7.81	7.52	7.52	6.01
200-300	16.23	10.53	10.07	13.40	15.62	13.13	15.21	11.85	15.18	14.34	15.20	12.03
0-300	55.15	37.47	37.18	43.31	52.92	41.62	50.27	38.30	47.68	45.56	48.89	42.00
300-400	15.07	11.55	8.67	8.45	8.95	8.82	13.24	4.35	14.80	9.54	15.60	9.89
400-500	12.09	8.66	8.72	7.90	10.63	5.98	11.55	3.31	7.85	7.94	10.18	6.88
500-600	8.87	6.77	7.35	5.93	7.43	4.38	9.09	4.70	8.31	8.69	7.37	5.10
600-700	6.02	3.96	5.81	2.85	5.78	3.56	7.10	4.37	6.85	4.71	5.31	3.18
700-800	6.85	3.47	4.28	3.27	10.56	3.96	5.11	4.37	4.24	3.68	3.66	3.18
800-900	3.22	3.14	3.33	2.51	4.62	4.22	4.57	4.37	3.26	3.75	4.74	1.83
900-1000	3.14	2.74	2.48	3.27	4.46	3.06	3.76	1.40	3.08	2.23	3.54	1.21
1000-1100	2.31	2.05	2.39	1.91	3.30	2.29	3.91	1.40	2.92	2.33	3.06	1.21
1100-1200	2.56	2.05	1.62	2.08	4.62	2.48	3.19	1.40	1.78	1.95	2.98	0.87
300-1200	60.12	44.37	44.66	38.18	60.33	38.74	61.51	29.68	53.08	44.81	56.44	33.34
0-1200	115.27	81.84	81.84	81.49	113.25	80.36	111.79	67.97	100.76	90.37	105.33	75.34

Values below 12 start in the 400-500 mm layer and then decrease to 5 at 1200 mm. It seems that relative to OC, TN appears to accumulate in these very wet subsoils. What probably happens is that in the process of the micro-organisms using organic matter for food, CO_2 is released, whereas the N remains as one or other organic compound as part of the bodies of the living or dead micro-organisms. Very little is evidently present in the ionic form in which it could easily be leached.

There is evidence, depicted in Figure 4.3, that these processes occur in all these soils, the degree to which they occur evidently being influenced by the prevailing conditions in each kind of soil. The graphs, based on the mean values from all 27 profiles, show how the decrease in OC with depth is far more pronounced than the decrease in TN. The extent to which this relationship is accentuated in the very poorly drained group (group C) is also shown by the results in Table 4.3. Whereas the mean C:N ratio for groups A, B ad H for the 300-1200 mm layer is between 10.2 and 11.5, the equivalent value for group C is 8.7.

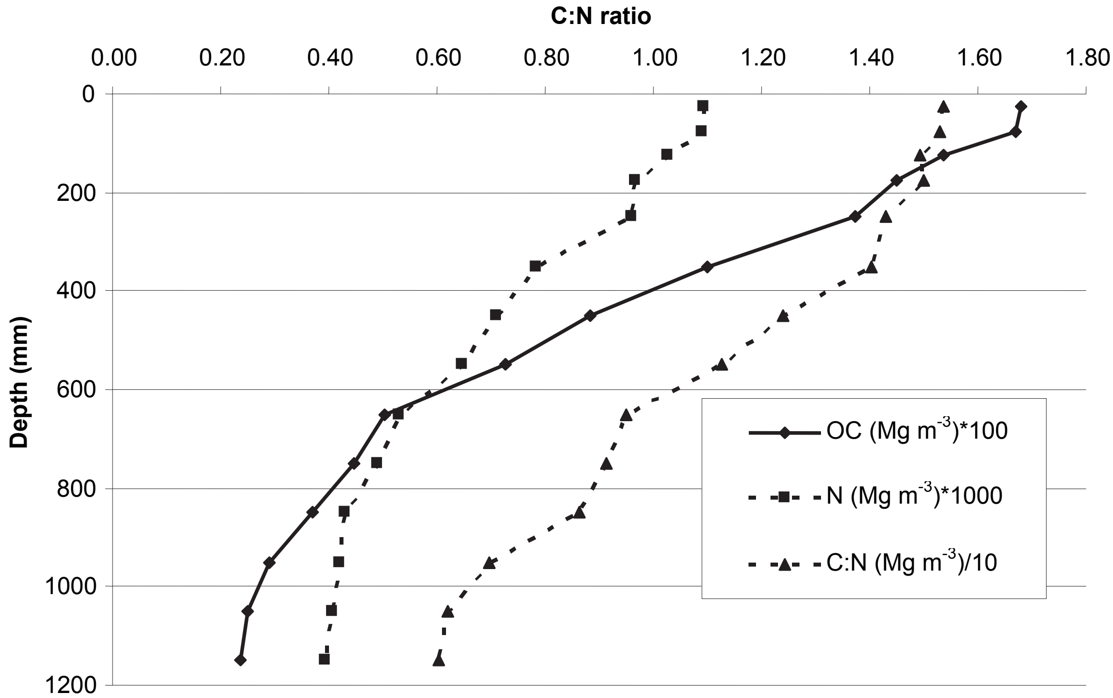

Figure 4.3 Mean values of OC and TN contents and C:N ratios at different depths for all soils in the afforested area of the Weatherley catchment. The C:N values are divided by 10 to fit the graph.

5. SUMMARY AND CONCLUSIONS

5.1 Main findings

It is considered that the objectives of the project have been satisfactorily achieved. The following are important findings of this baseline study:

- Differences in the amounts and distribution of OC are shown to occur between groups of similar soils (Table 4.3). The excessively drained soils (group A; Hutton and Clovelly forms) have the largest amounts of OC in both the 0-300 mm layer (53 Mg ha^{-1}) and 300-1200 mm layer (58 Mg ha^{-1}). The average biomass yield from these soils was also the highest at 4070 kg ha^{-1} yr^{-1}. The next highest amounts of OC were found in the poorly drained soils (group C: Longlands, Katspruit, Westleigh, Kroonstad and Klapmuts forms) with 46 and 51 Mg ha^{-1} in the 0-300 and 300-1200 mm layers respectively, and a biomass yield of 4020 kg ha^{-1}. Groups B and H, the well and freely drained soils (Bloemdal, Pinedene and Tukulu forms), had similar characteristics regarding OC amounts and distribution patterns. They had around 43 Mg ha^{-1} of OC in both the 0-300 and 300-1200 mm layers and biomass yields between 2670 and 2850 kg ha^{-1} yr^{-1}.

- A prominent feature of the distribution of OC (Mg m^{-3}) with depth is an almost linear decrease from the surface to a depth of about 600 mm in all the soils irrespective of the kind of B horizon present (Figure 4.1).
- With regard to TN a significant observation is its accumulation in the subsoils of the strongly hydromorphic soils. Whereas the C:N ratios in the 300-1200 mm layers of three other groups range between 10.2 and 11.5, in group C the value is 8.7 (Table 4.3). It is suggested that this accumulation has been promoted by the long periods of anaerobic conditions in these horizons.
- The OC contents of the soils in each of the tree species areas, for the 0-1200 mm layer are ranging between 74 and 93 Mg ha^{-1} (Table 4.4).
- An average biomass yield (oven dry material) from the grassland in the area earmarked for afforestation was found to be 3400 kg ha^{-1} yr^{-1}.

5.2 Carbon sequestration

It is of interest to estimate the efficiency with which C is sequestered by the grassland vegetation in the Weatherley catchment and compare it with predicted values for afforestation. Using the mean annual biomass yield of 3400 kg ha^{-1} yr^{-1} and assuming that this material has a C content of 50% (Houghton, 1996; Hall, Maynick & Williams, 1991), C sequestration by grassland in the Weatherley catchment is estimated to be 1700 kg C ha^{-1} yr^{-1}. Taking the mean annual Et/Eto and ETo values for the catchment as 0.62 and 1329 mm respectively (Van Huyssteen *et al*., 2005), the mean annual ET_{grass} is estimated to be 824 mm. The C sequestration efficiency by the grassland is therefore 1700/824 = 2.06 kg C ha^{-1} yr^{-1} mm^{-1}.

In a study of 20 mature *P. patula* and *P. elliottii* stands at NECF a mean annual increment (MAI) value of 15 m^3 ha^{-1} yr^{-1}, and a mean wood density of 0.39 Mg m^{-3} was obtained (Zwolinski, Hensley & Monnik, 1997). Using these values and assuming that the dry biomass has a C content of 50% (Houghton, 1996; Hall, Maynick & Williams, 1991), in the long term a yield of 2.93 Mg C ha^{-1} yr^{-1} from wood can be expected from *P. patula* and *P. elliottii* plantations at NECF. This value does not include the C in the branches and leaves. As a value for these parts is not available at present, and its contribution is probably relatively small, it will be ignored in the calculation which follows. In a study comparing water use by veld grass and four to seven year old *P. patula* (full canopy) trees on the

Funeray estate of NECF, over a 41 month period, the following equation was found to describe their ET/Eo relationship satisfactorily (Hensley & Anderson, 1998).

$$(ET/Eo)_p = 1.17\ (ET/Eo)_g + 0.09 \qquad (1)$$

The subscripts p and g represent *P. patula* and grass respectively. It will be assumed that as a first approximation this equation will be valid for Weatherley, provisionally ignoring the difference between Eo and ETo. Substituting the mean $(ET/ETo)_{grass}$ value of 0.62 found for Weatherley (Van Huyssteen *et al.,* 2005) into equation 1 gives an estimated $(ET/ETo)_p$ value for *P. patula* at Weatherley of 0.815. Applying this to the mean annual ETo for Weatherley of 1329 mm provides an estimate of long-term annual *P. patula* water use of 1083 mm, a little more than the MAR for Weatherley of 1064 mm! The latter figure will therefore be used in the calculation which follows.

The C sequestration efficiency of the *P. patula* area (*P. elliottii* is expected to be similar) can therefore be estimated to be 2930/1064 = 2.75 kg C ha^{-1} yr^{-1} mm^{-1}. As expected the C sequestration efficiency per unit of water used is slightly higher for the trees. Over a 20 year growing cycle it is estimated that the trees will have sequestrated about 2.75 x 1064 x 20 = 58.5 Mg C ha^{-1} and the veld grass about 33.9 above ground Mg C ha^{-1}. These values are surprisingly small compared to the average value of 95 Mg C ha^{-1} stored in the soil to a depth of 1200 mm.

The selected soils at Weatherley classify as Ultisols and Entisols (Soil Survey Staff, 1999). It is of value to compare the organic carbon contents of world soils with those at Weatherley. Information is provided in Table 5.1. The results presented for the Weatherley soils fit well into this wide range and are shown to be similar to the Ultisols and Entisols.

Table 5.1 Mass of OC in the world's soils (After Brady & Weil, 1996)

Soil order	OC (Mg ha^{-1} m^{-1})
Entisols	99
Inceptisols	163
Histosols	2045
Andisols	306
Vertisols	58
Aridisols	35
Mollisols	131
Spodosols	146
Alfisols	69
Ultisols	93
Oxisols	101

5.3 Recommended future research

- Soil sampling as for this report at the same sites at 5 year intervals.
- Measure amounts of C in the vegetation of the afforested areas at 5 year intervals.
- Measure ET for periods as long as possible on the afforested areas, and also on the grassland area without trees, especially the marsh.
- Continue soil water measurements with NWM and tensiometers at all the present measurement sites.
- Obtain C sequestration efficiencies per mm of water used for the trees for each 5 year period up to maturity.
- Continue measuring biomass yields annually from the grass at the two control sites and calculate C sequestration efficiency per mm water used for each 5 year period.

REFERENCES

BEEH, 2003. Weatherley database V 1.0. School of Bioresources Engineering and Environmental Hydrology, University of KwaZulu-Natal, Pietermaritzburg.

BIRRU, T.C., 2002. Organic matter restoration by conversion of cultivated land to perennial pasture on three agro-ecosystems in the Free State. Unpublished M.Sc. Agric. dissertation, University of the Free State, Bloemfontein.

BLAKE, G.R. & HARTGE, K.H., 1986. Bulk density. In: A. Klute (Ed.) Methods of soil analysis. Part 1. Physical and mineralogical methods. Am. Soc. of Agron., Madison, Wisconsin.

BRADY, N.C. & WEIL, R.R., 1996. The nature and properties of soils, Prentice Hall International, New Jersey.

BREMNER, J.M. & MULVANEY, C.S., 1982. Nitrogen-total. In A.L. Page (ed.). Methods of soil analysis. Part 2. Chemical and microbiological properties. Am. Soc. of Agron., Madison, Wisconsin.

CHIEF DIRECTOR OF SURVEYS AND MAPPING, 1993. South Africa 1:50 000 sheet 3128 AB Maclear. Chief Director of Surveys and Mapping, Mowbray.

DE DECKER, R.H., 1981. 1:250000 Geological series 3028 Kokstad. Council for Geoscience, Pretoria.

DU TOIT, M. E., DU PREEZ, C.C., HENSLEY, M. & BENNIE, A.T.P., 1994. Effect of cultivation on the organic matter content of selected dryland soils in South Africa. *S. Afr. J. Plant Soil* 11, 71-79.

FSD., 1995. Forest industry soils database (FSD) co-operative. Soil surveys standards for consultants. Version 1.2.

HALL, D.O., MYNICK, H.E. & WILLIAMS, R.H., 1991. Cooling the greenhouse with bio energy. *Nature* 353, 11-12.

HENSLEY, M. & ANDERSON, J.J., 1998. Water balance studies at four locations at North East Cape Forests. ARC-ISCW Report to Mondi, Pretoria.

HOUGHTON, R.A., 1996. Converting terrestrial ecosystems from sources to sinks of carbon. *Ambio* 25, 267-272.

LE ROUX, P.A.L., VAN HUYSSTEEN, C.W. & HENSLEY, M., 2003. Soil properties and hillslope hydrology in the Weatherley catchment. 50th Conference of the Soil Science Society of South Africa, Stellenbosch.

LOBE, I., AMELUNG,W. & DU PREEZ, C.C., 2001. Losses of soil carbon and nitrogen with prolonged arable cropping from sandy soils of the South African Highveld. *Eur. J. Soil Sci* 52, 93-101.

LOW, A.B. & REBELO, A.G., 1996. Vegetation of South Africa, Lesotho and Swaziland. Department of Environmental Affairs and Tourism, Pretoria.

MUELLER-DOMBOIS, D. & ELLENBERG, H. 1974. Aims and methods of Vegetation Ecology. John-Wiley and Sons, Inc.

NELSON, D.W. & SOMMERS, L.E., 1992. Total carbon, organic carbon and organic matter. In A.L. Page (ed.). Methods of soil analysis. Part 2. Chemical and microbiological properties. *Am. Soc. of Agron.*, Madison, Wisconsin.

REGINATO, R.J., 1974. Gamma radiation measurements of bulk density changes in a soil pedon following irrigation. *Soil Sci. Soc. Am. Proc*. 38, 24-29.

ROBERTS, V.G., HENSLEY, M., SMITH-BAILLIE, A.L. & PATTERSON, D.G., 1996. Detailed soil survey of the Weatherley Catchment. ISCW Report No. GW/A/96/33. ARC-ISCW, Pretoria.

SCHEEPERS, J.C. 1983. Progress with vegetation studies in South Africa. *Bothalia*. 14: 683-690.

SOIL CLASSIFICATION WORKING GROUP, 1991. Soil Classification, A Taxonomic System for South Africa. Mem. agric. nat. Resour. S. Afr. No. 15 Dept. Agric. Dev., Pretoria.

SOIL SURVEY STAFF, 1999. Keys to Soil Taxonomy, 8th edn. Pocahontas Press Inc., Blacksburg, Virginia.

TURNER, D.P., 1991. A procedure for describing soil profiles. ISCW report No. GB/A/91/67. ARC-ISCW, Pretoria.

VAN HUYSSTEEN, C.W., HENSLEY, M., LE ROUX, P.A.L., ZERE, T.B. & DU PREEZ, C.C., 2005. The relationship between soil water regime and soil profile morphology in the Weatherley catchment, an afforestation area in the North Eastern Cape. WRC report 1317/1/05, Pretoria.

WERGER, M.J.A. 1974. On concepts and techniques applied in the Zürich-Montpellier method of vegetation survey. *Bothalia*. 11, 309-323.

ZWOLINSKI, J., HENSLEY, M. & MONNIK, K.A., 1998. Site conditions and growth of pines at the North East Cape Forests. *Southern African Forestry Journal*. 183: 1-16.

APPENDIX 1

Abbreviated soil profile descriptions, results of the vegetation survey, and biomass yields at each test site.

Longlands 2000 (P201), map unit Bf16, *Pinus elliottii*

Profile description

Latitude & Longitude: 31° 06' 06.0" / 28° 20' 18.0", **Terrain unit:** Upper midslope, **Slope:** 4 %

Horizon	**Depth (mm)**	**Diagnostic horizons**
A	0 – 430	Orthic A horizon
E	430 – 730	E horizon
B	730 – 980	Soft plinthic B horizon
C	980 – 1210	Saprolite / rock

Plant species composition

Species
Themeda triandra
Tristachya leucothrix
Blepharis integrifolia
Bulbostylis schoenoides
Digitaria tricholaenoides
Eragrostis plana
Helichrysum aureonitens
Kyllinga alata
Cyperus obtusiflorus var. flavissimus
Eragrostis capensis
Ficinia cinnamomea
Haplocarpha scaposa
Helichrysum miconiifolium
Hypochoeris radicata
Rhyncosia totta
Wahlenbergia undulate
Cyanotis speciosa
Eragrostis curvula
Gazania krebsiana
Microchloa caffra
Zornia capensis

Biomass yield (g m^{-2})

Season	12/1/2002*	6/1/2003*	6/1/2004**
	169	363	285

*Unprepared site **Prepared site

Pinedene 1100 (P202), map unit Bd15 , *Pinus elliottii*

Profile description

Latitude & Longitude: 31° 06' 06.0" / 28° 20' 15.1", **Terrain unit:** Upper midslope, **Slope:** 4 %

Horizon	Depth (mm)	Diagnostic horizons
A	0 - 400	Orthic A horizon
B	400 - 820	Yellow-brown apedal B horizon
C1	820 - 990	Unspecified material with signs of wetness
C2	990 - 1500	Unspecified material with signs of wetness

Plant species composition

Species
Koeleria capensis
Heteropogon contortus
Alloteropsis semialata
Bulbostylis schoenoides
Cyperus obtusiflorus var. flavissimus
Gazania krebsiana
Tristachya leucothrix
Walafrida tenuifolia
Indigophera hedyantha
Themeda triandra
Trachypogon spicatus
Zornia capensis
Cassia comosa
Euphorbia clavaroides
Harpochloa falx
Helichrysum aureonitens

Biomass yield (g m^{-2})

Season	12/1/2002*	6/1/2003*	6/1/2004**
	73	252	109

*Unprepared site **Prepared site

Tukulu 2100 (P203), map unit He18, *Pinus elliottii*

Profile description

Latitude & Longitude: 31° 06' 05.9" / 28° 20' 13.0", **Terrain unit:** Upper midslope, **Slope:** 8 %

Horizon	Depth (mm)	Diagnostic horizons
A	0 - 380	Orthic A horizon
B	380 - 960	Neocutanic B horizon
C1	960 - 1300	Unspecified material with signs of wetness
C2	1300 - 1500	Unspecified material with signs of wetness

Plant species composition

Species
Digitaria setifolia
Themeda triandra
Tristachya leucothrix
Alloteropsis semialata subsp. Eckloniana
Alloteropsis semialata subsp. Semialata
Bulbostylis oritrephes
Ficinia cinnamomea
Gazania krebsiana
Helichrysum aureonitens
Indigophera hedyantha
Panicum natalense
Zornia capensis
Aster bakeranus
Walafrida tenuifolia

Biomass yield (g m^{-2})

Season	12/1/2002*	6/1/2003*	6/1/2004**
	57	115	267

*Unprepared site **Prepared site

Katspruit 1000 (P209), map unit Cb2 , control site 1

Profile description

Latitude & Longitude: 31° 06' 10.3" / 28° 19' 39.6", **Terrain unit:** Upper midslope, **Slope:** 8 %

Horizon	**Depth (mm)**	**Diagnostic horizons**
A	0 - 450	Orthic A horizon
G	450 - 1100	G horizon
C	1100 - 1400	Saprolite

Plant species composition

Species
Aristida junciformis
Helichrysum aureonitens
Hypoxis angustifolia
Plantago lanceolata
Rhynchospora brownie
Bulbostylis oritrephes
Digitaria setifolia
Elionurus muticus
Lobelia erinus
Monopsis decipiens
Alchemilla woodii
Commelina africana var. krebsiana
Helichrysum pilosellum
Tristachya leucothrix
Alloteropsis semialata
Sebaea leiostyla
Senicio erubescens
Senicio sp.

Biomass yield (g m^{-2})

Season	**12/1/2002***	**6/1/2003***	**6/1/2004***
	207	303	220

*Unprepared site **Prepared site

Bloemdal 1100 (P210), map unit He3, *Eucalyptus nitens*

Profile description

Latitude & Longitude: 31° 06' 10.5" / 28° 19' 34.9", **Terrain unit:** Upper midslope, **Slope:** 5 %

Horizon	Depth (mm)	Diagnostic horizons
A1	0 - 260	Orthic A horizon
A2	260 - 530	Orthic A horizon
B1	530 - 810	Red apedal B horizon
B2	810 - 1200	Red apedal B horizon
C1	1200 - 1580	Unconsolidated material with signs of wetness
C2	1580 - 1750	Saprolite

Plant species composition

Species
Alloteropsis semialata
Andropogon appendiculatus
Digitaria setifolia
Tristachya leucothrix
Themeda triandra
Vernonia natalensis
Zornia capensis
Acalypha caperonoides
Cyanotis speciosa
Ficinia cinnamomea
Gazania krebsiana
Hypoxis argentea
Hypoxis costata
Lotononis foliosa
Gnidia kraussiana
Hypochoeris radicata
Rhyncosia totta

Biomass yield (g m^{-2})

Season	12/1/2002*	6/1/2003*	6/1/2004***
	137	101	363

*Unprepared site ***Unprepared site (disturbed)

Tukulu 1110 (P212), map unit He11, *Pinus patula*

Profile description

Latitude & Longitude: 31° 06' 32.0" / 28° 19' 34.0", **Terrain unit:** Upper midslope, **Slope:** 4 %

Horizon	Depth(mm)	Diagnostic horizons
A	0 - 300	Orthic A horizon
B1	300 - 570	Neocutanic B horizon
B2	570 - 1300	Neocutanic B horizon
C	1300 - 1500	Unspecified material with signs of wetness

Plant species composition

Species
Themeda triandra
Digitaria tricholaenoides
Ficinia cinnamomea
Blepharis integrifolia
Alloteropsis semialata subsp. eckloniana
Bulbostylis schoenoides
Cyperus obtusiflorus var. flavissimus
Gnidia kraussiana
Helichrysum aureonitens
Zornia capensis
Argylobium tuberosum
Digitaria monodactyla

Biomass yield (g m^{-2})

Season	6/1/2004**
	264

**Prepared site

Bloemdal 2100 (P220), map unit Bd2, *Eucalyptus nitens*

Profile description

Latitude & Longitude: 31° 06' 59.9" / 28° 19' 38.9", **Terrain unit:** Upper midslope, **Slope:** 16 %

Horizon	Depth(mm)	Diagnostic horizons
A	0 - 540	Orthic A horizon
B	540 - 880	Red apedal B horizon
C1	880 - 1080	Unspecified material with signs of wetness
C2	1080 - 1500	Unspecified material with signs of wetness

Plant species composition

Species
Themeda triandra
Alloteropsis semialata subsp. eckloniana
Tristachya leucothrix
Blepharis integrifolia
Ficinia cinnamomea
Helichrysum nudifolium
Cyanotis speciosa
Gnidia kraussiana
Zornia capensis

Biomass yield (g m^{-2})

Season	6/1/2004***
	35

***Unprepared site (disturbed)

Hutton 2100 (P221), map unit Af4, *Eucalyptus nitens*

Profile description

Latitude & Longitude: 31° 06' 00.3" / 28° 19' 42.9", **Terrain unit:** Upper footslope, **Slope:** 8 %

Horizon	**Depth(mm)**	**Diagnostic horizons**
A	0 - 250	Orthic A horizon
A/B	250 - 580	Orthic A / red apedal B horizon
B	580 - 1250	Red apedal B horizon
C	1250 - 1800	Unspecified material with signs of wetness

Plant species composition

Species
Digitaria setifolia
Themeda triandra
Tristachya leucothrix
Alloteropsis semialata subsp. eckloniana
Bulbostylis schoenoides
Cyperus obtusiflorus var. flavissimus
Helichrysum aureonitens
Zornia capensis

Biomass yield (g m^{-2})

Season	**6/1/2004*** **
	385

***Unprepared site (disturbed)

Oakleaf 1210 (P222), map unit Bd4, *Eucalyptus nitens*

Profile description

Latitude & Longitude: 31° 05' 59.7" / 28° 19' 49.0", **Terrain unit:** Lower midslope, **Slope:** 7 %

Horizon	Depth(mm)	Diagnostic horizons
A	0 - 420	Orthic A horizon
B1	420 - 690	Neocutanic B horizon
B2	690 - 960	Neocutanic B horizon
C	960 - 1800	Saprolite

Plant species composition

Species
Eragrostis plana
Helictotrichon turgidulum
Blepharis integrifolia
Hypochoeris radicata
Paspalum dilatatum
Themeda triandra
Zornia capensis

Biomass yield (g m^{-2})

Season	6/1/2004***
	290

***Unprepared site (disturbed)

Katspruit 1000 (P232), map unit Ca5, *Pinus elliottii*

Profile description

Latitude & Longitude: 31° 06' 01.6" / 28° 20' 14.8", **Terrain unit:** Crest / Footslope, **Slope:** 2 %

Horizon	Depth (mm)	Diagnostic horizons
A1	0 - 220	Orthic A horizon
A2	220 - 500	Orthic A horizon
G1	500 - 840	G horizon
G2	840 - 1120	G horizon
G3	1120 - 1360	G horizon
G4	1360 - 1500	G horizon

Plant species composition

Species
Digitaria setifolia *Themeda triandra* *Aristida junciformis* *Harpochloa falx* *Cyanotis speciosa* *Eragrostis curvula* *Tristachya leucothrix* *Alloteropsis semialata subsp. Eckloniana*

Biomass yield (g m^{-2})

Season	6/1/2004**
	436

**Prepared site

Pinedene 2100 (P233), map unit He17, *Pinus elliottii*

Profile description

Latitude & Longitude: 31° 06' 02.1" / 28° 20' 16.9", **Terrain unit:** Footslope, **Slope:** 2 %

Horizon	**Depth (mm)**	**Diagnostic horizons**
A	0 - 300	Orthic A horizon
B1	300 - 500	Yellow-brown apedal B horizon
B2	500 - 600	Yellow-brown apedal B horizon
C1	600 - 1040	Unspecified material with signs of wetness
C2	1040 - 1570	Unspecified material with signs of wetness

Plant species composition

Species
Digitaria setifolia
Tristachya leucothrix
Alloteropsis semialata subsp. eckloniana
Themeda triandra
Ficinia cinnamomea
Helichrysum aureonitens
Blepharis integrifolia
Andropogon appendiculatus
Zornia capensis

Biomass yield (g m^{-2})

Season	6/1/2004**
	278

**Prepared site

Katspruit 1000 (P235), map unit Swamp, control 2

Profile description

Latitude & Longitude: 31° 05' 57.8" / 28° 20' 02.4", **Terrain unit:** Lower footslope, **Slope:** 3 %

Horizon	Depth (mm)	Diagnostic horizons
A1	0 - 250	Orthic A horizon
A2	250 - 490	Orthic A horizon
G1	490 - 780	G horizon
G2	780 - 1200	G horizon

Plant species composition

Species
Eragrostis capensis
Themeda triandra
Aristida junciformis
Digitaria setifolia
Elionurus muticus
Helichrysum pilosellum
Alloteropsis semialata subsp. semialata
Pycreus macranthus
Tristachya leucothrix

Biomass yield (g m^{-2})

Season	6/1/2004*
	292

*Unprepared site

Hutton 2100 (P240), map unit Af10, *Pinus patula*

Profile description

Latitude & Longitude: 31° 06' 37.7" / 28° 19' 28.0", **Terrain unit:** Upper foot slope, **Slope:** 10 %

Horizon	**Depth (mm)**	**Diagnostic horizons**
A	0 – 600	Orthic A horizon
B	600 –1200	Red apedal B horizon

Plant species composition

Species
Digitaria setifolia
Themeda triandra
Tristachya leucothrix
Alloteropsis semialata subsp. eckloniana
Bulbostylis schoenoides
Cyperus obtusiflorus var. flavissimus
Helichrysum aureonitens
Zornia capensis

Biomass yield (g m^{-2})

Season	**6/1/2004****
	248

**Prepared site

Longlands 2000 (P241), map unit Cb12b, *Pinus patula*

Profile description

Latitude & Longitude: 31° 06' 51.0" / 28° 19' 543", **Terrain unit:** Upper foot slope, **Slope:** 4 %

Horizon	Depth (mm)	Diagnostic horizons
A	0 - 220	Orthic A horizon
E	220 - 400	E horizon
B	400 - 600	Soft plinthic B horizon
C	600 - 1200	Unspecified material with signs of wetness

Remarks: Fluctuating water table occur.

Plant species composition

Species
Digitaria setifolia
Aristida junciformis
Alloteropsis semialata
Tristachya leucothrix

Biomass yield (g m^{-2})

Season	6/1/2004*
	436

*Unprepared site

Longlands 2000 (P242), map unit Cb12a, *Pinus patula*

Table 15a. Profile description

Latitude & Longitude: 31° 06' 51.6" / 28° 19' 54.9", **Terrain unit:** Upper foot slope, **Slope:** 4 %

Horizon	Depth (mm)	Diagnostic horizons
A	0 - 250	Orthic A horizon
E	250 - 350	E horizon
B	350 - 500	Soft plinthic B horizon
C	500 - 1200	Unspecified material with signs of wetness

Plant species composition

Species
Digitaria setifolia
Aristida junciformis
Alloteropsis semialata
Tristachya leucothrix

Biomass yield (g m^{-3})

Season	6/1/2004**
	399

**Prepared site

Tukulu 2110 (P243), map unit He8, *Pinus patula*

Profile description

Latitude & Longitude: 31° 06' 41.3" / 28° 19' 50.6", **Terrain unit:** Upper midslope, **Slope:** 10 %

Horizon	**Depth (mm)**	**Diagnostic horizons**
A	0 - 400	Orthic A horizon
B	400 –600	Neocutanic B horizon
C	600 -1200	Unspecified material with signs of wetness

Plant species composition

Species
Themeda triandra
Ficinia cinnamomea
Alloteropsis semialata subsp. eckloniana
Bulbostylis schoenoides
Helichrysum aureonitens
Zornia capensis
Tristachya leucothrix
Gazania krebsiana

Biomass yield (g m^{-2})

Season	**6/1/2004****
	395

**Prepared site

Pinedene 1100 (P244), map unit Bd7, *Pinus patula*

Profile description

Latitude & Longitude: 31° 06' 30.6" / 28° 19' 55.4", **Terrain unit:** Upper midslope, **Slope:** 8 **%**

Horizon	**Depth (mm)**	**Diagnostic horizons**
A	0 - 550	Orthic A horizon
B	550 –900	Yellow apedal B horizon
C	900 -1200	Unspecified material with signs of wetness

Plant species composition

Species
Tristachya leucothrix
Themeda triandra
Alloteropsis semialata subsp. eckloniana
Ficinia cinnamomea
Zornia capensis
Helichrysum aureonitens

Biomass yield (g m^{-2})

Season	6/1/2004**
	300

**Prepared site

Pinedene 1100 (P245), map unit Bf6, *Pinus patula*

Profile description

Latitude & Longitude: 31° 06' 28.6" / 28° 19' 56.7", **Terrain unit:** Upper midslope, **Slope:** 8 %

Horizon	Depth (mm)	Diagnostic horizons
A	0 - 550	Orthic A horizon
B	550-900	Yellow apedal B horizon
C	900 -1200	Unspecified material with signs of wetness

Plant species composition

Species
Tristachya leucothrix
Themeda triandra
Alloteropsis semialata subsp. eckloniana
Ficinia cinnamomea
Zornia capensis
Helichrysum aureonitens

Biomass yield (g m^{-2})

Season	6/1/2004**
	302

**Prepared site

Pinedene 1100 (P246), map unit Af9b, *Eucalyptus nitens*

Profile description

Latitude & Longitude: 31° 06' 14.6" / 28° 19' 52.9", **Terrain unit:** Upper middle slope, **Slope:** 5 %

Horizon	**Depth (mm)**	**Diagnostic horizons**
A	0 - 450	Orthic A horizon
B	450 –950	Yellow apedal B horizon
C	950 -1200	Unspecified material with signs of wetness

Plant species composition

Species
Digitaria setifolia *Themeda triandra* *Tristachya leucothrix* *Alloteropsis semialata subsp. eckloniana* *Bulbostylis schoenoides* *Cyperus obtusiflorus var. flavissimus* *Helichrysum aureonitens* *Zornia capensis*

Biomass yield (g m^{-2})

Season	6/1/2004#

#Not determined - ploughed

Pinedene 1100 (P247), map unit Bf3, *Eucalyptus nitens*

Profile description

Latitude & Longitude: 31° 06' 08.3" / 28° 19' 64.4", **Terrain unit:** Upper middle slope, **Slope:** 13 %

Horizon	Depth (mm)	Diagnostic horizons
A	0 - 550	Orthic A horizon
B	550 –750	Yellow apedal B horizon
C	750 -1200	Unspecified material with signs of wetness

Plant species composition

Species
Tristachya leucothrix
Themeda triandra
Alloteropsis semialata subsp. eckloniana
Ficinia cinnamomea
Zornia capensis
Helichrysum aureonitens

Biomass yield(g m^{-2})

Season	6/1/2004#

#Not determined - ploughed

Tukulu 2100 (P248), map unit He1, *Eucalyptus nitens*

Profile description

Latitude & Longitude: 31° 05' 96.2" / 28° 19' 80.3", **Terrain unit:** Upper foot slope, **Slope:** 10 %

Horizon	Depth (mm)	Diagnostic horizons
A	0 - 350	Orthic A horizon
B	350 –750	Neocutanic B horizon
C	750 -1200	Unspecified material with signs of wetness

Plant species composition

Species
Themeda triandra
Ficinia cinnamomea
Alloteropsis semialata subsp. eckloniana
Bulbostylis schoenoides
Helichrysum aureonitens
Zornia capensis
Tristachya leucothrix
Gazania krebsiana

Biomass yield (g m^{-2})

Season	6/1/2004#

#Not determined - ploughed

Kroonstad 2000 (P249), map unit Ca4, *Pinus elliottii*

Profile description

Latitude & Longitude: 31° 06' 02.0" / 28° 20' 21.0", **Terrain unit:** Upper foot slope, **Slope:** 7 %

Horizon	**Depth (mm)**	**Diagnostic horizons**
A	0 - 550	Orthic A horizon
E	550 –850	E horizon
G	850 -1200	G horizon

Plant species composition

Species
Digitaria setifolia
Aristida junciformis
Alloteropsis semialata
Tristachya leucothrix

Biomass yield (g m^{-2})

Season	**6/1/2004****
	587

**Prepared site

Pinedene1100 (P250), map unit Ah4, *Pinus elliottii*

Profile description

Latitude & Longitude: 31° 06' 06.2" / 28° 20' 23.5", **Terrain unit:** Upper foot slope, **Slope:** 10 %

Horizon	**Depth (mm)**	**Diagnostic horizons**
A	0 - 630	Orthic A horizon
B	630 –1100	Yellow brown apedal B horizon
C	1100 -1200	Unspecified material with signs of wetness

Plant species composition

Species
Digitaria setifolia
Themeda triandra
Tristachya leucothrix
Alloteropsis semialata subsp. eckloniana
Bulbostylis schoenoides
Cyperus obtusiflorus var. flavissimus
Helichrysum aureonitens
Zornia capensis

Biomass yield (g m^{-2})

Season	6/1/2004**
	306

**Prepared site

Clovelly 1200 (P251), map unit Af13, *Pinus elliottii*

Profile description

Latitude & Longitude: 31° 06' 19.0" / 28° 19' 99.8", **Terrain unit:** Upper foot slope, **Slope:** 10 %

Horizon	Depth (mm)	Diagnostic horizons
A	0 - 450	Orthic A horizon
B	450 –1200	Yellow brown apedal B horizon

Plant species composition

Species
Digitaria setifolia
Themeda triandra
Tristachya leucothrix
Alloteropsis semialata subsp. eckloniana
Bulbostylis schoenoides
Cyperus obtusiflorus var. flavissimus
Helichrysum aureonitens
Zornia capensis

Biomass yield (g m^{-2})

Season	6/1/2004**
	261

**Prepared site

Kroonstad 2000 (P252), map unit Db3, *Pinus elliottii*

Profile description

Latitude & Longitude: 31° 06' 17.6" / 28° 19' 96.1", **Terrain unit:** Upper foot slope, **Slope:** 7 %

Horizon	Depth (mm)	Diagnostic horizons
A	0 - 250	Orthic A horizon
E	250 –500	E horizon
G	500-1200	G horizon

Plant species composition

Species
Aristida junciformis
Themeda triandra
Digitaria setifolia
Heteropogon contortus
Tristachya leucothrix
Vernonia sp.

Biomass yield (g m^{-2})

Season	6/1/2004**
	372

**Prepared site

Klapmuts 1120 (P253), map unit Db5, *Pinus elliottii*

Profile description

Latitude & Longitude: 31° 06' 39.0" / 28° 19' 89.5", **Terrain unit:** Upper foot slope, **Slope:** 10 %

Horizon	Depth (mm)	Diagnostic horizons
A	0 – 400	Orthic A horizon
E	400 –900	E horizon
B	900-1200	Pedocutanic B horizon

Plant species composition

Species
Aristida junciformis
Themeda triandra
Digitaria setifolia
Heteropogon contortus
Tristachya leucothrix
Vernonia sp.

Biomass yield (g m^{-2})

Season	6/1/2004**
	574

**Prepared site

Hutton 2100 (P254), map unit Af9a, *Pinus patula*

Profile description

Latitude & Longitude: 31° 06' 16.7" / 28° 19' 53.3", **Terrain unit:** Upper mid slope, **Slope:** 8 %

Horizon	**Depth (mm)**	**Diagnostic horizons**
A	0 – 600	Orthic A horizon
B	600 –1200	Red apedal B horizon

Plant species composition

Species
Digitaria setifolia *Themeda triandra* *Tristachya leucothrix* *Alloteropsis semialata subsp. eckloniana* *Bulbostylis schoenoides* *Cyperus obtusiflorus var. flavissimus* *Helichrysum aureonitens* *Zornia capensis*

Biomass yield (g m^{-2})

Season	6/1/2004**
	733

**Prepared site

APPENDIX 2

Results of OC %, TN % and bulk density (Db) determinations of replicated topsoil (0-300 m) samples (4 x for OC and TN and 2 x for Db) for the 27 sample sites in the Weatherley catchment.

Explanatory notes

1. The % OC and % TN values both come from the same sample, and the resultant C:N value recorded in the same line is therefore specific for that sample. The average C:N ratio for a specific depth at a specific sample site is the average % OC ÷ average % TN; it is not the average of the four C:N values. The slight difference between these two possible calculation procedures is due to differences caused by rounding off results. Average values are presented in Appendix 3. The average Db values for each sample depth, presented in Appendix 3, were used to convert % OC and % TN values to amounts of OC and TN in Mg m^{-3} per particular layer.

2. The duplicate bulk density (Db) values were obtained as follows. Because it was hypothesised that Db would be lower below the grass tufts than below the bare areas, these two regions were sampled separately. The first value for each depth represents the sample from under the bare soil and the second one represents the sample taken below the tuft. Statistical analysis showed that there was no significant difference between the two sets of values. The average of the two results was therefore used, and is presented in Appendix 3.

Profile 201

Depth (mm)	Replication	C (%)	N (%)	C:N	Db ($Mg\ m^{-3}$)
0-50	1	1.19	0.064	18.6	1.44
	2	1.22	0.064	19.1	1.00
	3	0.66	0.056	11.8	
	4	1.30	0.063	20.6	
	Mean	1.09	0.062	17.6	1.22
50-100	1	1.13	0.064	17.7	1.44
	2	1.15	0.053	21.7	1.31
	3	0.95	0.057	16.7	
	4	1.15	0.065	17.7	
	Mean	1.10	0.060	18.3	1.38
100-150	1	1.08	0.051	21.2	1.52
	2	0.85	0.056	15.2	1.37
	3	0.80	0.057	14.0	
	4	0.95	0.053	17.9	
	Mean	0.92	0.054	17.0	1.45
150-200	1	0.80	0.044	18.2	1.52
	2	0.79	0.048	16.5	1.53
	3	0.72	0.047	15.3	
	4	0.73	0.047	15.5	
	Mean	0.76	0.047	16.2	1.53
200-300	1	0.74	0.044	16.8	1.50
	2	0.84	0.045	18.7	1.54
	3	0.62	0.043	14.4	
	4	0.66	0.046	14.3	
	Mean	0.72	0.045	16.0	1.52

Profile 202

Depth (mm)	**Replication**	**C (%)**	**N (%)**	**C:N**	**Db (Mg m^{-3})**
0-50	1	0.73	0.046	15.9	1.31
	2	0.77	0.048	16.0	1.41
	3	0.86	0.047	18.3	
	4	0.83	0.043	19.3	
	Mean	0.80	0.046	17.4	1.36
50-100	1	0.70	0.045	15.6	1.48
	2	0.99	0.047	21.1	1.49
	3	0.80	0.046	17.4	
	4	0.96	0.092	10.4	
	Mean	0.86	0.058	14.8	1.49
100-150	1	0.76	0.044	17.3	1.52
	2	0.75	0.045	16.7	1.47
	3	0.83	0.048	17.3	
	4	0.80	0.093	8.6	
	Mean	0.79	0.058	13.6	1.50
150-200	1	0.76	0.040	19.0	1.49
	2	0.80	0.043	18.6	1.53
	3	0.92	0.044	20.9	
	4	0.71	0.043	16.5	
	Mean	0.80	0.043	18.6	1.51
200-300	1	0.69	0.038	18.2	1.53
	2	0.75	0.041	18.3	1.59
	3	0.77	0.041	18.8	
	4	0.67	0.041	16.3	
	Mean	0.72	0.040	18.0	1.56

Profile 203

Depth (mm)	Replication	C (%)	N (%)	C:N	Db (Mg m^{-3})
0-50	1	1.06	0.060	17.7	1.46
	2	0.75	0.070	10.7	1.44
	3	0.83	0.049	16.9	
	4	0.98	0.055	17.8	
	Mean	0.91	0.059	15.4	1.45
50-100	1	1.04	0.066	15.8	1.47
	2	1.00	0.058	17.2	1.48
	3	0.74	0.046	16.1	
	4	0.81	0.053	15.3	
	Mean	0.90	0.056	16.1	1.48
100-150	1	1.03	0.054	19.1	1.62
	2	0.83	0.024	34.6	1.57
	3	0.69	0.042	16.4	
	4	0.85	0.050	17.0	
	Mean	0.85	0.043	19.8	1.60
150-200	1	0.91	0.053	17.2	1.52
	2	0.89	0.041	21.7	1.56
	3	0.79	0.055	14.4	
	4	0.75	0.047	16.0	
	Mean	0.84	0.049	17.1	1.54
200-300	1	0.92	0.051	18.0	1.55
	2	0.67	0.046	14.6	1.61
	3	0.76	0.057	13.3	
	4	0.63	0.044	14.3	
	Mean	0.75	0.050	15.0	1.58

Profile 209

Depth (mm)	**Replication**	**C (%)**	**N (%)**	**C:N**	**Db ($Mg\ m^{-3}$)**
0-50	1	1.39	0.106	13.1	1.23
	2	1.59	0.139	11.4	1.27
	3	1.64	0.120	13.6	
	4	1.66	0.122	13.6	
	Mean	1.57	0.122	12.9	1.25
50-100	1	1.24	0.106	11.7	1.29
	2	1.45	0.128	11.3	1.30
	3	1.32	0.102	12.9	
	4	1.26	0.107	11.8	
	Mean	1.32	0.111	11.9	1.30
100-150	1	1.04	0.095	10.9	1.36
	2	1.25	0.103	12.1	1.36
	3	1.19	0.110	10.8	
	4	1.09	0.086	12.7	
	Mean	1.14	0.099	11.5	1.36
150-200	1	0.89	0.083	10.7	1.42
	2	0.97	0.092	10.5	1.35
	3	1.06	0.082	13.0	
	4	1.04	0.087	11.9	
	Mean	0.99	0.086	11.5	1.39
200-300	1	0.88	0.082	10.7	1.42
	2	0.81	0.070	11.6	1.46
	3	1.10	0.100	11.0	
	4	0.87	0.085	10.2	
	Mean	0.91	0.084	10.8	1.44

Profile 210

Depth (mm)	Replication	C (%)	N (%)	C:N	Db (Mg m^{-3})
0-50	1	1.32	0.087	15.2	1.33
	2	1.59	0.090	17.7	1.27
	3	1.27	0.087	14.6	
	4	1.30	0.090	14.4	
	Mean	1.37	0.089	15.4	1.30
50-100	1	1.38	0.079	17.5	1.48
	2	1.26	0.079	15.9	1.41
	3	1.36	0.070	19.4	
	4	1.26	0.088	14.3	
	Mean	1.32	0.079	16.7	1.45
100-150	1	1.35	0.075	18.0	1.56
	2	1.08	0.069	15.7	1.49
	3	1.30	0.067	19.4	
	4	1.29	0.078	16.5	
	Mean	1.26	0.072	17.5	1.53
150-200	1	1.29	0.066	19.5	1.53
	2	1.05	0.071	14.8	1.51
	3	1.20	0.068	17.6	
	4	1.26	0.075	16.8	
	Mean	1.20	0.070	17.1	1.52
200-300	1	1.25	0.068	18.4	1.57
	2	1.18	0.061	19.3	1.67
	3	1.02	0.066	15.5	
	4	1.11	0.077	14.4	
	Mean	1.14	0.068	16.8	1.62

Profile 212

Depth (mm)	**Replication**	**C (%)**	**N (%)**	**C:N**	**Db (Mg m^{-3})**
0-50	1	0.92	0.054	17.0	1.56
	2	1.07	0.053	20.2	1.37
	3	1.08	0.068	15.9	
	4	0.90	0.057	15.8	
	Mean	0.99	0.058	17.1	1.47
50-100	1	0.85	0.052	16.3	1.64
	2	0.93	0.052	17.9	1.60
	3	0.93	0.054	17.2	
	4	0.88	0.054	16.3	
	Mean	0.90	0.053	17.0	1.62
100-150	1	1.01	0.053	19.1	1.53
	2	0.96	0.050	19.2	1.64
	3	0.70	0.054	13.0	
	4	0.81	0.050	16.2	
	Mean	0.87	0.052	16.7	1.59
150-200	1	0.86	0.048	17.9	1.65
	2	0.78	0.048	16.3	1.57
	3	0.78	0.048	16.3	
	4	0.75	0.042	17.9	
	Mean	0.79	0.047	16.8	1.61
200-300	1	0.83	0.050	16.6	1.64
	2	0.92	0.051	18.0	1.68
	3	0.69	0.044	15.7	
	4	0.69	0.049	14.1	
	Mean	0.78	0.049	15.9	1.66

Profile 220

Depth (mm)	Replication	C (%)	N (%)	C:N	Db (Mg m^{-3})
0-50	1	0.97	0.067	14.5	1.36
	2	0.97	0.066	14.7	1.46
	3	1.18	0.068	17.4	
	4	0.91	0.068	13.4	
	Mean	1.01	0.067	15.1	1.41
50-100	1	1.02	0.065	15.7	1.73
	2	0.85	0.062	13.7	1.62
	3	0.89	0.061	14.6	
	4	0.75	0.050	15.0	
	Mean	0.88	0.060	14.7	1.68
100-150	1	0.83	0.057	14.6	1.65
	2	0.79	0.057	13.9	1.59
	3	0.89	0.054	16.5	
	4	0.90	0.050	18.0	
	Mean	0.85	0.055	15.5	1.62
150-200	1	0.74	0.050	14.8	1.67
	2	0.72	0.057	12.6	1.70
	3	0.90	0.055	16.4	
	4	0.88	0.051	17.3	
	Mean	0.81	0.053	15.3	1.69
200-300	1	0.63	0.053	11.9	1.72
	2	0.72	0.052	13.8	1.69
	3	0.83	0.052	16.0	
	4	0.80	0.054	14.8	
	Mean	0.75	0.053	14.2	1.71

Profile 221

Depth (mm)	Replication	C (%)	N (%)	C:N	Db (Mg m^{-3})
0-50	1	1.42	0.097	14.6	1.27
	2	1.30	0.079	16.5	1.34
	3	1.16	0.060	19.3	
	4	1.02	0.072	14.2	
	Mean	1.23	0.077	16.0	1.31
50-100	1	1.19	0.077	15.5	1.46
	2	1.03	0.072	14.3	1.49
	3	1.09	0.067	16.3	
	4	1.03	0.065	15.8	
	Mean	1.09	0.070	15.6	1.48
100-150	1	1.23	0.078	15.8	1.59
	2	1.00	0.066	15.2	1.60
	3	1.02	0.065	15.7	
	4	1.05	0.059	17.8	
	Mean	1.08	0.067	16.1	1.60
150-200	1	1.07	0.071	15.1	1.64
	2	1.00	0.032	31.3	1.71
	3	0.79	0.055	14.4	
	4	0.89	0.059	15.1	
	Mean	0.94	0.054	17.4	1.68
200-300	1	1.02	0.055	18.5	1.64
	2	0.93	0.051	18.2	1.65
	3	0.83	0.058	14.3	
	4	0.92	0.047	19.6	
	Mean	0.93	0.053	17.5	1.65

Profile 222

Depth (mm)	Replication	C (%)	N (%)	C:N	Db (Mg m^{-3})
0-50	1	1.18	0.075	15.7	1.38
	2	1.30	0.076	17.1	1.32
	3	1.29	0.077	16.8	
	4	1.16	0.081	14.3	
	Mean	1.23	0.077	16.0	1.35
50-100	1	1.04	0.059	17.6	1.41
	2	1.16	0.071	16.3	1.49
	3	1.12	0.072	15.6	
	4	1.09	0.082	13.3	
	Mean	1.10	0.071	15.5	1.45
100-150	1	0.89	0.054	16.5	1.54
	2	1.07	0.067	16.0	1.57
	3	1.14	0.062	18.4	
	4	1.05	0.062	16.9	
	Mean	1.04	0.061	17.0	1.56
150-200	1	0.90	0.049	18.4	1.45
	2	0.92	0.067	13.7	1.55
	3	1.03	0.069	14.9	
	4	0.92	0.057	16.1	
	Mean	0.94	0.061	15.4	1.50
200-300	1	0.86	0.046	18.7	1.52
	2	0.86	0.066	13.0	1.44
	3	1.03	0.060	17.2	
	4	0.99	0.065	15.2	
	Mean	0.94	0.059	15.9	1.48

Profile 232

Depth (mm)	Replication	C (%)	N (%)	C:N	Db (Mg m^{-3})
0-50	1	1.64	0.090	18.2	1.20
	2	1.80	0.095	18.9	1.30
	3	1.83	0.089	20.6	
	4	1.81	0.089	20.3	
	Mean	1.77	0.091	19.5	1.25
50-100	1	1.58	0.086	18.4	1.35
	2	1.59	0.090	17.7	1.37
	3	1.53	0.090	17.0	
	4	1.37	0.080	17.1	
	Mean	1.52	0.087	17.5	1.36
100-150	1	1.41	0.083	17.0	1.51
	2	1.42	0.084	16.9	1.36
	3	1.38	0.072	19.2	
	4	1.30	0.067	19.4	
	Mean	1.38	0.077	17.9	1.44
150-200	1	1.47	0.079	18.6	1.48
	2	1.29	0.080	16.1	1.55
	3	1.30	0.078	16.7	
	4	1.16	0.070	16.6	
	Mean	1.31	0.077	17.0	1.52
200-300	1	1.31	0.097	13.5	1.55
	2	1.17	0.059	19.8	1.56
	3	0.80	0.078	10.3	
	4	1.12	0.060	18.7	
	Mean	1.10	0.074	14.9	1.56

Profile 233

Depth (mm)	**Replication**	**C (%)**	**N (%)**	**C:N**	**Db ($Mg\ m^{-3}$)**
0-50	1	1.12	0.063	17.8	1.28
	2	1.28	0.066	19.4	1.32
	3	1.34	0.103	13.0	
	4	1.25	0.051	24.5	
	Mean	1.25	0.071	17.6	1.30
50-100	1	0.87	0.055	15.8	1.39
	2	1.15	0.077	14.9	1.50
	3	1.09	0.062	17.6	
	4	1.10	0.065	16.9	
	Mean	1.05	0.065	16.2	1.45
100-150	1	0.71	0.062	11.5	1.54
	2	0.99	0.056	17.7	1.43
	3	1.04	0.059	17.6	
	4	1.03	0.062	16.6	
	Mean	0.94	0.060	15.7	1.49
150-200	1	0.91	0.048	19.0	1.47
	2	0.91	0.059	15.4	1.49
	3	1.00	0.053	18.9	
	4	0.88	0.051	17.3	
	Mean	0.93	0.053	17.5	1.48
200-300	1	0.77	0.051	15.1	1.60
	2	0.93	0.051	18.2	1.58
	3	0.93	0.057	16.3	
	4	0.89	0.051	17.5	
	Mean	0.88	0.053	16.6	1.59

Profile 235

Depth (mm)	**Replication**	**C (%)**	**N (%)**	**C:N**	**Db ($Mg\ m^{-3}$)**
0-50	1	1.26	0.037	34.1	1.48
	2	1.21	0.074	16.4	1.29
	3	1.19	0.066	18.0	
	4	1.07	0.067	16.0	
	Mean	1.18	0.061	19.3	1.39
50-100	1	0.98	0.057	17.2	1.48
	2	0.91	0.060	15.2	1.56
	3	1.09	0.062	17.6	
	4	0.87	0.058	15.0	
	Mean	0.96	0.059	16.3	1.52
100-150	1	0.76	0.054	14.1	1.48
	2	0.78	0.056	13.9	1.62
	3	0.94	0.047	20.0	
	4	0.73	0.047	15.5	
	Mean	0.80	0.051	15.7	1.55
150-200	1	0.68	0.054	12.6	1.52
	2	0.65	0.053	12.3	1.60
	3	0.63	0.043	14.7	
	4	0.68	0.045	15.1	
	Mean	0.66	0.049	13.5	1.56
200-300	1	0.63	0.041	15.4	1.63
	2	0.89	0.046	19.3	1.68
	3	0.47	0.045	10.4	
	4	0.65	0.041	15.9	
	Mean	0.66	0.043	15.3	1.66

Profile 240

Depth (mm)	Replication	C (%)	N (%)	C:N	Db (Mg m^{-3})
0-50	1	1.79	0.131	13.7	1.45
	2	1.63	0.100	16.3	1.45
	3	1.61	0.112	14.4	
	4	1.56	0.110	14.2	
	Mean	1.65	0.113	14.6	1.45
50-100	1	1.51	0.099	15.3	1.43
	2	1.50	0.102	14.7	1.39
	3	1.48	0.093	15.9	
	4	1.49	0.101	14.8	
	Mean	1.50	0.099	15.2	1.41
100-150	1	1.41	0.096	14.7	1.45
	2	1.45	0.092	15.8	1.49
	3	1.28	0.100	12.8	
	4	1.44	0.090	16.0	
	Mean	1.40	0.095	14.7	1.47
150-200	1	1.41	0.090	15.7	1.48
	2	1.33	0.091	14.6	1.47
	3	1.32	0.079	16.7	
	4	1.29	0.088	14.7	
	Mean	1.34	0.087	15.4	1.48
200-300	1	1.22	0.083	14.7	1.50
	2	1.34	0.091	14.7	1.31
	3	1.17	0.079	14.8	
	4	1.25	0.081	15.4	
	Mean	1.25	0.084	14.9	1.41

Profile 241

Depth (mm)	Replication	C (%)	N (%)	C:N	Db (Mg m^{-3})
0-50	1	1.09	0.068	16.0	1.50
	2	1.51	0.082	18.4	1.41
	3	1.06	0.065	16.3	
	4	1.29	0.085	15.2	
	Mean	1.24	0.075	16.5	1.46
50-100	1	0.97	0.059	16.4	1.55
	2	1.06	0.066	16.1	1.50
	3	0.91	0.066	13.8	
	4	1.06	0.089	11.9	
	Mean	1.00	0.070	14.3	1.53
100-150	1	0.81	0.053	15.3	1.64
	2	1.03	0.057	18.1	1.59
	3	0.92	0.050	18.4	
	4	0.94	0.069	13.6	
	Mean	0.93	0.057	16.3	1.62
150-200	1	0.82	0.048	17.1	1.64
	2	0.80	0.059	13.6	1.61
	3	0.97	0.045	21.6	
	4	0.86	0.065	13.2	
	Mean	0.86	0.054	15.9	1.63
200-300	1	0.76	0.045	16.9	1.68
	2	0.76	0.056	13.6	1.55
	3	0.58	0.043	13.5	
	4	0.86	0.063	13.7	
	Mean	0.74	0.052	14.2	1.62

Profile 242

Depth (mm)	Replication	C (%)	N (%)	C:N	Db (Mg m^{-3})
0-50	1	1.12	0.081	13.8	1.33
	2	1.02	0.078	13.1	1.34
	3	1.29	0.084	15.4	
	4	1.19	0.064	18.6	
	Mean	1.16	0.077	15.1	1.34
50-100	1	0.66	0.033	20.0	1.56
	2	0.78	0.032	24.4	1.54
	3	0.95	0.072	13.2	
	4	0.77	0.060	12.8	
	Mean	0.79	0.049	16.1	1.55
100-150	1	0.50	0.024	20.8	1.60
	2	0.78	0.056	13.9	1.63
	3	0.70	0.057	12.3	
	4	0.52	0.057	9.1	
	Mean	0.63	0.049	12.9	1.62
150-200	1	0.41	0.024	17.1	1.64
	2	0.48	0.049	9.8	1.66
	3	0.63	0.058	10.9	
	4	0.49	0.044	11.1	
	Mean	0.50	0.044	11.4	1.65
200-300	1	0.49	0.038	12.9	1.71
	2	0.54	0.043	12.6	1.69
	3	0.49	0.047	10.4	
	4	0.41	0.041	10.0	
	Mean	0.48	0.042	11.4	1.70

Profile 243

Depth (mm)	Replication	C (%)	N (%)	C:N	Db (Mg m^{-3})
0-50	1	1.29	0.080	16.1	1.50
	2	1.26	0.085	14.8	1.51
	3	1.20	0.082	14.6	
	4	1.00	0.079	12.7	
	Mean	1.19	0.082	14.5	1.51
50-100	1	1.12	0.074	15.1	1.59
	2	1.15	0.070	16.4	1.60
	3	1.07	0.069	15.5	
	4	1.31	0.070	18.7	
	Mean	1.16	0.071	16.3	1.60
100-150	1	0.97	0.065	14.9	1.59
	2	0.91	0.063	14.4	1.58
	3	1.01	0.060	16.8	
	4	0.76	0.055	13.8	
	Mean	0.91	0.061	14.9	1.59
150-200	1	0.87	0.062	14.0	1.63
	2	0.86	0.059	14.6	1.65
	3	0.73	0.054	13.5	
	4	0.68	0.050	13.6	
	Mean	0.79	0.056	14.1	1.64
200-300	1	0.98	0.054	18.1	1.64
	2	0.81	0.049	16.5	1.65
	3	0.71	0.052	13.7	
	4	0.84	0.049	17.1	
	Mean	0.84	0.051	16.5	1.65

Profile 244

Depth (mm)	**Replication**	**C (%)**	**N (%)**	**C:N**	**Db ($Mg\ m^{-3}$)**
0-50	1	1.26	0.060	21.0	1.52
	2	1.28	0.073	17.5	1.37
	3	1.14	0.065	17.5	
	4	0.87	0.057	15.3	
	Mean	1.14	0.064	17.8	1.45
50-100	1	0.99	0.051	19.4	1.61
	2	1.04	0.057	18.2	1.51
	3	1.03	0.055	18.7	
	4	0.87	0.050	17.4	
	Mean	0.98	0.053	18.5	1.56
100-150	1	0.84	0.044	19.1	1.61
	2	0.82	0.055	14.9	1.61
	3	0.79	0.046	17.2	
	4	0.51	0.043	11.9	
	Mean	0.74	0.047	15.7	1.61
150-200	1	0.85	0.041	20.7	1.65
	2	0.81	0.032	25.3	1.62
	3	0.70	0.024	29.2	
	4	0.53	0.040	13.3	
	Mean	0.72	0.034	21.2	1.64
200-300	1	0.95	0.044	21.6	1.64
	2	0.79	0.044	18.0	1.61
	3	0.53	0.041	12.9	
	4	0.37	0.041	9.0	
	Mean	0.66	0.043	15.3	1.63

Profile 245

Depth (mm)	Replication	C (%)	N (%)	C:N	Db (Mg m^{-3})
0-50	1	1.09	0.069	15.8	1.54
	2	1.02	0.058	17.6	1.45
	3	1.12	0.058	19.3	
	4	1.04	0.056	18.6	
	Mean	1.07	0.060	17.8	1.50
50-100	1	0.78	0.057	13.7	1.54
	2	0.93	0.051	18.2	1.49
	3	0.90	0.057	15.8	
	4	0.83	0.046	18.0	
	Mean	0.86	0.053	16.2	1.52
100-150	1	0.67	0.043	15.6	1.61
	2	0.80	0.052	15.4	1.56
	3	0.83	0.042	19.8	
	4	0.72	0.042	17.1	
	Mean	0.76	0.045	16.9	1.59
150-200	1	0.62	0.049	12.7	1.62
	2	0.73	0.041	17.8	1.61
	3	0.69	0.039	17.7	
	4	0.71	0.040	17.8	
	Mean	0.69	0.042	16.4	1.62
200-300	1	0.60	0.041	14.6	1.67
	2	0.64	0.041	15.6	1.64
	3	0.71	0.041	17.3	
	4	0.55	0.035	15.7	
	Mean	0.63	0.040	15.8	1.66

Profile 246

Depth (mm)	Replication	C (%)	N (%)	C:N	Db (Mg m^{-3})
0-50	1	1.23	0.090	13.7	1.50
	2	1.26	0.090	14.0	1.22
	3	1.38	0.096	14.4	
	4	1.19	0.079	15.1	
	Mean	1.27	0.089	14.3	1.36
50-100	1	1.05	0.083	12.7	1.55
	2	1.12	0.079	14.2	1.53
	3	1.15	0.083	13.9	
	4	1.10	0.074	14.9	
	Mean	1.11	0.080	13.9	1.54
100-150	1	0.97	0.075	12.9	1.46
	2	1.13	0.073	15.5	1.58
	3	1.06	0.077	13.8	
	4	0.97	0.073	13.3	
	Mean	1.03	0.075	13.7	1.52
150-200	1	1.03	0.063	16.3	1.57
	2	0.97	0.067	14.5	1.61
	3	0.98	0.066	14.8	
	4	0.96	0.065	14.8	
	Mean	0.99	0.065	15.2	1.59
200-300	1	0.86	0.060	14.3	1.58
	2	0.94	0.070	13.4	1.58
	3	0.95	0.066	14.4	
	4	0.81	0.062	13.1	
	Mean	0.89	0.065	13.7	1.58

Profile 247

Depth (mm)	**Replication**	**C (%)**	**N (%)**	**C:N**	**Db (Mg m^{-3})**
0-50	1	0.88	0.071	12.4	1.45
	2	0.96	0.070	13.7	1.46
	3	0.84	0.070	12.0	
	4	0.85	0.066	12.9	
	Mean	0.88	0.069	12.8	1.46
50-100	1	1.01	0.065	15.5	1.60
	2	0.97	0.069	14.1	1.63
	3	1.00	0.058	17.2	
	4	1.00	0.064	15.6	
	Mean	1.00	0.064	15.6	1.62
100-150	1	0.78	0.060	13.0	1.65
	2	0.85	0.029	29.3	1.59
	3	0.70	0.056	12.5	
	4	0.57	0.056	10.2	
	Mean	0.73	0.050	14.6	1.62
150-200	1	0.83	0.057	14.6	1.63
	2	0.70	0.052	13.5	1.65
	3	0.72	0.054	13.3	
	4	0.79	0.059	13.4	
	Mean	0.76	0.056	13.6	1.64
200-300	1	0.81	0.055	14.7	1.67
	2	0.68	0.050	13.6	1.67
	3	0.82	0.054	15.2	
	4	0.62	0.055	11.3	
	Mean	0.73	0.054	13.5	1.67

Profile 248

Depth (mm)	Replication	C (%)	N (%)	C:N	Db (Mg m^{-3})
0-50	1	1.59	0.117	13.6	1.28
	2	1.62	0.118	13.7	1.09
	3	1.60	0.116	13.8	
	4	1.53	0.107	14.3	
	Mean	1.59	0.115	13.8	1.19
50-100	1	1.44	0.110	13.1	1.27
	2	1.58	0.103	15.3	1.36
	3	1.30	0.108	12.0	
	4	1.52	0.108	14.1	
	Mean	1.46	0.107	13.6	1.32
100-150	1	1.19	0.091	13.1	1.54
	2	1.23	0.092	13.4	1.54
	3	1.10	0.088	12.5	
	4	1.08	0.089	12.1	
	Mean	1.15	0.090	12.8	1.54
150-200	1	1.06	0.083	12.8	1.60
	2	1.12	0.083	13.5	1.44
	3	1.01	0.086	11.7	
	4	1.03	0.079	13.0	
	Mean	1.06	0.083	12.8	1.52
200-300	1	1.09	0.087	12.5	1.65
	2	1.01	0.081	12.5	1.55
	3	1.08	0.082	13.2	
	4	0.99	0.075	13.2	
	Mean	1.04	0.081	12.8	1.60

Profile 249

Depth (mm)	**Replication**	**C (%)**	**N (%)**	**C:N**	**Db ($Mg\ m^{-3}$)**
0-50	1	1.61	0.107	15.0	1.16
	2	1.63	0.108	15.1	1.07
	3	1.55	0.088	17.6	
	4	1.56	0.103	15.1	
	Mean	1.59	0.102	15.6	1.12
50-100	1	1.59	0.100	15.9	1.30
	2	1.68	0.102	16.5	1.34
	3	1.50	0.097	15.5	
	4	1.60	0.102	15.7	
	Mean	1.59	0.100	15.9	1.32
100-150	1	1.58	0.099	16.0	1.46
	2	1.24	0.097	12.8	1.21
	3	1.24	0.091	13.6	
	4	1.27	0.102	12.5	
	Mean	1.33	0.097	13.7	1.34
150-200	1	1.27	0.098	13.0	1.40
	2	1.27	0.094	13.5	1.52
	3	1.20	0.087	13.8	
	4	1.24	0.103	12.0	
	Mean	1.25	0.096	13.0	1.46
200-300	1	1.27	0.097	13.1	1.55
	2	1.24	0.096	12.9	1.47
	3	1.03	0.083	12.4	
	4	1.13	0.093	12.2	
	Mean	1.17	0.092	12.7	1.51

Profile 250

Depth (mm)	Replication	C (%)	N (%)	C:N	Db (Mg m^{-3})
0-50	1	0.99	0.067	14.8	1.34
	2	1.19	0.080	14.9	1.42
	3	1.11	0.078	14.2	
	4	1.28	0.071	18.0	
	Mean	1.14	0.074	15.4	1.38
50-100	1	1.13	0.075	15.1	1.46
	2	1.11	0.070	15.9	1.50
	3	1.14	0.065	17.5	
	4	1.13	0.070	16.1	
	Mean	1.13	0.070	16.1	1.48
100-150	1	1.18	0.078	15.1	1.53
	2	0.96	0.067	14.3	1.54
	3	1.17	0.075	15.6	
	4	0.98	0.063	15.6	
	Mean	1.07	0.071	15.1	1.54
150-200	1	0.90	0.059	15.3	1.57
	2	0.96	0.062	15.5	1.64
	3	0.98	0.061	16.1	
	4	0.99	0.065	15.2	
	Mean	0.96	0.062	15.5	1.61
200-300	1	0.91	0.064	14.2	1.56
	2	0.77	0.063	12.2	1.62
	3	0.96	0.057	16.8	
	4	0.93	0.067	13.9	
	Mean	0.89	0.063	14.1	1.59

Profile 251

Depth (mm)	**Replication**	**C (%)**	**N (%)**	**C:N**	**Db (Mg m^{-3})**
0-50	1	1.60	0.094	17.0	1.50
	2	0.68	0.094	7.2	1.41
	3	1.67	0.096	17.4	
	4	1.54	0.090	17.1	
	Mean	1.37	0.094	14.6	1.46
50-100	1	1.15	0.082	14.0	1.61
	2	1.29	0.090	14.3	1.57
	3	1.26	0.083	15.2	
	4	1.09	0.091	12.0	
	Mean	1.20	0.087	13.8	1.59
100-150	1	1.14	0.085	13.4	1.64
	2	1.20	0.087	13.8	1.62
	3	1.18	0.084	14.0	
	4	1.01	0.065	15.5	
	Mean	1.13	0.080	14.1	1.63
150-200	1	1.05	0.073	14.4	1.66
	2	1.05	0.072	14.6	1.66
	3	1.06	0.067	15.8	
	4	0.95	0.068	14.0	
	Mean	1.03	0.070	14.7	1.66
200-300	1	0.96	0.071	13.5	1.69
	2	0.97	0.076	12.8	1.67
	3	0.93	0.066	14.1	
	4	0.85	0.065	13.1	
	Mean	0.93	0.070	13.3	1.68

Profile 252

Depth (mm)	Replication	C (%)	N (%)	C:N	Db (Mg m^{-3})
0-50	1	1.63	0.101	16.1	1.28
	2	1.53	0.094	16.3	1.06
	3	1.38	0.105	13.1	
	4	0.88	0.085	10.4	
	Mean	1.36	0.096	14.2	1.17
50-100	1	1.29	0.100	12.9	1.39
	2	1.60	0.099	16.2	1.36
	3	1.88	0.094	20.0	
	4	1.20	0.085	14.1	
	Mean	1.49	0.095	15.7	1.38
100-150	1	1.47	0.101	14.6	1.30
	2	1.26	0.096	13.1	1.42
	3	1.24	0.092	13.5	
	4	1.03	0.087	11.8	
	Mean	1.25	0.094	13.3	1.36
150-200	1	1.15	0.088	13.1	1.59
	2	1.14	0.091	12.5	1.42
	3	0.98	0.084	11.7	
	4	0.92	0.079	11.6	
	Mean	1.05	0.086	12.2	1.51
200-300	1	0.95	0.086	11.0	1.57
	2	1.01	0.085	11.9	1.51
	3	0.90	0.084	10.7	
	4	0.83	0.080	10.4	
	Mean	0.92	0.084	11.0	1.54

Profile 253

Depth (mm)	Replication	C (%)	N (%)	C:N	Db (Mg m^{-3})
0-50	1	1.61	0.126	12.8	1.34
	2	1.52	0.134	11.3	1.36
	3	1.26	0.103	12.2	
	4	0.77	0.091	8.5	
	Mean	1.29	0.114	11.3	1.35
50-100	1	1.40	0.106	13.2	1.47
	2	1.46	0.110	13.3	1.45
	3	1.15	0.081	14.2	
	4	1.19	0.094	12.7	
	Mean	1.30	0.098	13.3	1.46
100-150	1	1.17	0.106	11.0	1.51
	2	1.30	0.105	12.4	1.48
	3	1.15	0.088	13.1	
	4	1.03	0.083	12.4	
	Mean	1.16	0.096	12.1	1.50
150-200	1	1.26	0.101	12.5	1.55
	2	1.17	0.102	11.5	1.49
	3	0.97	0.084	11.5	
	4	1.03	0.083	12.4	
	Mean	1.11	0.093	11.9	1.52
200-300	1	1.16	0.094	12.3	1.58
	2	1.11	0.094	11.8	1.57
	3	0.90	0.081	11.1	
	4	0.89	0.076	11.7	
	Mean	1.02	0.086	11.9	1.58

Profile 254

Depth (mm)	**Replication**	**C (%)**	**N (%)**	**C:N**	**Db ($Mg\ m^{-3}$)**
0-50	1	1.50	0.105	14.3	1.33
	2	1.39	0.093	14.9	1.25
	3	1.51	0.098	15.4	
	4	1.49	0.101	14.8	
	Mean	1.47	0.099	14.8	1.29
50-100	1	1.29	0.101	12.8	1.17
	2	1.13	0.080	14.1	1.45
	3	1.28	0.099	12.9	
	4	1.20	0.079	15.2	
	Mean	1.23	0.090	13.7	1.31
100-150	1	1.12	0.089	12.6	1.46
	2	1.18	0.077	15.3	1.47
	3	1.17	0.075	15.6	
	4	1.24	0.072	17.2	
	Mean	1.18	0.078	15.1	1.47
150-200	1	1.23	0.083	14.8	1.51
	2	1.09	0.063	17.3	1.55
	3	1.18	0.065	18.2	
	4	1.11	0.069	16.1	
	Mean	1.15	0.070	16.4	1.53
200-300	1	0.88	0.079	11.1	1.55
	2	1.03	0.063	16.3	1.57
	3	0.99	0.058	17.1	
	4	0.95	0.067	14.2	
	Mean	0.96	0.067	14.3	1.56

APPENDIX 3

Data for each of the 27 test sites: mean values of OC (%), OC (Mg m^{-3}), TN (%), TN (Mg m^{-3}), C:N ratios, and Db (Mg m^{-3}) for each of the 5 surface layers up to a depth of 300 mm, and single values for the remaining nine 100 mm layers to a depth of 1200 mm

Organic C (%)

Depth	Profile number																										
(mm)	201	202	203	209	210	212	220	221	222	232	233	235	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254
0-50	1.09	0.79	0.91	1.57	1.37	0.99	1.01	1.23	1.23	1.77	1.25	1.18	1.65	1.24	1.15	1.19	1.14	1.07	1.27	0.88	1.59	1.59	1.14	1.37	1.35	1.29	1.47
50-100	1.10	0.86	0.90	1.32	1.32	0.90	0.88	1.08	1.10	1.52	1.05	0.97	1.49	1.00	0.79	1.17	0.98	0.86	1.10	0.99	1.46	1.59	1.13	1.20	1.49	1.30	1.22
100-150	0.92	0.79	0.85	1.14	1.26	0.87	0.85	1.08	1.04	1.38	0.94	0.80	1.39	0.93	0.62	0.91	0.74	0.75	1.03	0.73	1.15	1.33	1.07	1.13	1.25	1.16	1.18
150-200	0.76	0.80	0.83	0.99	1.20	0.79	0.81	0.93	0.94	1.30	0.92	0.66	1.33	0.86	0.50	0.78	0.72	0.69	0.99	0.76	1.05	1.25	0.96	1.03	1.05	1.11	1.15
200-300	0.72	0.72	0.75	0.91	1.14	0.78	0.74	0.92	0.93	1.10	0.88	0.66	1.24	0.74	0.48	0.84	0.66	0.62	0.89	0.73	1.04	1.17	0.89	0.93	0.92	1.02	0.96
300-400	0.43	0.42	0.25	0.57	0.33	0.38	0.47	0.98	1.31	1.03	0.44	0.61	1.02	0.47	0.56	0.68	0.73	0.67	0.89	0.65	0.66	0.88	0.79	0.57	0.89	0.95	0.90
400-500	0.68	0.13	0.19	0.37	0.33	0.37	0.41	0.52	0.74	0.76	0.31	0.45	0.79	0.37	0.65	0.59	0.53	0.52	0.69	0.50	0.49	0.78	0.68	0.66	0.75	0.68	0.75
500-600	0.29	0.21	0.27	0.35	0.39	0.25	0.58	0.55	0.61	0.75	0.15	0.26	0.76	0.37	0.49	0.47	0.47	0.35	0.61	0.52	0.28	0.51	0.46	0.45	0.59	0.65	0.37
600-700	0.21	0.10	0.27	0.26	0.14	0.15	0.33	0.42	0.51	0.49	0.29	0.12	0.46	0.26	0.42	0.19	0.25	0.23	0.32	0.35	0.13	0.39	0.26	0.35	0.44	0.60	0.27
700-800	0.14	0.16	0.27	0.26	0.23	0.18	0.17	0.26	0.31	0.29	0.25	0.12	0.28	0.23	0.27	0.21	0.20	0.22	0.25	0.23	0.14	0.28	0.31	0.64	0.37	0.45	0.55
800-900	0.33	0.15	0.27	0.16	0.31	0.15	0.13	0.20	0.24	0.17	0.38	0.06	0.20	0.17	0.22	0.15	0.20	0.18	0.27	0.18	0.33	0.16	0.24	0.28	0.28	0.43	0.19
900-1000	0.11	0.14	0.08	0.08	0.17	0.27	0.09	0.19	0.24	0.25	0.17	0.06	0.24	0.18	0.11	0.13	0.20	0.12	0.16	0.11	0.19	0.15	0.24	0.27	0.24	0.36	0.14
1000-1100		0.13	0.08	0.08	0.10	0.11	0.09	0.18	0.15	0.18	0.17	0.06	0.13	0.11	0.17	0.12	0.08	0.16	0.31	0.05	0.22	0.07	0.11	0.20	0.33	0.35	0.15
1100-1200		0.11	0.08		0.12	0.11	0.09	0.11	0.14	0.18	0.15	0.05	0.13	0.09	0.10	0.14	0.10	0.14	0.13	0.12	0.22	0.15	0.18	0.28	0.17	0.26	0.18

Organic C (Mg m^{-3} x 10^{-2})

Depth	Profile number																									
(mm)	201	202	203	209	210	212	220	221	222	232	233	235	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254
0-50	1.33	1.07	1.32	1.96	1.78	1.46	1.42	1.61	1.66	2.21	1.63	1.64	2.39	1.81	1.54	1.80	1.65	1.61	1.73	1.28	1.89	1.78	1.57	2.00	1.58	1.74	1.90
50-100	1.52	1.28	1.33	1.72	1.91	1.46	1.48	1.60	1.60	2.07	1.52	1.47	2.18	1.53	1.22	1.87	1.53	1.31	1.69	1.60	1.93	2.10	1.67	1.91	2.06	1.90	1.60
100-150	1.33	1.19	1.36	1.55	1.93	1.38	1.38	1.73	1.62	1.99	1.40	1.24	2.04	1.51	1.00	1.45	1.19	1.19	1.57	1.18	1.77	1.78	1.65	1.84	1.70	1.74	1.73
150-200	1.16	1.21	1.28	1.38	1.82	1.27	1.37	1.56	1.41	1.98	1.36	1.03	1.97	1.40	0.83	1.28	1.18	1.12	1.57	1.25	1.60	1.83	1.55	1.71	1.59	1.69	1.76
200-300	1.09	1.12	1.19	1.31	1.85	1.29	1.27	1.52	1.38	1.72	1.40	1.10	1.75	1.20	0.82	1.39	1.08	1.03	1.41	1.22	1.66	1.77	1.42	1.56	1.42	1.61	1.50
300-400	0.68	0.68	0.44	0.94	0.53	0.62	0.79	1.48	2.04	1.66	0.71	1.04	1.60	0.78	0.96	1.07	1.20	1.11	1.41	1.09	1.08	1.33	1.26	0.89	1.47	1.49	1.41
400-500	1.07	0.21	0.33	0.61	0.53	0.61	0.69	0.79	1.23	1.22	0.50	0.77	1.24	0.63	1.11	0.97	0.87	0.86	1.12	0.84	0.81	1.18	1.08	1.06	1.24	1.07	1.18
500-600	0.46	0.34	0.47	0.58	0.63	0.41	0.97	0.83	1.01	1.25	0.24	0.44	1.19	0.63	0.84	0.78	0.78	0.58	1.01	0.86	0.46	0.81	0.73	0.74	1.01	1.02	0.58
600-700	0.35	0.17	0.44	0.43	0.24	0.25	0.54	0.68	0.85	0.82	0.47	0.21	0.76	0.44	0.72	0.32	0.41	0.38	0.53	0.58	0.21	0.64	0.43	0.58	0.75	0.99	0.45
700-800	0.23	0.28	0.44	0.43	0.40	0.30	0.28	0.42	0.50	0.48	0.40	0.21	0.46	0.39	0.46	0.36	0.33	0.36	0.41	0.39	0.24	0.46	0.51	1.06	0.63	0.74	0.91
800-900	0.54	0.26	0.44	0.26	0.53	0.25	0.21	0.33	0.38	0.28	0.61	0.10	0.33	0.29	0.38	0.26	0.33	0.30	0.45	0.31	0.56	0.27	0.40	0.46	0.48	0.71	0.31
900-1000	0.20	0.24	0.14	0.14	0.29	0.43	0.15	0.31	0.38	0.42	0.28	0.10	0.40	0.31	0.19	0.22	0.34	0.21	0.27	0.19	0.32	0.26	0.40	0.45	0.41	0.59	0.23
1000-1100		0.22	0.14	0.14	0.17	0.18	0.15	0.29	0.24	0.30	0.28	0.10	0.21	0.19	0.29	0.21	0.14	0.27	0.53	0.09	0.38	0.12	0.18	0.33	0.56	0.58	0.25
1100-1200		0.19	0.14		0.20	0.18	0.15	0.18	0.22	0.30	0.25	0.09	0.21	0.15	0.17	0.24	0.17	0.24	0.22	0.21	0.38	0.26	0.31	0.46	0.29	0.43	0.30

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Total N (%)

Depth	Profile number																										
(mm)	201	202	203	209	210	212	220	221	222	232	233	235	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254
0-50	0.06	0.05	0.06	0.12	0.09	0.06	0.07	0.08	0.08	0.09	0.07	0.06	0.11	0.08	0.08	0.08	0.06	0.06	0.09	0.07	0.12	0.10	0.07	0.09	0.10	0.11	0.10
50-100	0.06	0.06	0.06	0.11	0.08	0.05	0.06	0.07	0.07	0.09	0.07	0.06	0.10	0.07	0.05	0.07	0.05	0.05	0.08	0.06	0.11	0.10	0.07	0.09	0.10	0.10	0.09
100-150	0.05	0.06	0.04	0.10	0.07	0.05	0.05	0.07	0.06	0.08	0.06	0.05	0.10	0.06	0.05	0.06	0.05	0.05	0.08	0.05	0.09	0.10	0.07	0.08	0.09	0.10	0.08
150-200	0.05	0.04	0.05	0.09	0.07	0.05	0.05	0.05	0.06	0.08	0.05	0.05	0.09	0.05	0.04	0.06	0.04	0.04	0.07	0.06	0.08	0.10	0.06	0.07	0.09	0.09	0.07
200-300	0.05	0.04	0.05	0.08	0.07	0.05	0.05	0.05	0.06	0.07	0.05	0.04	0.08	0.05	0.04	0.05	0.04	0.04	0.06	0.05	0.08	0.09	0.06	0.07	0.08	0.09	0.07
300-400	0.04	0.03	0.02	0.05	0.04	0.04	0.04	0.04	0.07	0.06	0.03	0.04	0.07	0.03	0.05	0.04	0.04	0.04	0.06	0.05	0.05	0.08	0.06	0.04	0.09	0.09	0.06
400-500	0.04	0.02	0.02	0.05	0.04	0.03	0.03	0.03	0.07	0.07	0.02	0.04	0.07	0.04	0.05	0.04	0.04	0.03	0.05	0.04	0.05	0.06	0.05	0.04	0.08	0.08	0.06
500-600	0.03	0.02	0.02	0.04	0.03	0.02	0.03	0.04	0.06	0.06	0.02	0.04	0.06	0.03	0.06	0.03	0.03	0.03	0.04	0.04	0.04	0.06	0.04	0.04	0.07	0.07	0.04
600-700	0.02	0.02	0.01	0.04	0.03	0.02	0.02	0.02	0.06	0.04	0.04	0.02	0.02	0.03	0.05	0.03	0.02	0.02	0.03	0.03	0.03	0.04	0.03	0.04	0.06	0.06	0.03
700-800	0.02	0.02	0.01	0.04	0.03	0.02	0.01	0.02	0.04	0.04	0.04	0.02	0.02	0.02	0.04	0.02	0.02	0.02	0.03	0.02	0.03	0.04	0.03	0.04	0.05	0.06	0.05
800-900	0.02	0.02	0.01	0.04	0.03	0.02	0.01	0.03	0.04	0.03	0.04	0.02	0.01	0.02	0.04	0.02	0.02	0.02	0.02	0.02	0.04	0.02	0.02	0.04	0.05	0.05	0.03
900-1000	0.01	0.02	0.01	0.04	0.02	0.02	0.01	0.03	0.04	0.02	0.03	0.02	0.03	0.02	0.03	0.01	0.02	0.01	0.02	0.02	0.04	0.03	0.03	0.04	0.05	0.05	0.03
1000-1100		0.03	0.01	0.04	0.02	0.02	0.01	0.02	0.03	0.03	0.02	0.02	0.03	0.03	0.02	0.01	0.01	0.01	0.02	0.01	0.04	0.02	0.02	0.03	0.04	0.04	0.03
1100-1200		0.03	0.01		0.02	0.02	0.01	0.02	0.02	0.03	0.03	0.02	0.03	0.03	0.03	0.01	0.01	0.01	0.02	0.02	0.04	0.03	0.02	0.03	0.04	0.04	0.03

Total N (Mg m^{-3} x 10^{-2})

Depth	Profile number																										
(mm)	201	202	203	209	210	212	220	221	222	232	233	235	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254
0-50	0.08	0.06	0.08	0.15	0.11	0.09	0.09	0.10	0.10	0.11	0.09	0.08	0.16	0.11	0.10	0.12	0.09	0.09	0.12	0.10	0.14	0.11	0.10	0.14	0.11	0.15	0.13
50-100	0.08	0.08	0.08	0.14	0.11	0.09	0.10	0.10	0.10	0.12	0.09	0.09	0.14	0.11	0.08	0.11	0.08	0.08	0.12	0.10	0.14	0.13	0.10	0.14	0.13	0.14	0.12
100-150	0.08	0.09	0.07	0.13	0.11	0.08	0.09	0.11	0.10	0.11	0.09	0.08	0.14	0.09	0.08	0.10	0.08	0.07	0.11	0.08	0.14	0.13	0.11	0.13	0.13	0.14	0.11
150-200	0.07	0.06	0.08	0.12	0.11	0.07	0.09	0.09	0.09	0.12	0.08	0.08	0.13	0.09	0.07	0.09	0.06	0.07	0.10	0.09	0.13	0.14	0.10	0.12	0.13	0.14	0.11
200-300	0.07	0.06	0.08	0.12	0.11	0.08	0.09	0.09	0.09	0.11	0.08	0.07	0.12	0.08	0.07	0.08	0.07	0.07	0.10	0.09	0.13	0.14	0.10	0.12	0.13	0.14	0.10
300-400	0.07	0.04	0.03	0.09	0.06	0.06	0.06	0.06	0.11	0.10	0.05	0.07	0.11	0.06	0.08	0.06	0.07	0.06	0.09	0.08	0.08	0.12	0.09	0.07	0.14	0.14	0.09
400-500	0.06	0.04	0.04	0.07	0.06	0.04	0.05	0.04	0.11	0.11	0.04	0.06	0.10	0.06	0.08	0.06	0.06	0.06	0.07	0.07	0.08	0.10	0.07	0.06	0.13	0.12	0.09
500-600	0.04	0.04	0.04	0.06	0.05	0.04	0.05	0.05	0.10	0.10	0.03	0.07	0.09	0.06	0.10	0.05	0.05	0.04	0.07	0.06	0.06	0.09	0.06	0.06	0.12	0.11	0.06
600-700	0.04	0.04	0.02	0.06	0.04	0.03	0.03	0.04	0.09	0.07	0.06	0.04	0.04	0.06	0.08	0.04	0.04	0.03	0.05	0.05	0.05	0.07	0.04	0.06	0.10	0.10	0.06
700-800	0.03	0.03	0.02	0.06	0.04	0.03	0.02	0.04	0.06	0.06	0.06	0.04	0.03	0.04	0.08	0.04	0.04	0.04	0.05	0.04	0.05	0.06	0.04	0.06	0.09	0.10	0.08
800-900	0.03	0.03	0.02	0.06	0.05	0.03	0.02	0.04	0.06	0.05	0.06	0.03	0.01	0.04	0.06	0.03	0.03	0.03	0.04	0.03	0.06	0.04	0.03	0.06	0.08	0.08	0.05
900-1000	0.02	0.04	0.02	0.06	0.04	0.03	0.02	0.04	0.06	0.04	0.04	0.03	0.04	0.04	0.05	0.02	0.03	0.02	0.03	0.03	0.06	0.05	0.04	0.06	0.08	0.08	0.05
1000-1100		0.05	0.02	0.07	0.04	0.03	0.02	0.04	0.04	0.05	0.04	0.03	0.05	0.04	0.04	0.01	0.02	0.02	0.03	0.02	0.07	0.04	0.04	0.05	0.07	0.07	0.05
1100-1200		0.05	0.02		0.03	0.03	0.02	0.04	0.04	0.05	0.04	0.03	0.05	0.04	0.04	0.02	0.02	0.02	0.03	0.03	0.07	0.04	0.04	0.05	0.06	0.06	0.05

C:N

Depth	Profile number																									
(mm)	201	202	203	209	210	212	220	221	222	232	233	235	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254
0-50	17.58	17.17	15.69	12.87	15.57	17.07	15.07	15.97	15.97	19.45	17.61	19.34	14.60	16.53	14.94	14.69	17.81	17.83	14.27	12.75	13.83	15.59	15.41	14.57	14.06	11.42	14.85
50-100	18.33	15.09	16.07	11.89	16.71	16.98	14.67	15.43	15.49	17.67	16.15	16.44	15.05	14.29	16.12	16.48	18.15	16.23	13.75	15.47	13.64	15.90	16.14	13.95	15.68	13.27	13.56
100-150	17.04	13.86	19.77	11.52	17.50	16.73	15.74	16.12	17.05	17.92	15.67	15.69	14.63	16.32	12.65	14.92	15.74	16.67	13.73	14.60	12.78	13.71	15.07	14.13	13.30	12.21	15.13
150-200	16.17	19.05	16.94	11.51	17.14	17.17	15.28	17.22	15.41	16.88	17.36	13.47	15.29	15.93	11.36	13.93	20.57	16.43	15.23	13.82	12.65	13.16	15.48	14.71	12.35	12.07	16.43
200-300	16.00	18.00	15.00	10.83	16.76	16.25	13.96	17.36	15.76	15.07	16.60	15.35	14.94	14.23	11.43	16.47	15.71	15.50	13.91	13.77	12.84	12.72	14.13	13.29	10.95	11.86	14.33
300-400	10.24	16.15	16.67	10.56	9.43	9.74	13.43	23.90	17.95	16.61	13.33	15.25	14.37	13.82	12.44	17.44	16.59	17.18	16.18	14.44	13.20	11.43	14.11	13.57	10.47	11.05	16.36
400-500	18.89	5.65	9.05	8.22	9.43	13.70	13.23	18.57	11.21	11.34	14.09	12.16	12.15	10.57	14.13	16.39	14.72	15.29	15.00	11.36	10.65	12.19	15.11	16.92	9.87	8.95	13.16
500-600	11.15	9.55	12.86	10.00	12.58	10.87	18.71	15.71	10.17	12.50	7.89	6.67	12.67	10.88	8.75	14.24	16.79	14.00	14.52	14.44	7.18	8.79	13.14	12.50	8.55	8.90	9.74
600-700	9.13	4.76	22.50	6.84	5.60	7.50	15.71	19.09	9.27	11.95	7.25	5.22	20.00	7.65	9.13	7.60	10.87	12.11	10.32	12.50	4.06	8.86	9.63	9.72	7.86	9.52	7.94
700-800	7.00	8.42	22.50	6.84	9.20	10.00	14.17	10.83	8.16	8.06	6.76	5.22	16.47	9.58	6.14	10.00	8.70	9.57	8.33	10.00	5.19	7.57	12.40	17.30	7.40	7.38	11.00
800-900	20.63	7.89	22.50	4.10	10.33	7.89	11.82	8.00	6.67	5.67	10.27	3.00	25.00	7.39	5.95	7.50	10.00	10.59	12.27	11.25	9.17	7.27	13.33	7.78	5.83	8.43	6.55
900-1000	9.17	6.09	6.67	2.29	7.39	13.50	9.00	7.31	6.67	11.90	6.30	3.00	8.89	8.57	3.79	9.29	11.76	8.57	8.42	6.47	5.00	5.56	9.23	7.71	5.33	7.50	4.67
1000-1100		4.81	6.67	1.86	4.55	6.11	9.00	7.50	5.36	6.21	7.39	3.00	4.06	4.23	7.08	15.00	7.27	13.33	20.67	3.57	5.24	3.18	5.00	6.45	8.05	8.75	4.69
1100-1200		3.93	6.67		7.06	6.11	6.92	4.78	5.83	6.21	5.77	2.63	4.19	3.46	3.85	10.00	11.11	10.77	7.22	7.50	5.64	6.00	8.57	8.48	4.86	6.84	5.45

Bulk density (Mg m^{-3})

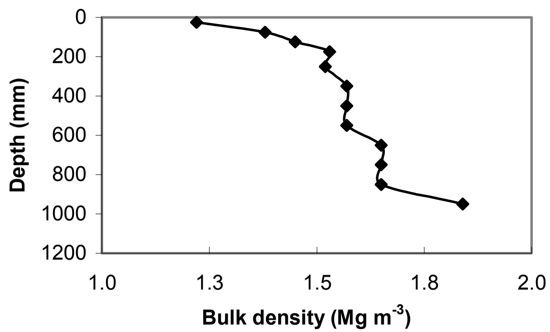
Depth	Profile number																										
(mm)	201	202	203	209	210	212	220	221	222	232	233	235	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254
0-50	1.22	1.36	1.45	1.25	1.30	1.47	1.41	1.31	1.35	1.25	1.30	1.39	1.45	1.46	1.34	1.51	1.45	1.50	1.36	1.46	1.19	1.12	1.38	1.46	1.17	1.35	1.29
50-100	1.38	1.49	1.48	1.30	1.45	1.62	1.68	1.48	1.45	1.36	1.45	1.52	1.46	1.53	1.55	1.60	1.56	1.52	1.54	1.62	1.32	1.32	1.48	1.59	1.38	1.46	1.31
100-150	1.45	1.50	1.60	1.36	1.53	1.59	1.62	1.60	1.56	1.44	1.49	1.55	1.47	1.62	1.62	1.59	1.61	1.59	1.52	1.62	1.54	1.34	1.54	1.63	1.36	1.50	1.47
150-200	1.53	1.51	1.54	1.39	1.52	1.61	1.69	1.68	1.50	1.52	1.48	1.56	1.48	1.63	1.65	1.64	1.64	1.62	1.59	1.64	1.52	1.46	1.61	1.66	1.51	1.52	1.53
200-300	1.52	1.56	1.58	1.44	1.62	1.66	1.71	1.65	1.48	1.56	1.59	1.66	1.41	1.62	1.70	1.65	1.63	1.66	1.58	1.67	1.60	1.51	1.59	1.68	1.54	1.58	1.56
300-400	1.57	1.61	1.74	1.65	1.62	1.64	1.68	1.51	1.56	1.61	1.62	1.70	1.57	1.65	1.71	1.57	1.64	1.66	1.58	1.67	1.63	1.51	1.59	1.57	1.65	1.57	1.57
400-500	1.57	1.61	1.74	1.65	1.62	1.64	1.68	1.51	1.66	1.61	1.62	1.70	1.57	1.71	1.71	1.65	1.64	1.66	1.62	1.67	1.65	1.51	1.59	1.61	1.65	1.57	1.57
500-600	1.57	1.61	1.74	1.65	1.62	1.64	1.68	1.51	1.66	1.67	1.62	1.70	1.57	1.71	1.71	1.65	1.65	1.65	1.65	1.66	1.65	1.58	1.59	1.65	1.71	1.57	1.57
600-700	1.65	1.72	1.62	1.64	1.72	1.64	1.63	1.63	1.66	1.67	1.61	1.74	1.65	1.71	1.71	1.71	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.65	1.71	1.65	1.65
700-800	1.65	1.72	1.62	1.64	1.72	1.64	1.63	1.63	1.60	1.67	1.61	1.74	1.65	1.71	1.71	1.71	1.65	1.65	1.65	1.68	1.68	1.65	1.65	1.65	1.71	1.65	1.65
800-900	1.65	1.72	1.62	1.64	1.72	1.64	1.63	1.63	1.60	1.67	1.61	1.74	1.65	1.71	1.71	1.71	1.65	1.65	1.65	1.71	1.71	1.68	1.65	1.65	1.71	1.65	1.65
900-1000	1.84	1.71	1.75	1.73	1.70	1.60	1.63	1.62	1.60	1.67	1.66	1.73	1.65	1.71	1.71	1.71	1.71	1.71	1.68	1.71	1.71	1.71	1.65	1.65	1.71	1.65	1.65
1000-1100		1.71	1.75	1.73	1.70	1.60	1.63	1.62	1.57	1.67	1.66	1.73	1.65	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.65	1.65	1.71	1.65	1.65
1100-1200		1.71	1.75		1.70	1.60	1.63	1.62	1.57	1.67	1.66	1.73	1.65	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.65	1.71	1.65	1.65

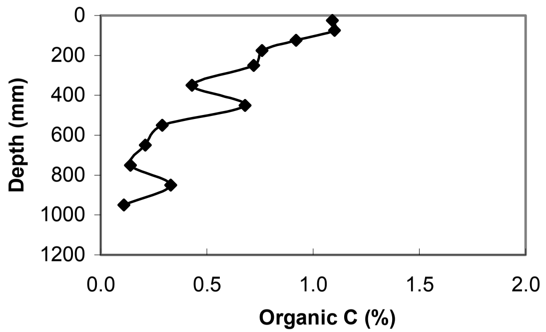
APPENDIX 4

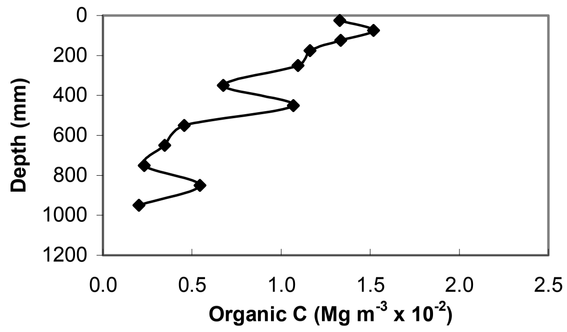
Data for each of the 27 test sites: diagrams showing the Db, OC (%), OC (Mg m^{-3}), TN (%), TN (Mg m^{-3}) values at each depth up to 1200 mm.

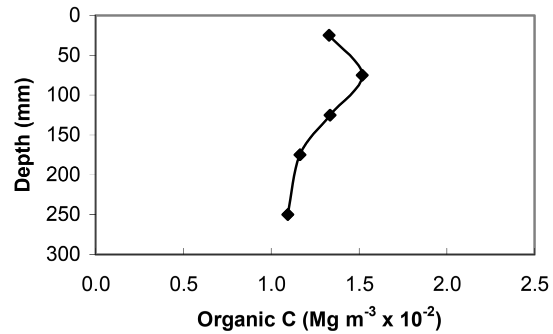
Longlands 2000 **201**

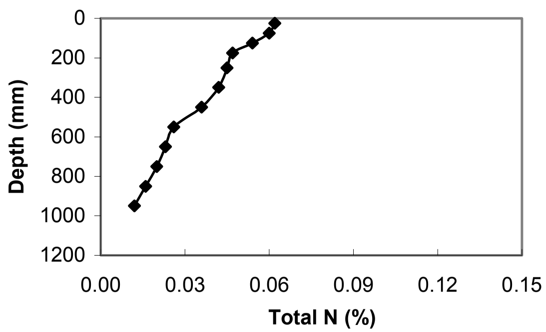
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 430	Orthic A
E	430 - 730	E
B	730 - 980	Soft plinthic B
C	980 - 1210	Saprolite/Rock

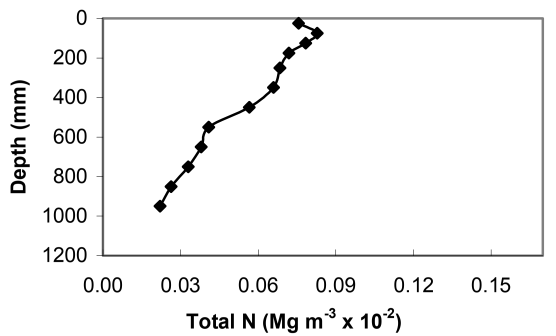


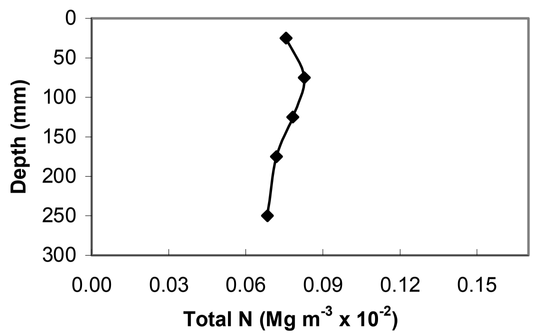






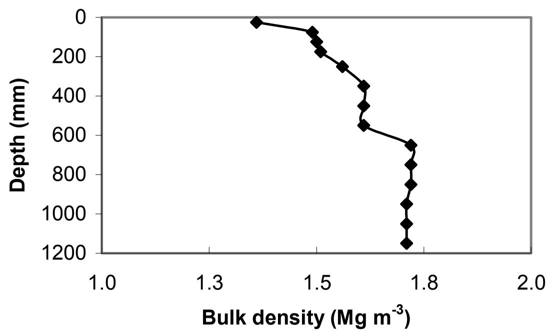


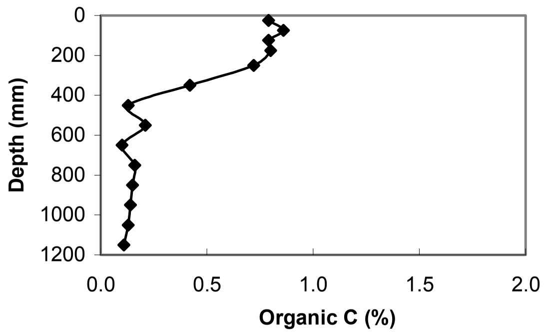


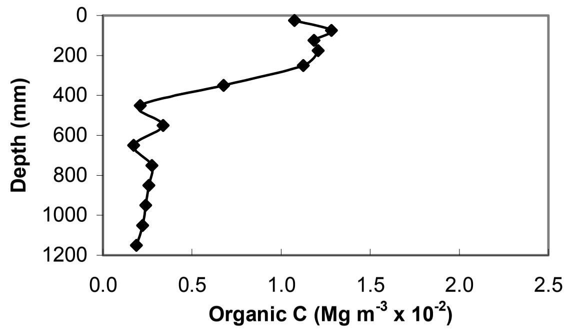


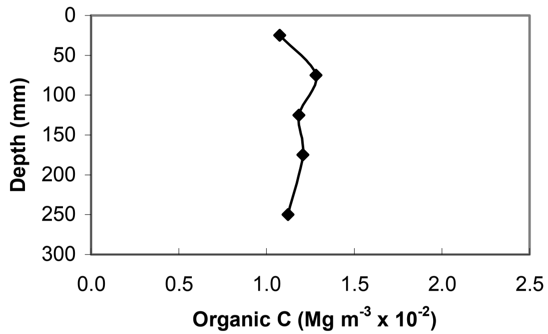
Pinedene 1100 **202**

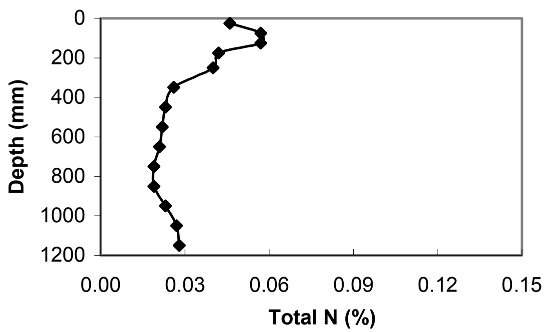
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 400	Orthic A
B	400 - 820	Yellow-brown apedal B
C1	820 - 990	Unspecified material with signs of wetness
C2	990 - 1500	Unspecified material with signs of wetness

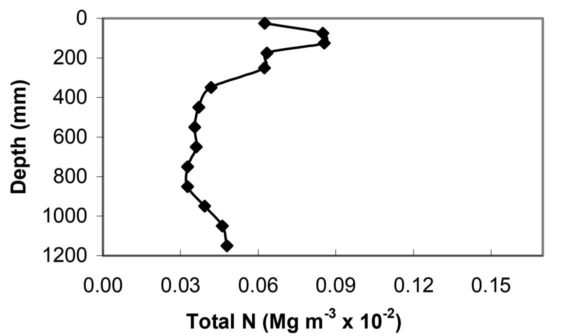


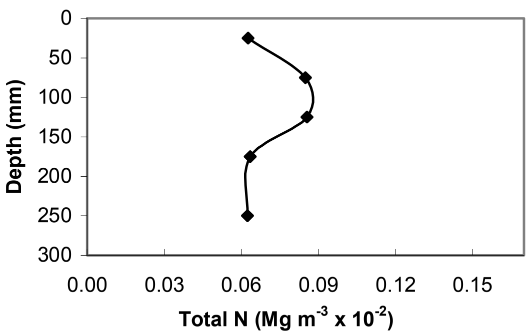






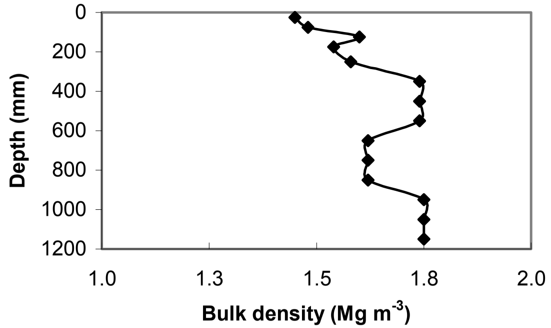


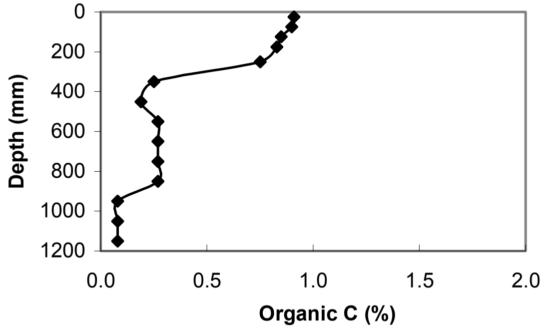


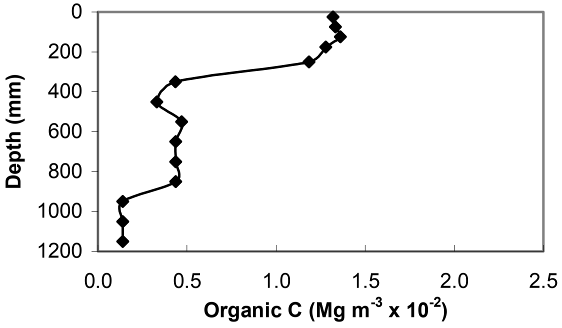


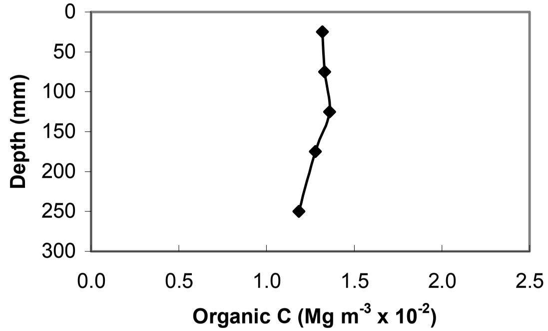
Tukula 2100 **203**

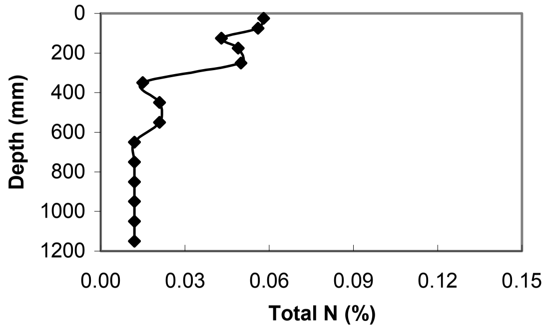
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 380	Orthic A
B	380 - 960	Neocutanic B
C1	960 - 1300	Unspecified material with signs of wetness
C2	1300 - 1500	Unspecified material with signs of wetness

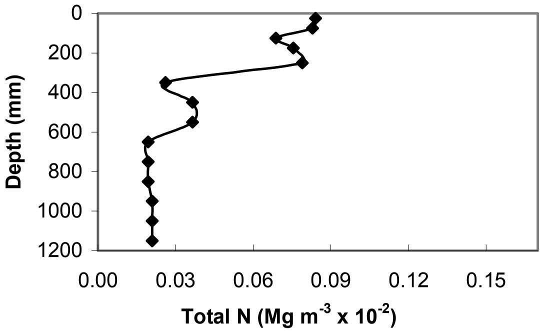


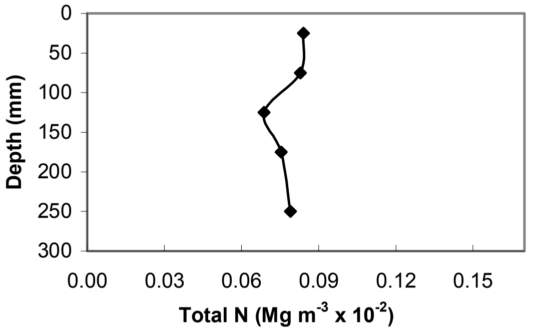






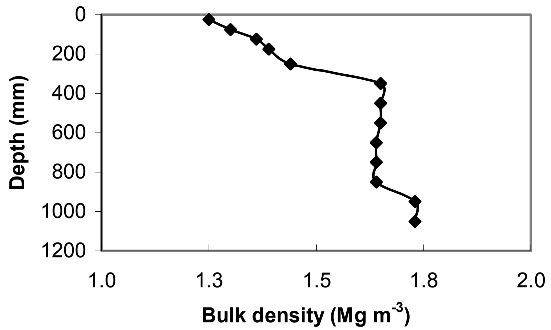


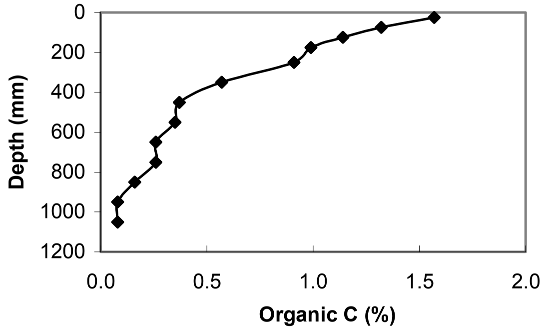


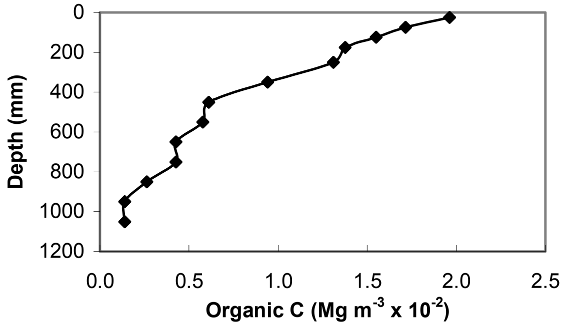


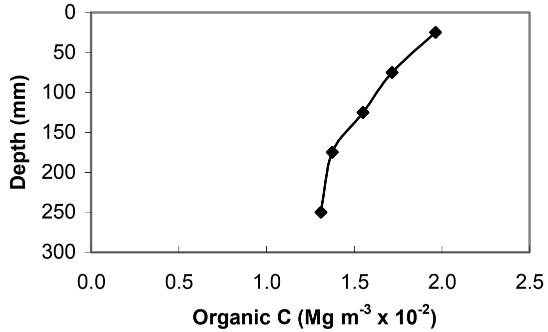
Katspruit 1000 **209**

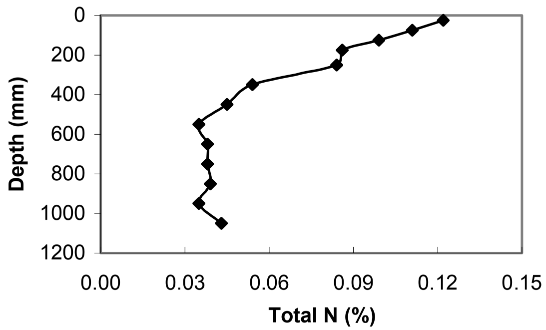
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 450	Orthic A
G	450 -1100	G
C	1100 - 1400	Saprolite

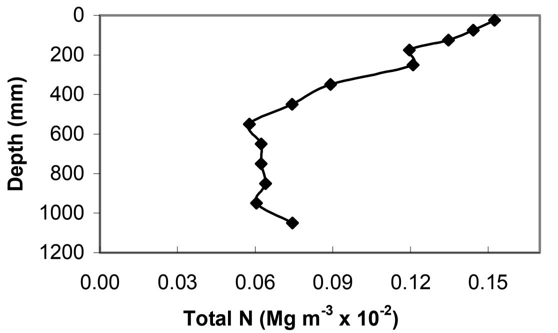


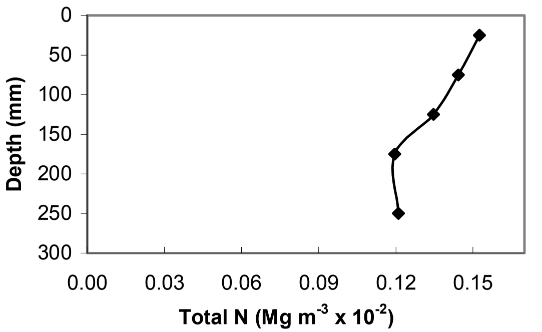






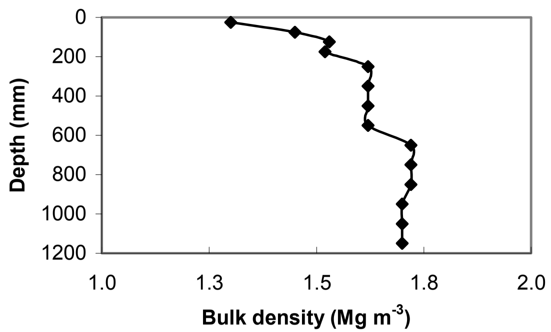


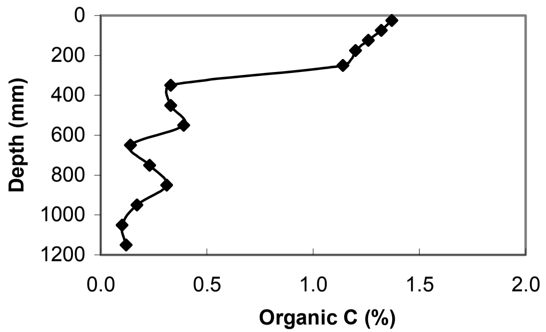


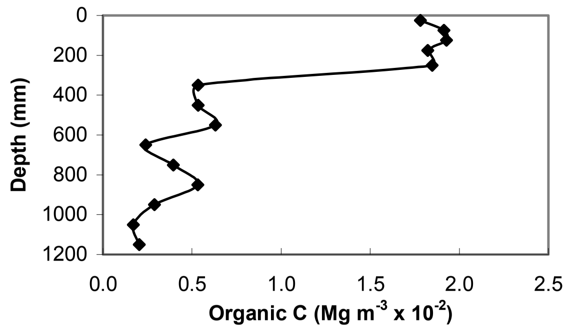


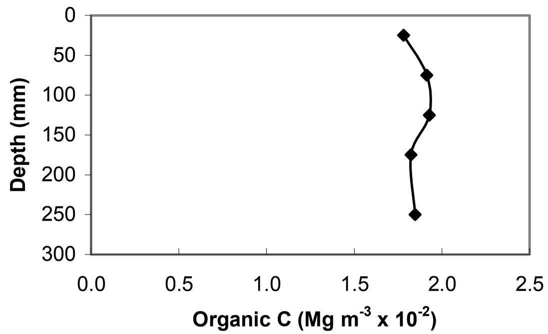
Bloemdal 1100 **210**

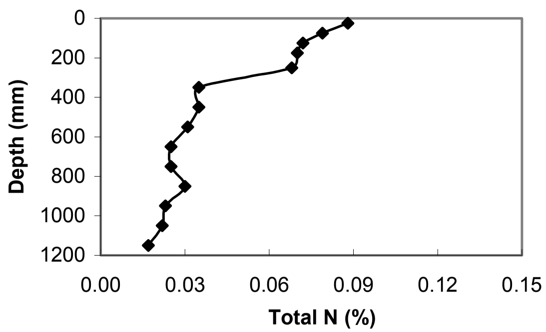
Horizon	Depth(mm)	Diagnostic horizon
A1	0 - 260	Orthic A
A2	260 - 530	Orthic A
B1	530 - 810	Red apedal B
B2	810 - 1200	Red apedal B
C1	1200 - 1580	Unspecified material with signs of wetness
C2	1580 - 1750	Unspecified material with signs of wetness

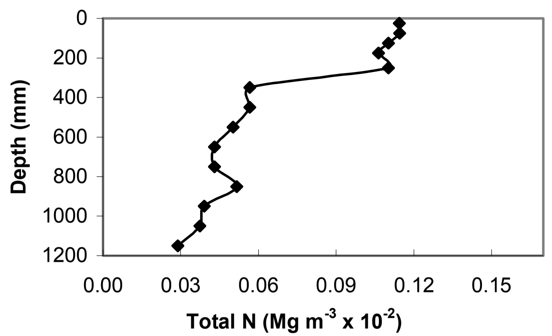


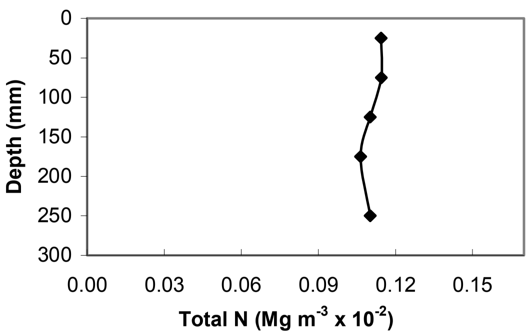






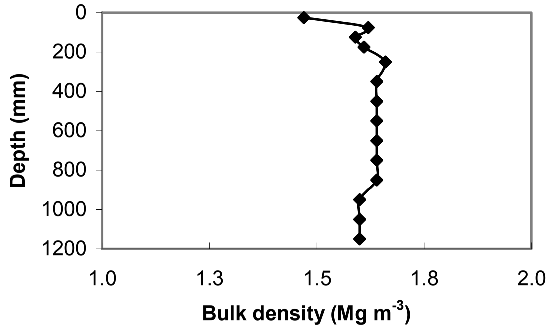


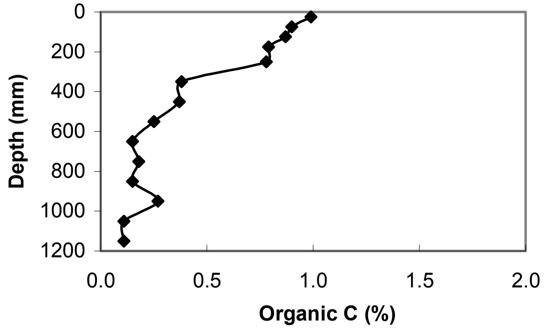


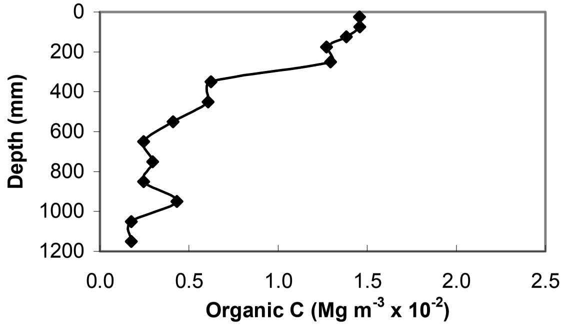


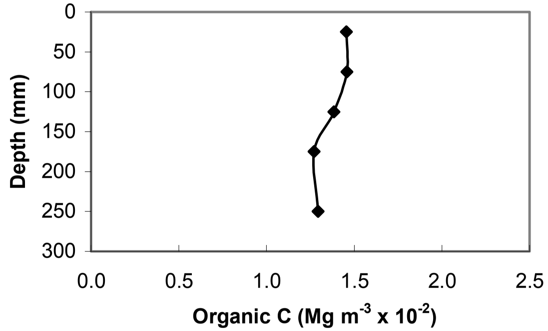
Tukulu 1110 **212**

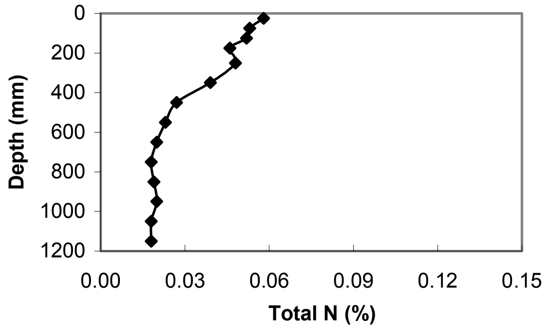
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 300	Orthic A
B1	300 - 570	Neocutanic B
B2	570 - 1300	Neocutanic B
C	1300 - 1500	Unspecified material with signs of wetness

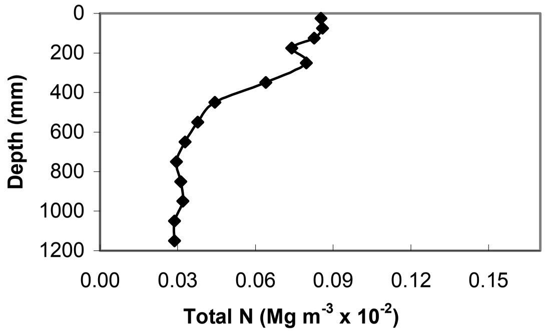


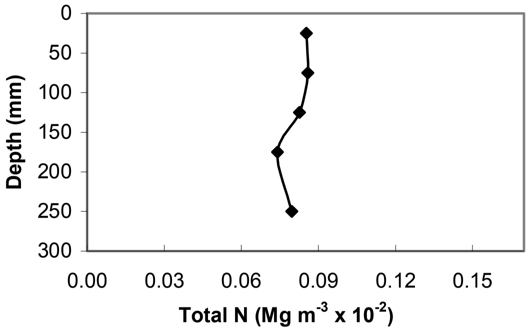






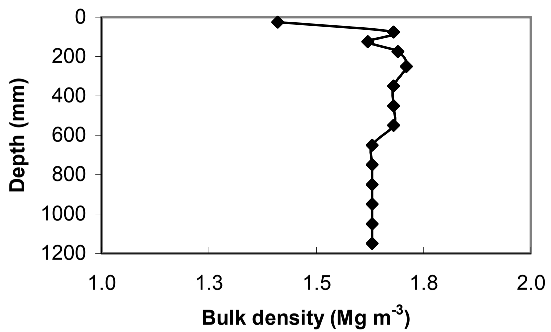


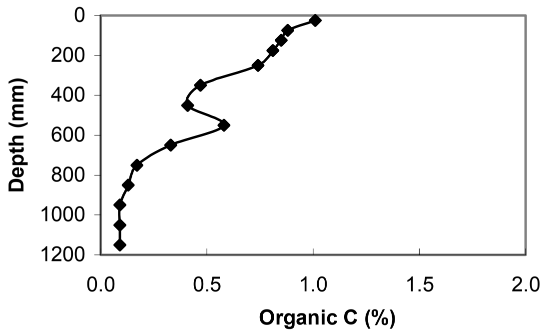


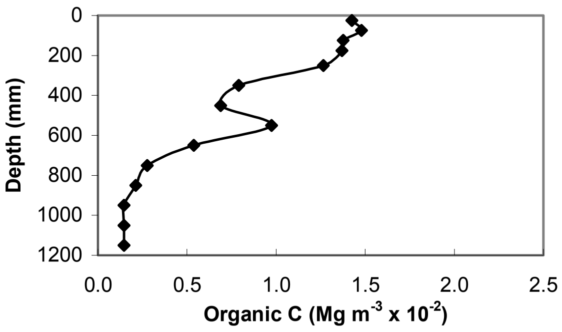


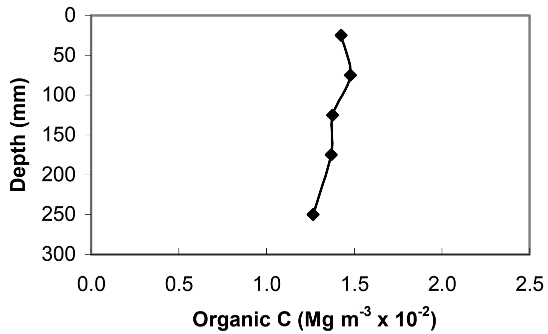
Bloemdal 2100 **220**

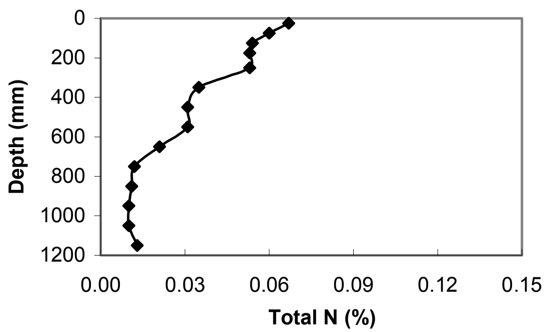
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 540	Orthic A
B	540 - 880	Red apedal B
C1	880 - 1080	Unspecified material with signs of wetness
C2	1080 - 1500	Unspecified material with signs of wetness

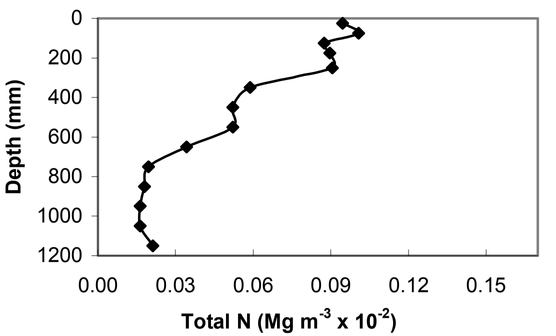


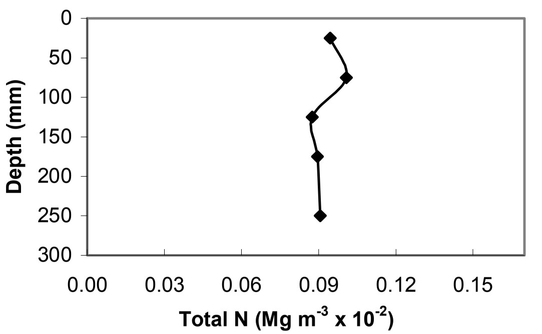






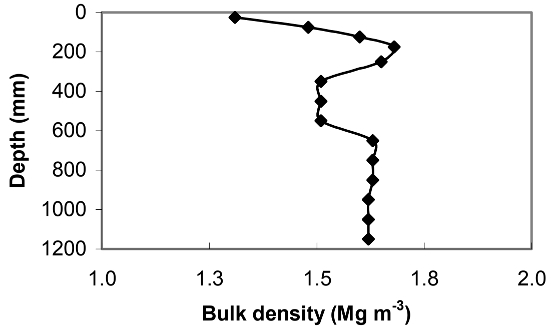


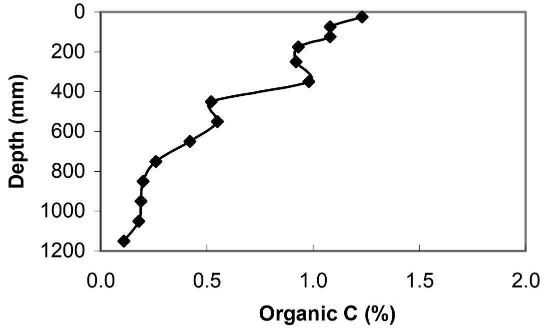


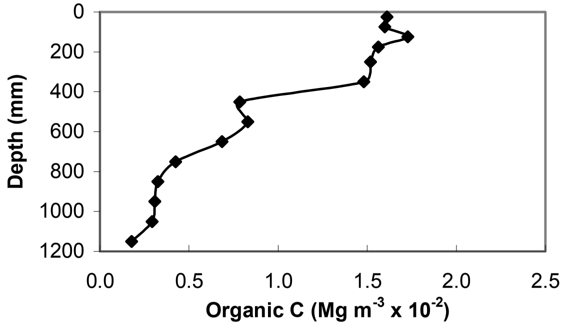


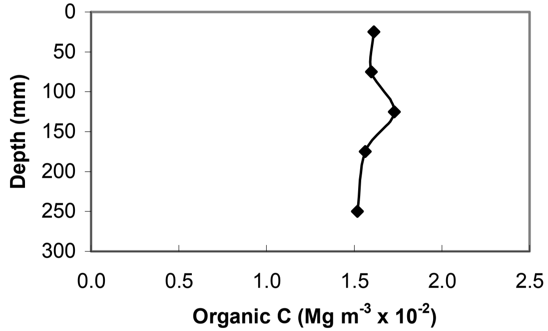
Hutton 2100 **221**

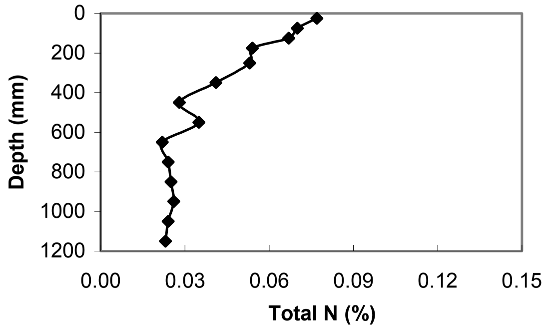
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 250	Orthic A
A/B	250 - 580	Orthic A/Red apedal B
B	580 - 1250	Red apedal B
C	1250 - 1800	Unspecified material with signs of wetness

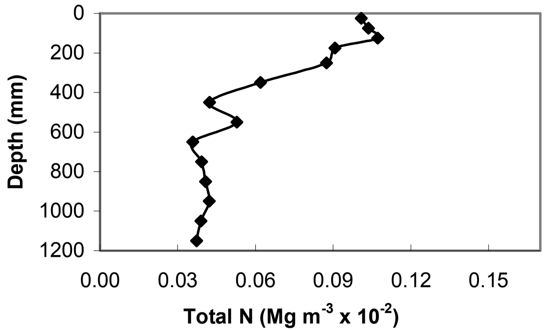


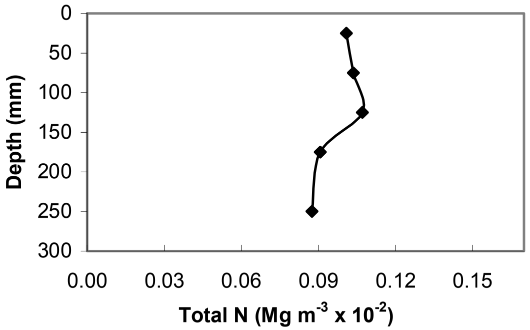






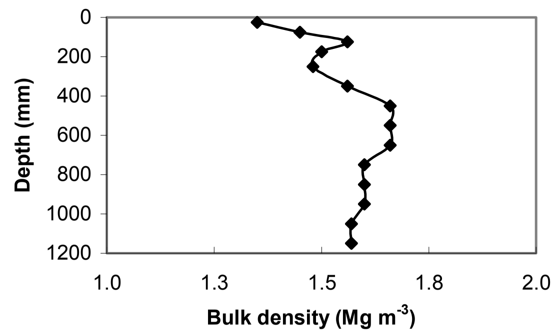


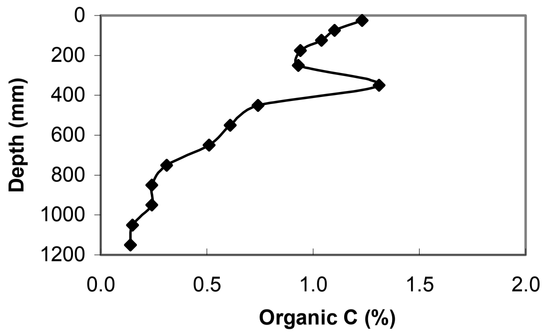


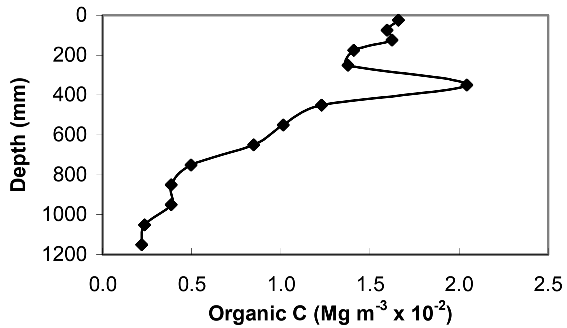


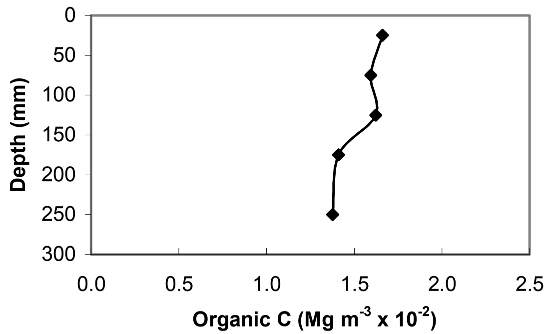
Tukulu 1210 **222**

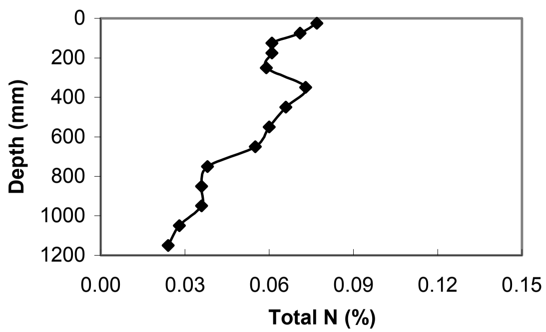
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 420	Orthic A
B1	420 - 690	Neocutanic B
B2	690 - 960	Neocutanic B
C	960 - 1800	Unspecified material with signs of wetness

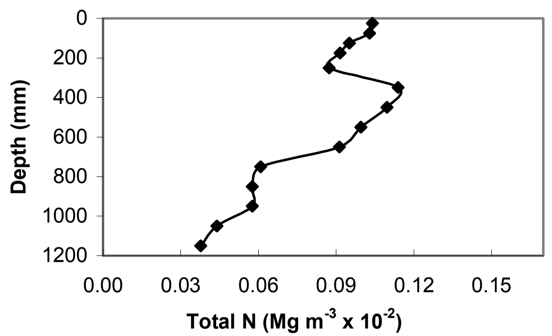


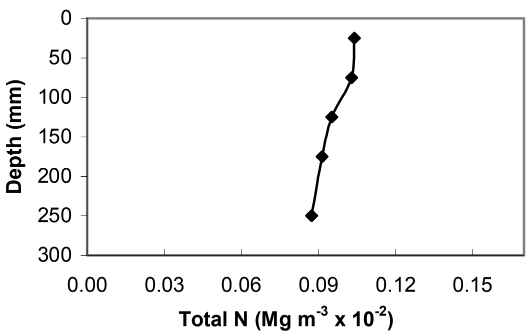






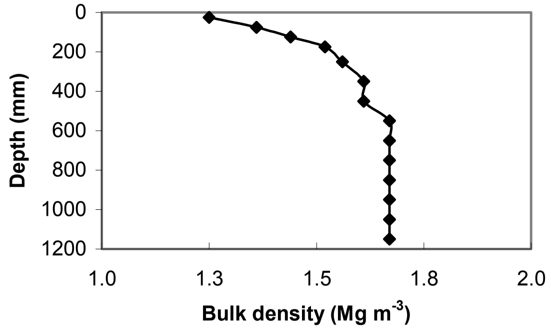


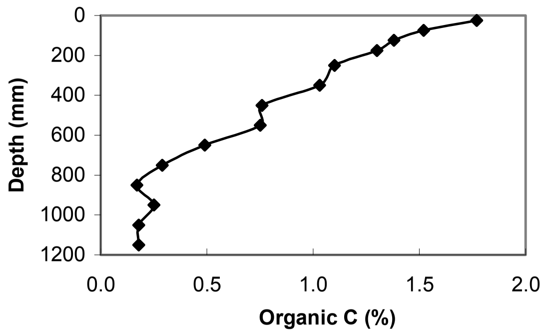


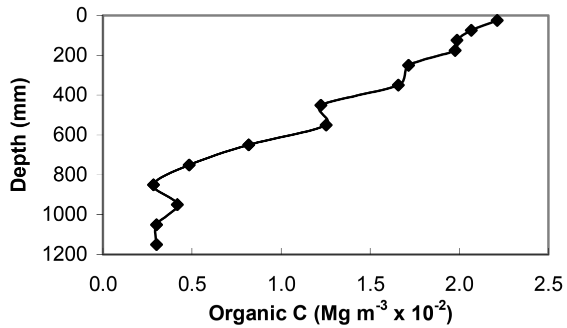


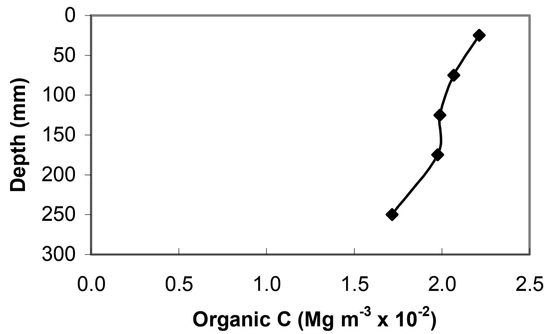
Westleigh 1000 **232**

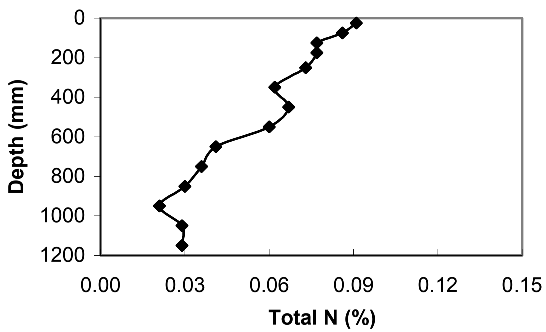
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 220	Orthic A
B1	220 - 500	Soft plinthic B
B2	500 - 840	Soft plinthic B
G1	840 - 1120	G
G2	1120 - 1360	G
G3	1360 - 1500	G

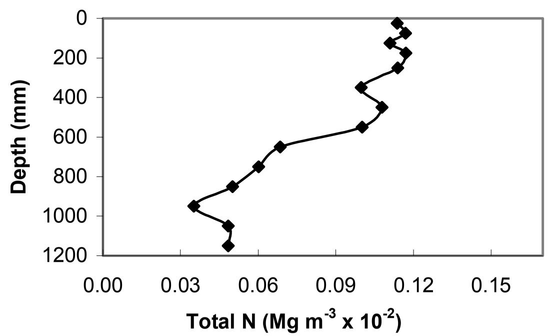


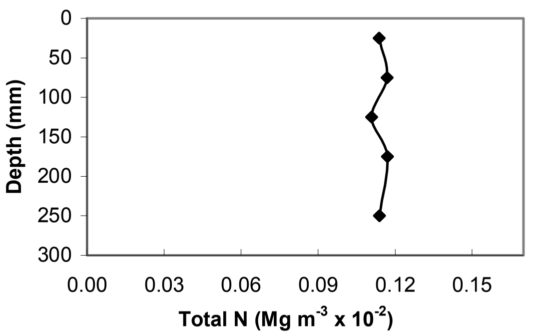






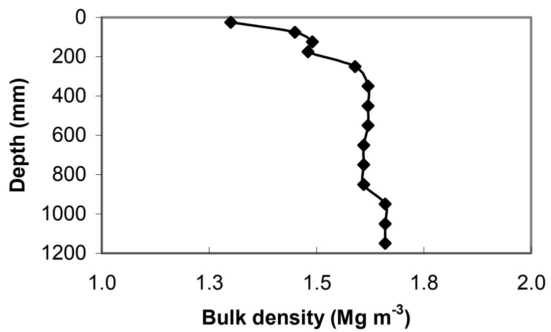


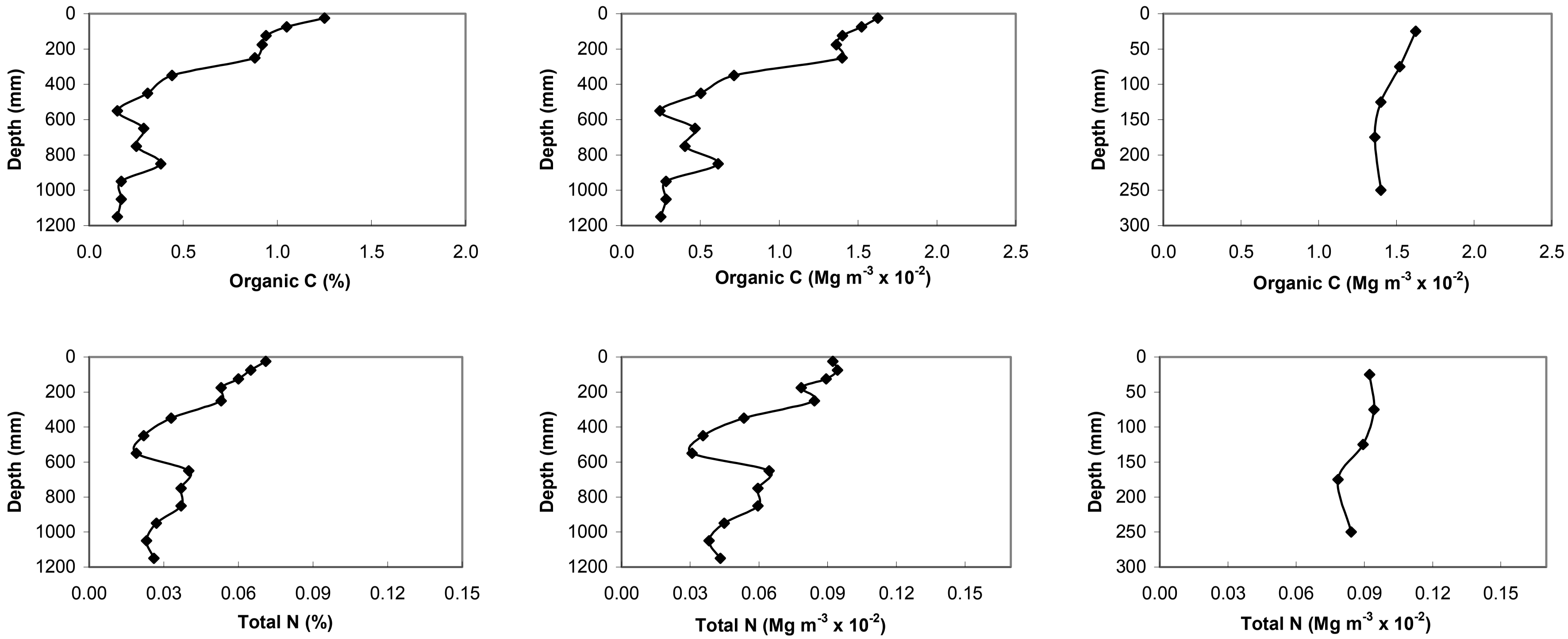




Pinedene 2100 **233**

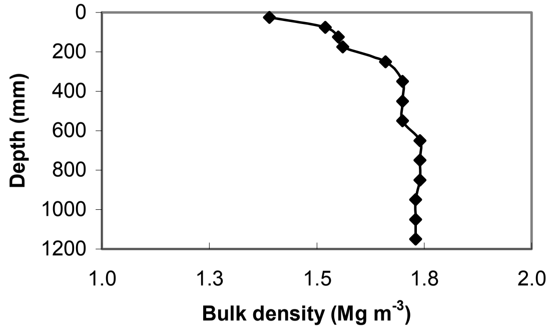
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 300	Orthic A
B1	300 - 500	Yellow-brown apedal B
B2	500 - 600	Yellow-brown apedal B
C1	600 - 1040	Unspecified material with signs of wetness
C2	1040 - 1570	Unspecified material with signs of wetness

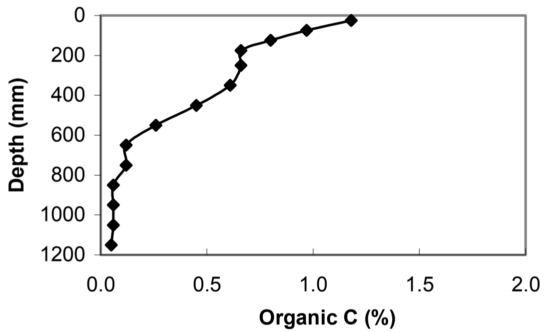


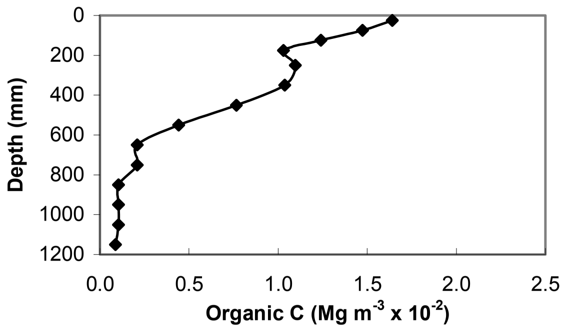


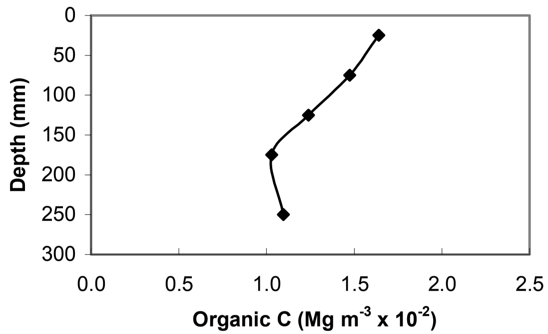
Katspruit 1000 **235**

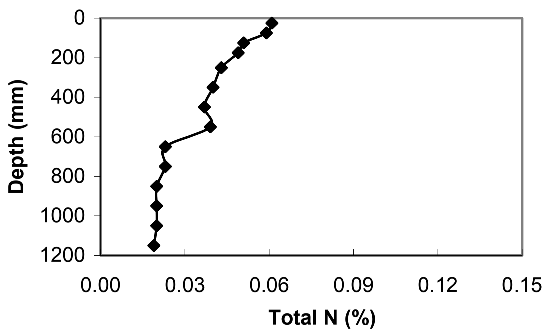
Horizon	Depth(mm)	Diagnostic horizon
A1	0 - 250	Orthic A
A2	250 - 490	Orthic A
G1	490 - 780	G
G2	780 - 1200	G

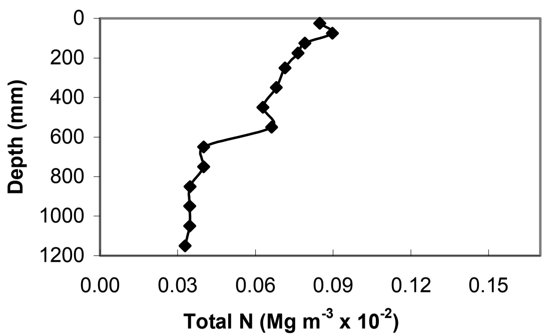


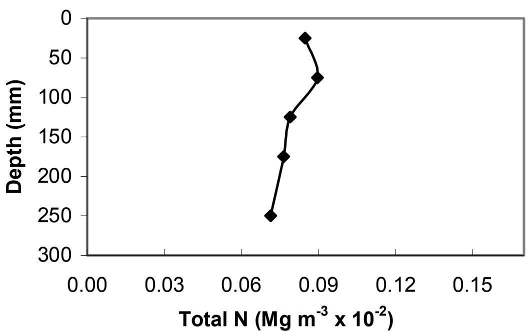






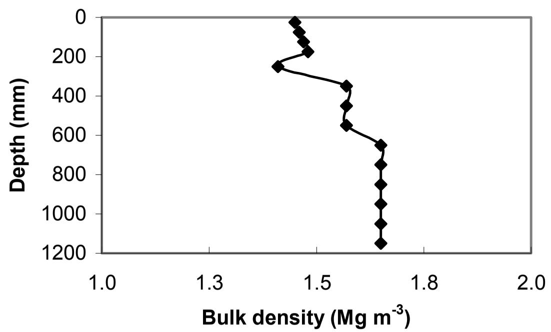


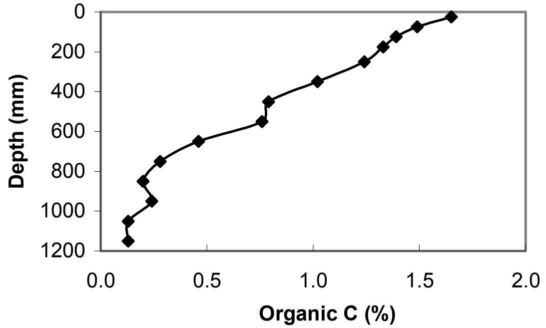


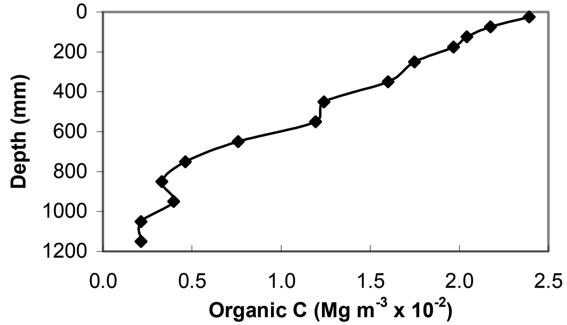


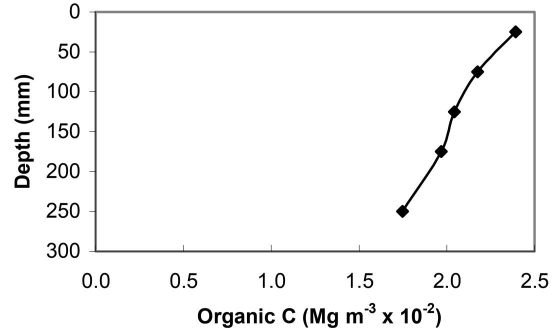
Hutton 2100 **240**

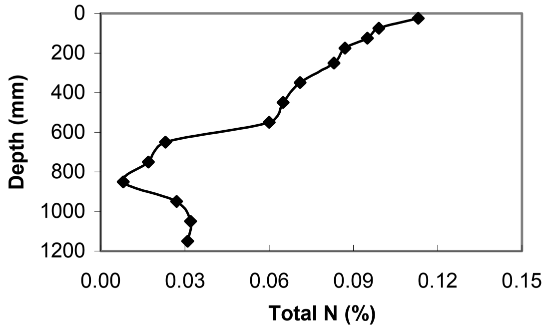
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 600	Orthic A
B	600 - 1200	Red apedal B

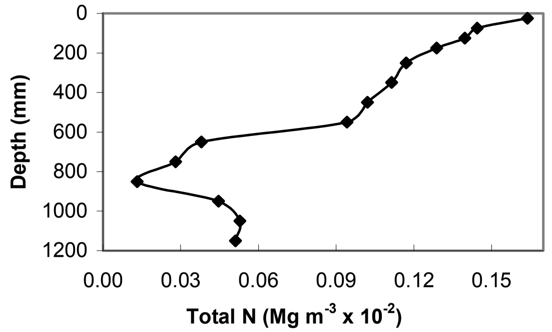


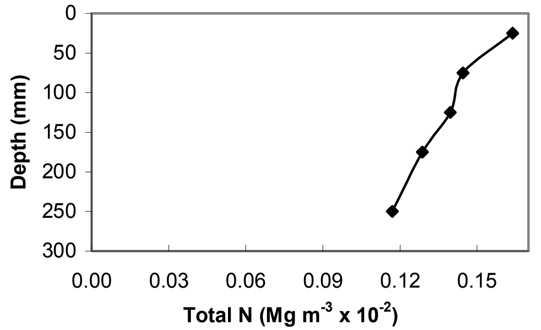






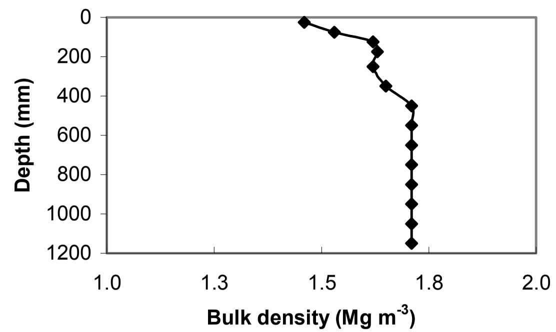


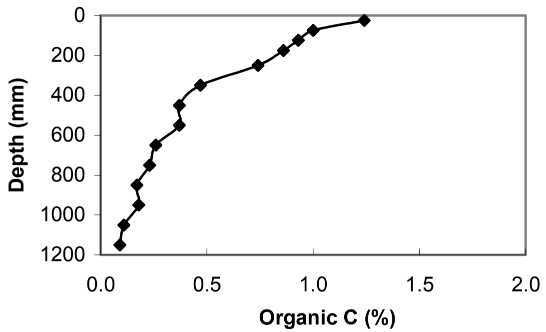


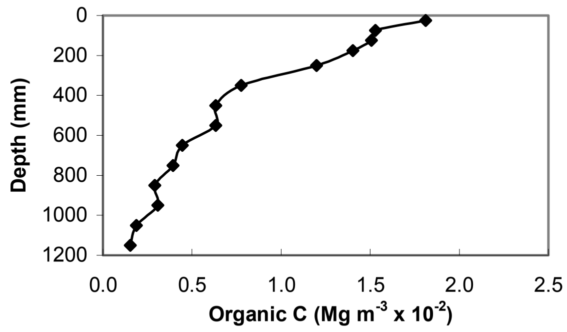


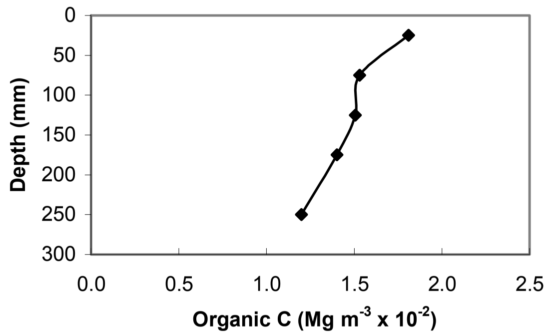
Longlands 2000 **241**

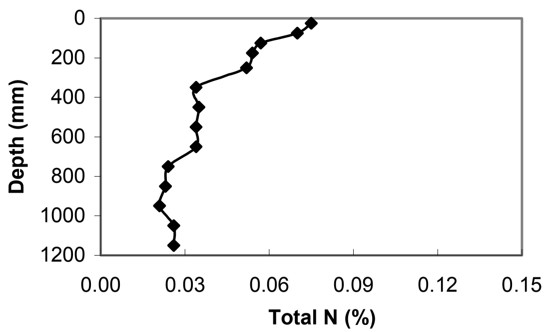
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 220	Orthic A
E	220 - 400	E
B	400 - 600	Soft plinthic B
C	600 - 1200	Unspecified material with signs of wetness

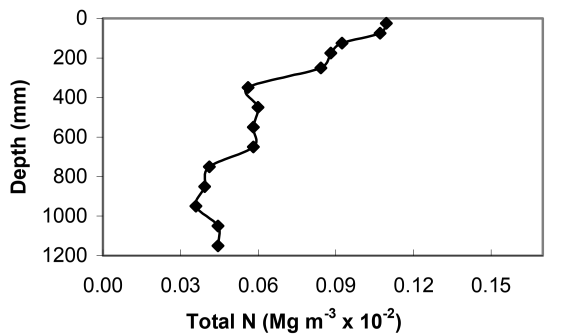


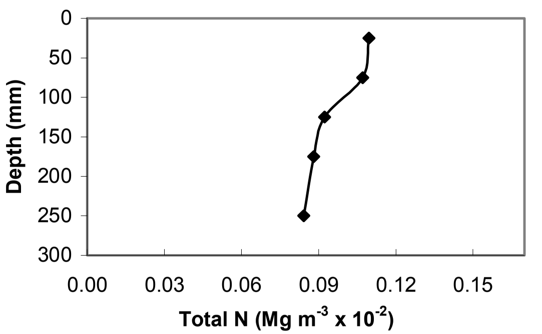






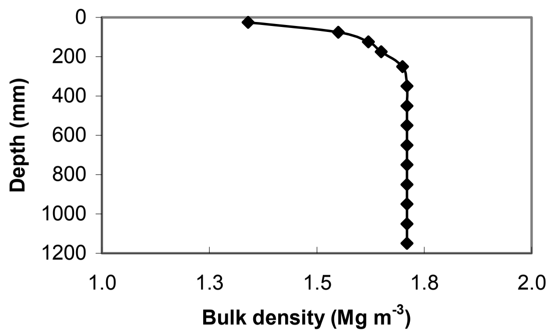


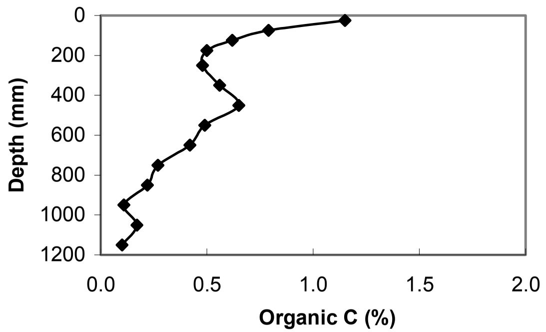


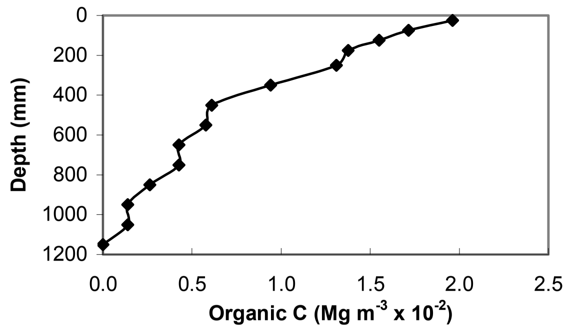


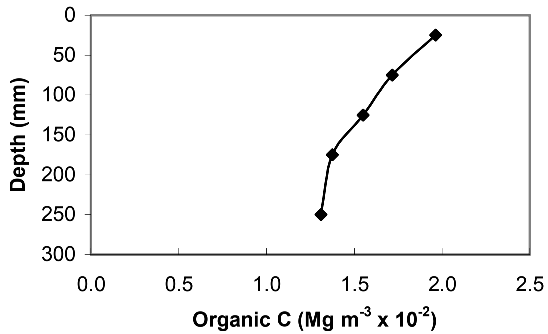
Longlands 2000 **242**

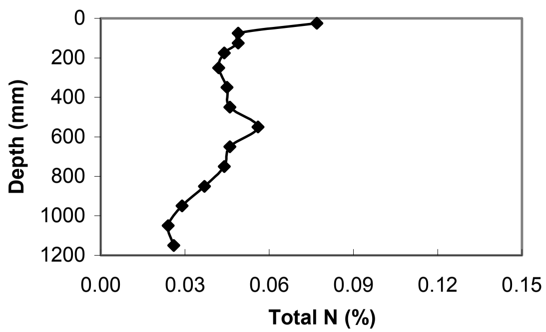
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 250	Orthic A
E	250 - 350	E
B	350 - 500	Soft plinthic B
C	500 - 1200	Unspecified material with signs of wetness

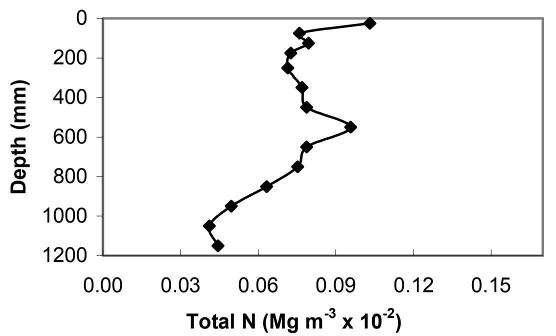


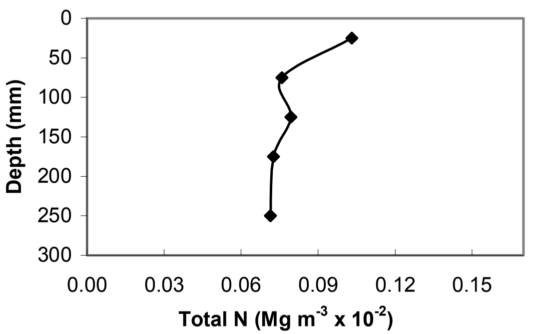






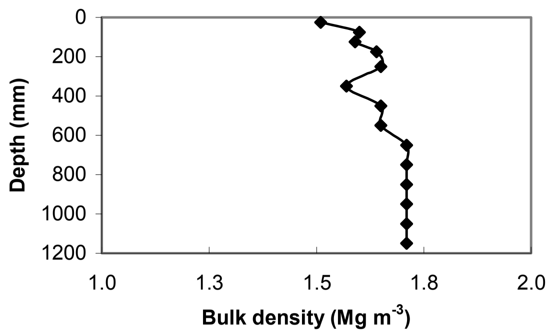


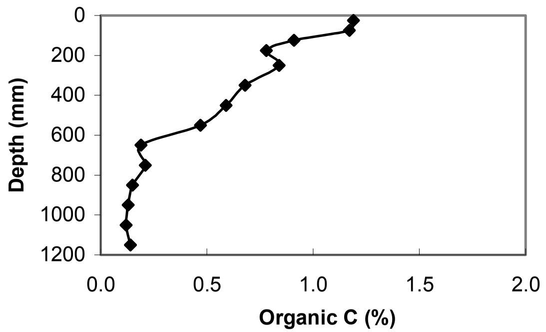


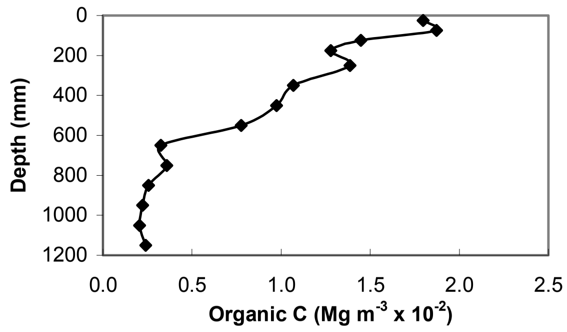


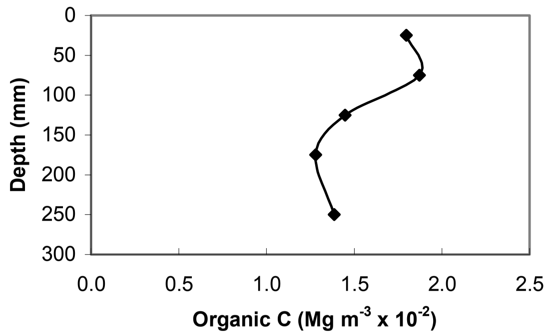
Tukulu 2110 **243**

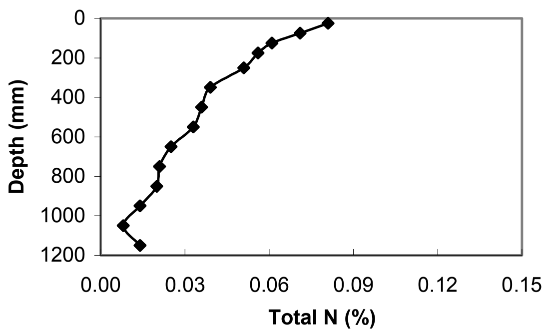
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 400	Orthic A
B	400 - 600	Neocutanic B
C	600 - 1200	Unspecified material with signs of wetness

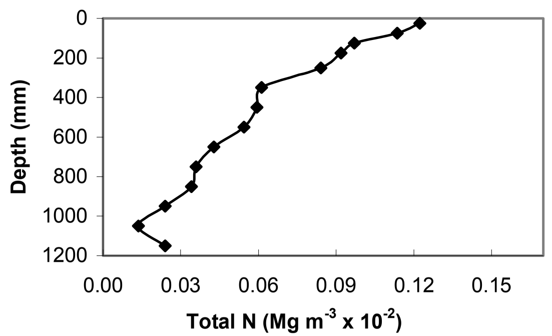


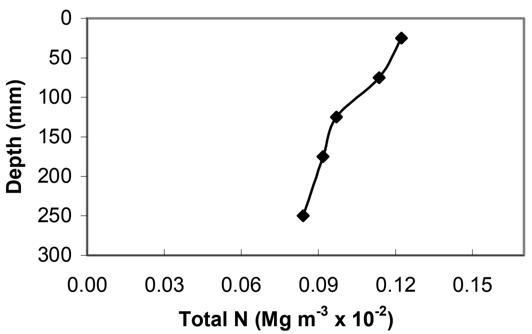






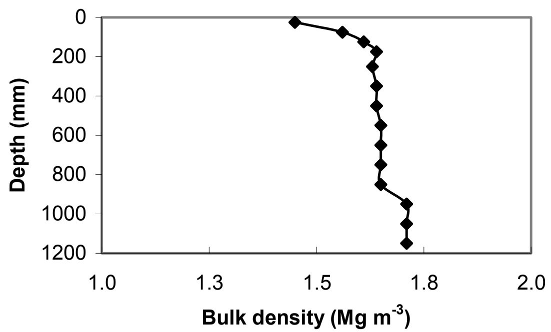


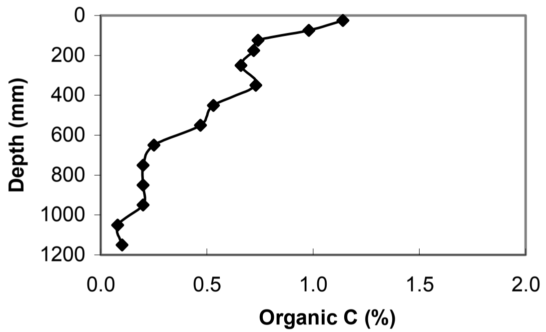


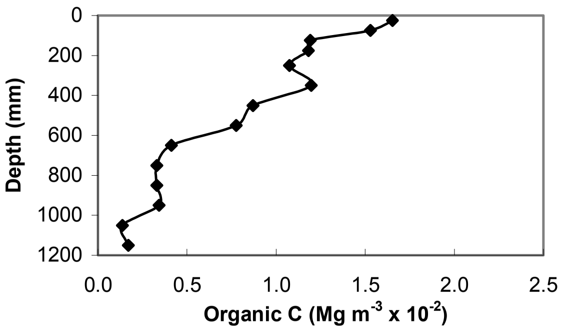


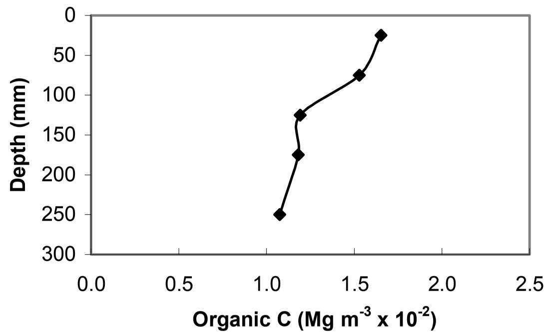
Pinedene 1100 **244**

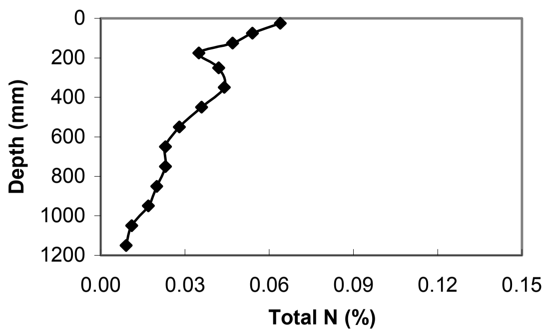
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 550	Orthic A
B	550 - 900	Yellow-brown apedal B
C	900 - 1200	Unspecified material with signs of wetness

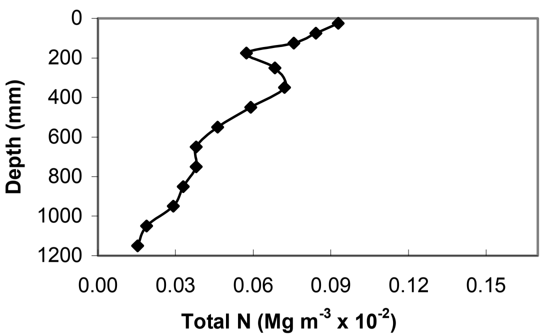


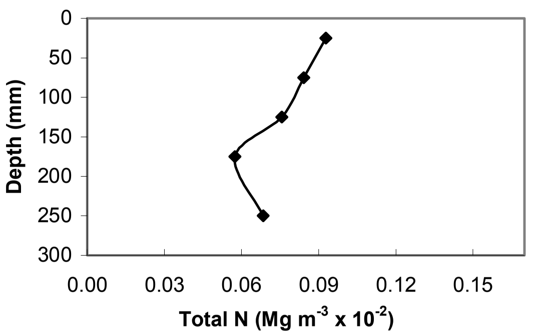






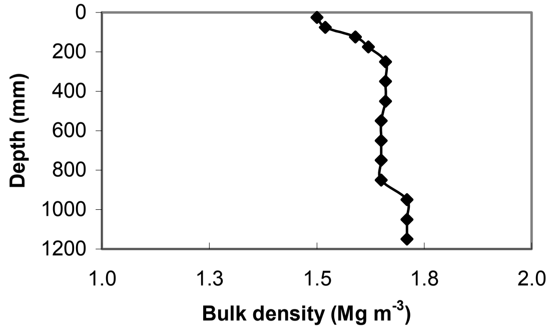


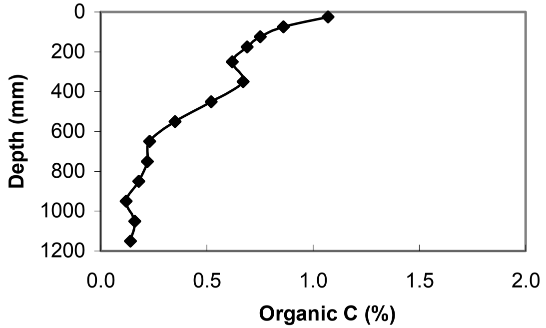


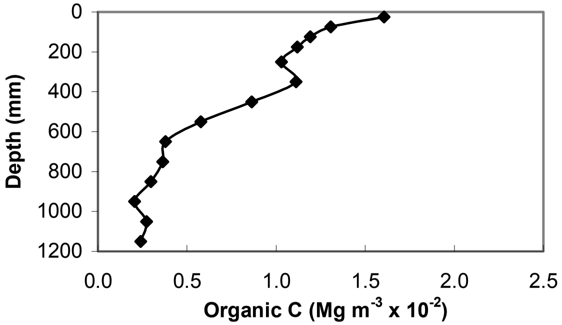


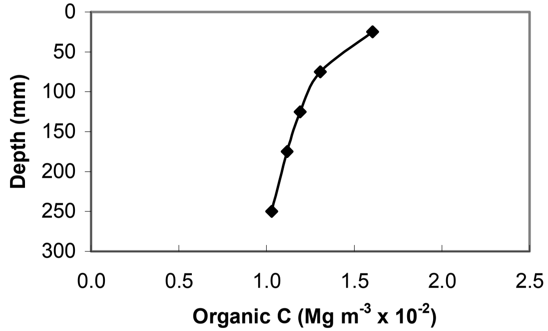
Pinedene 1100 **245**

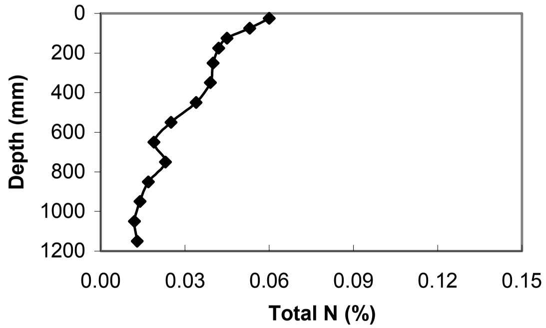
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 550	Orthic A
B	550 - 900	Yellow-brown apedal B
C	900 - 1200	Unspecified material with signs of wetness

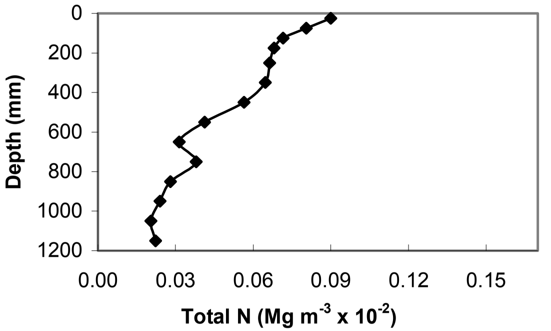


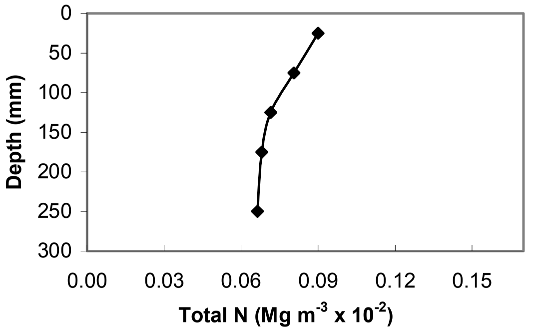






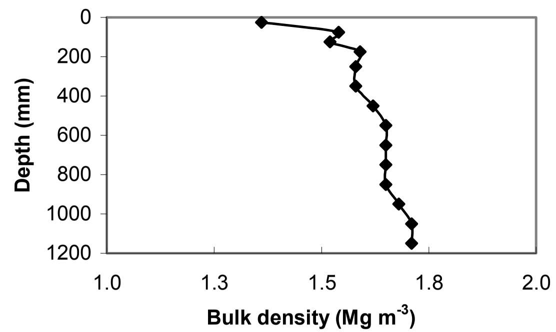


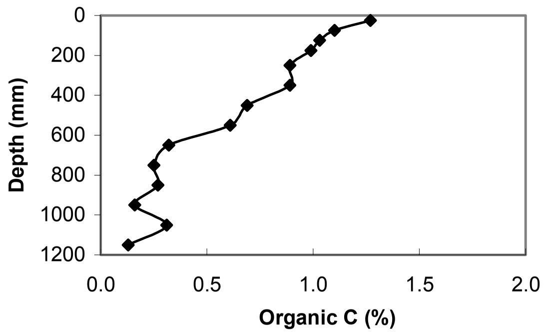


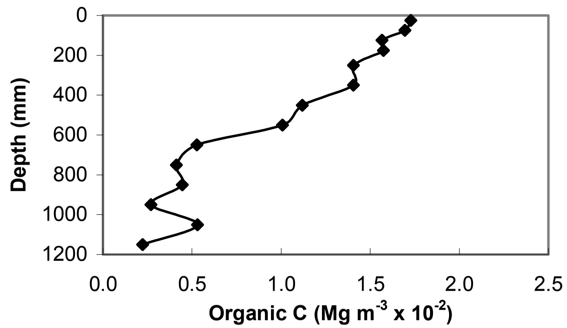


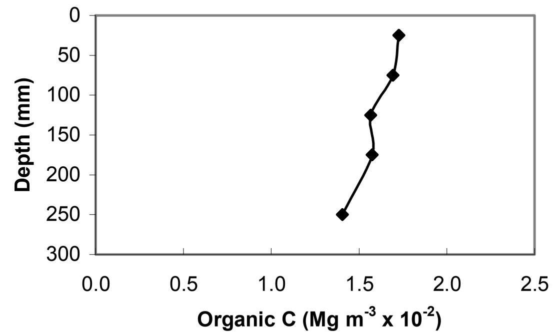
Pinedene 1100 **246**

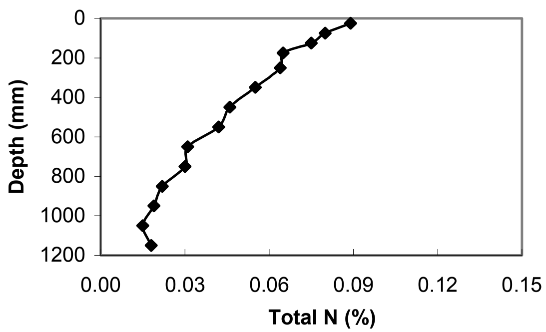
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 450	Orthic A
B	450 - 950	Yellow-brown apedal B
C	950 - 1200	Unspecified material with signs of wetness

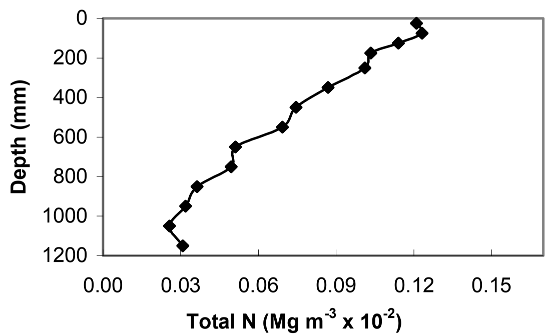


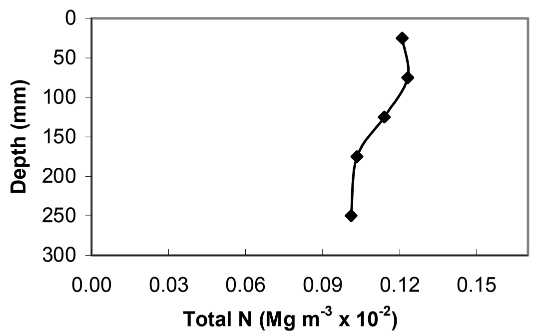






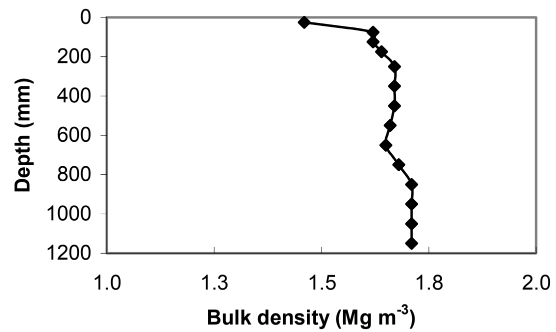


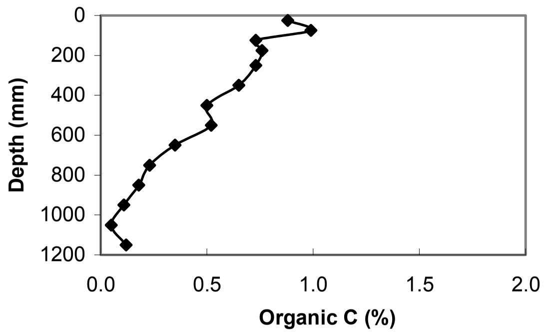


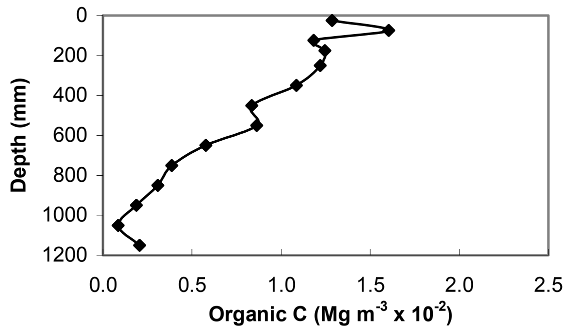


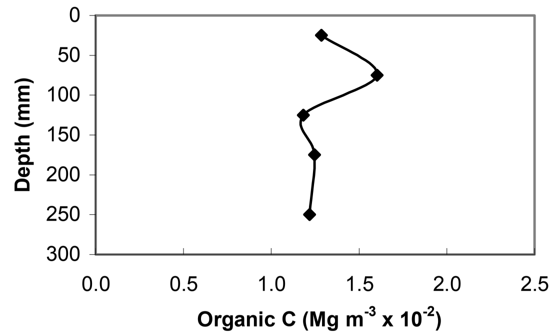
Pinedene 1100 **247**

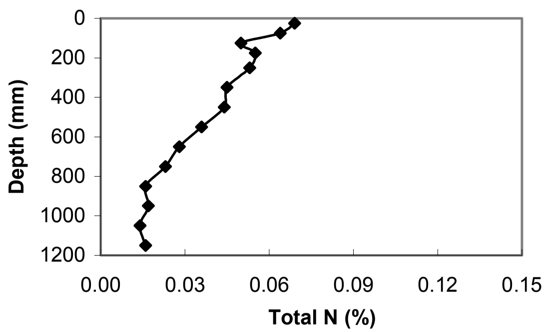
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 550	Orthic A
B	550 - 750	Yellow-brown apedal B
C	750 - 1200	Unspecified material with signs of wetness

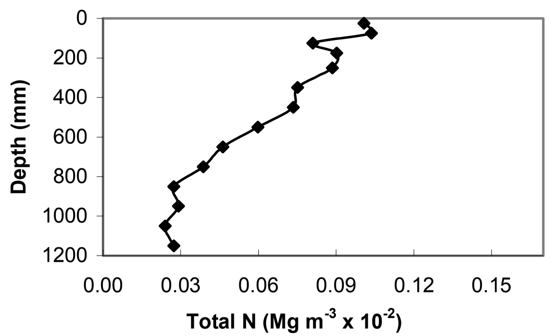


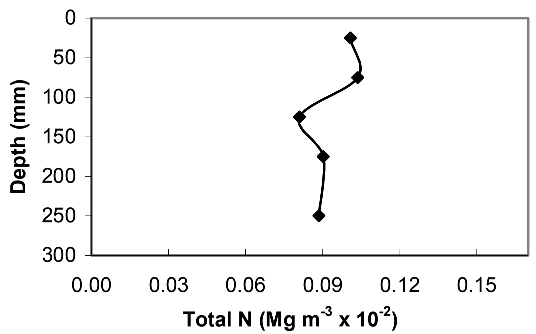






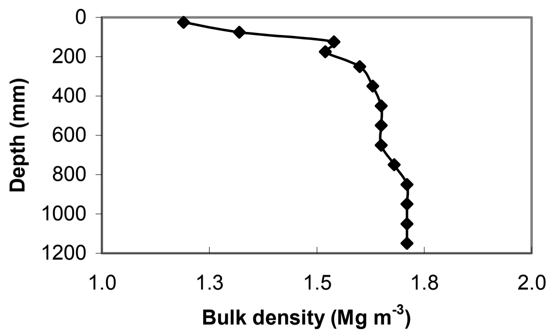


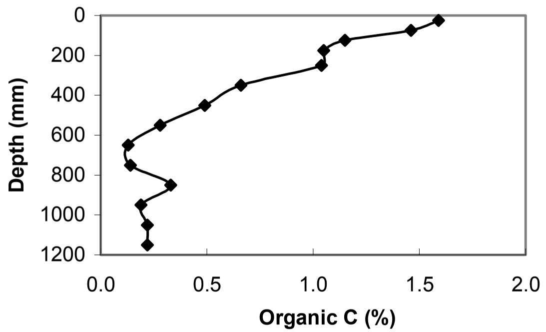


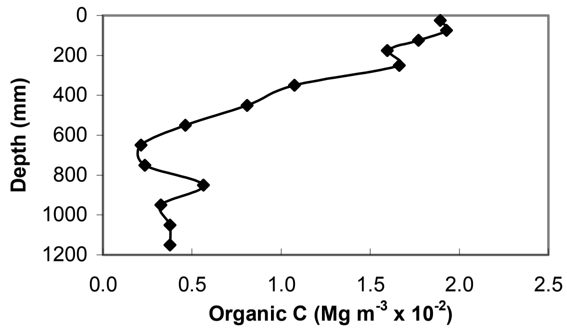


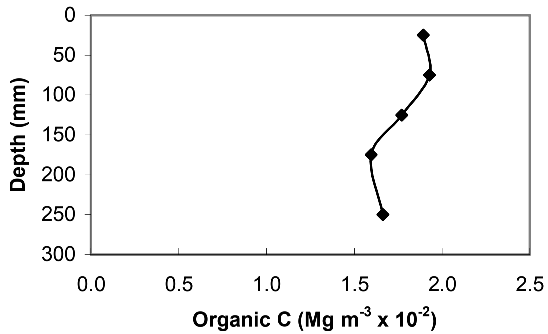
Tukulu 2100 **248**

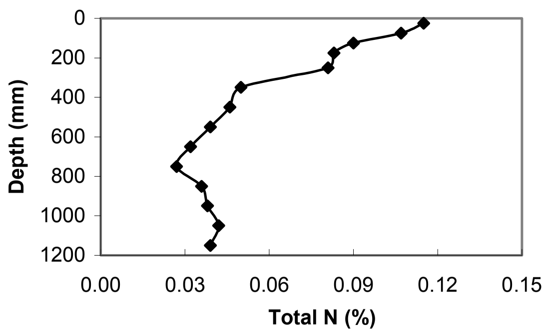
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 350	Orthic A
B	350 - 750	Neocutanicl B
C	750 - 1200	Unspecified material with signs of wetness

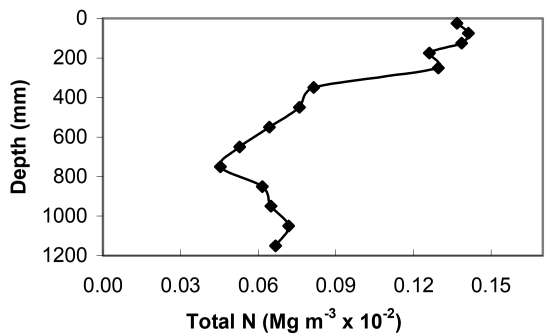


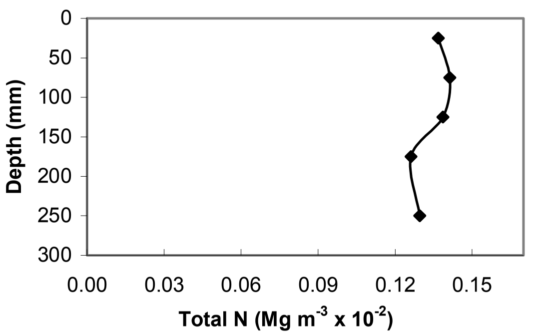






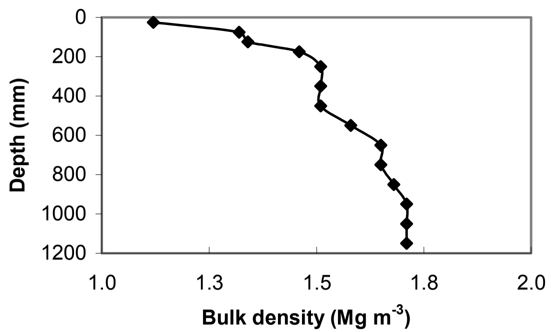


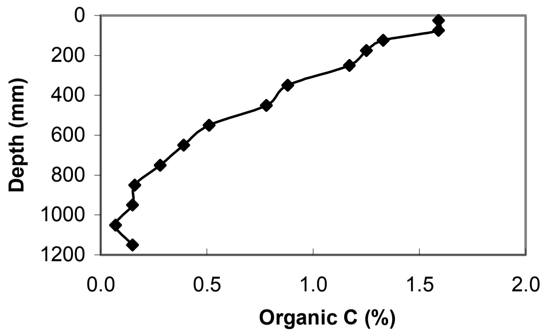


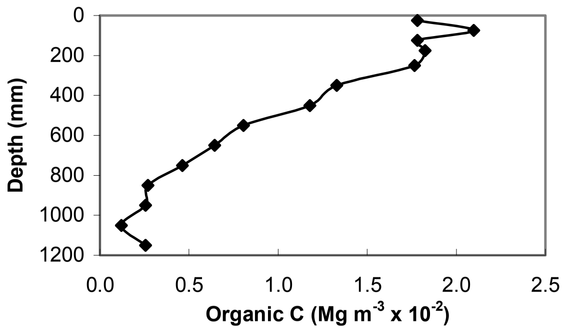


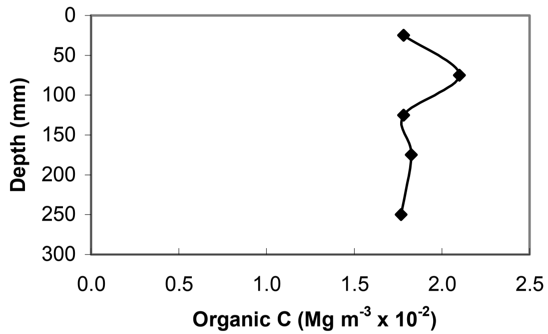
Kroonstad 2000 **249**

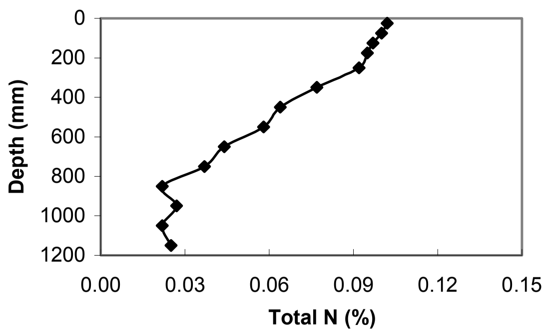
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 550	Orthic A
E	550 - 850	E
G	850 - 1200	G

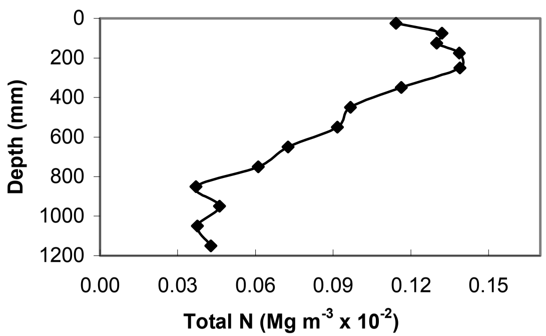


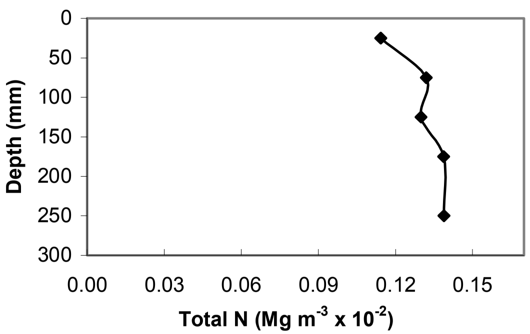






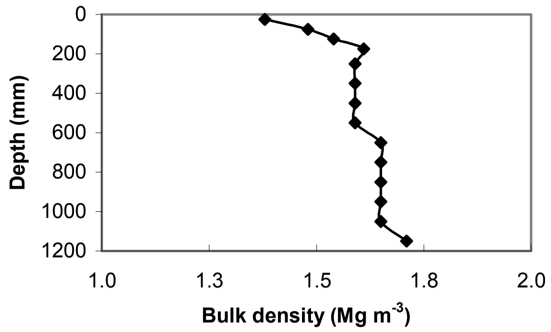


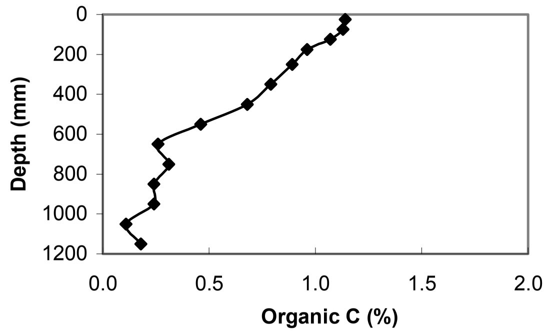


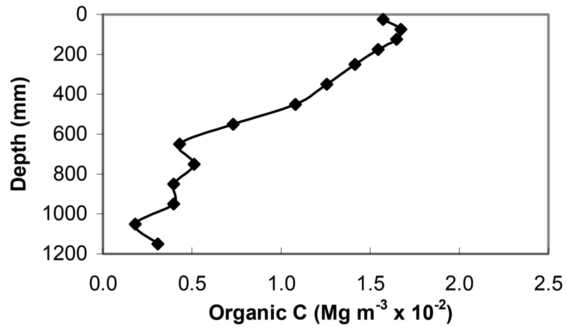


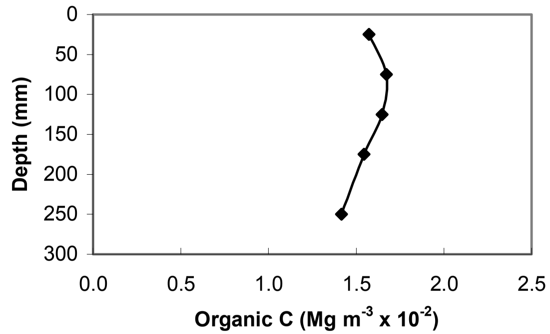
Pinedene 1100 **250**

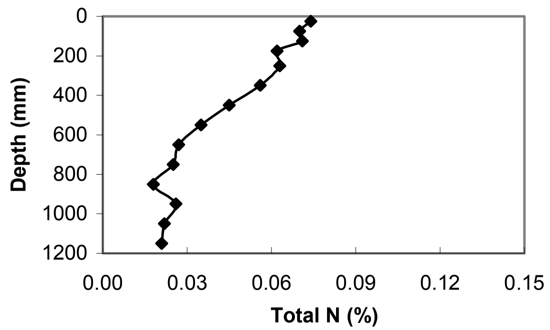
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 630	Orthic A
B	630 - 1100	Yellow-brown apedal B
C	1100 - 1200	Unspecified material with signs of wetness

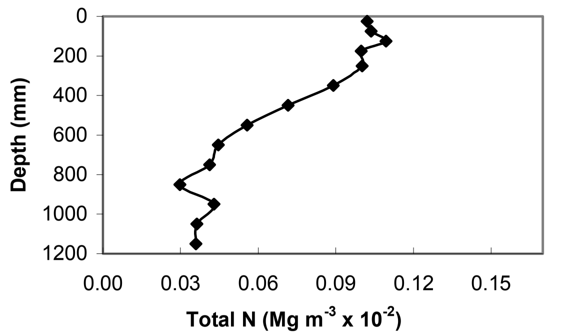


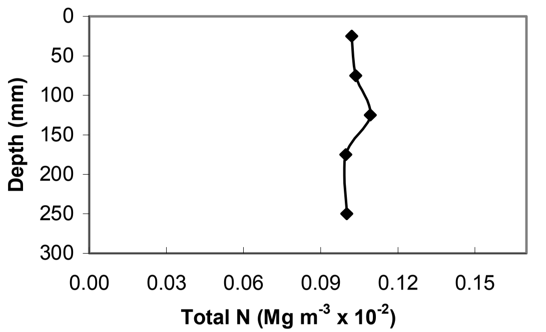






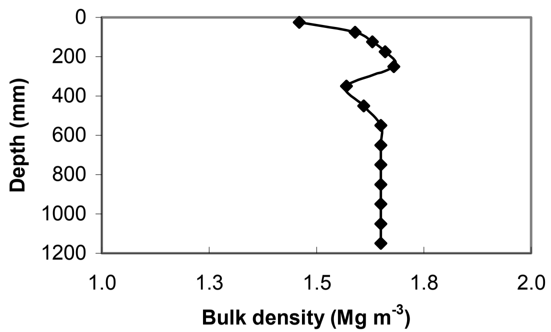


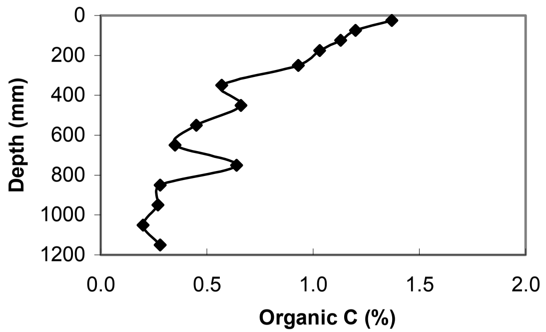


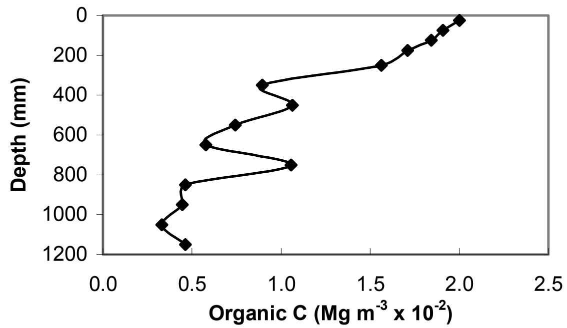


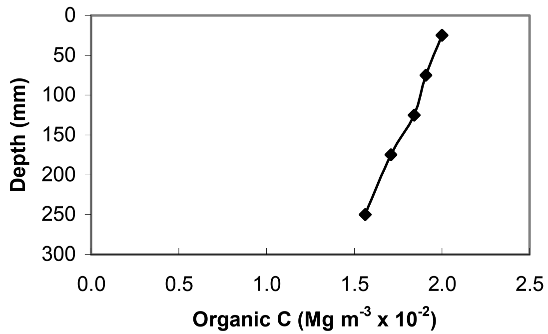
Clovelly 1200 **251**

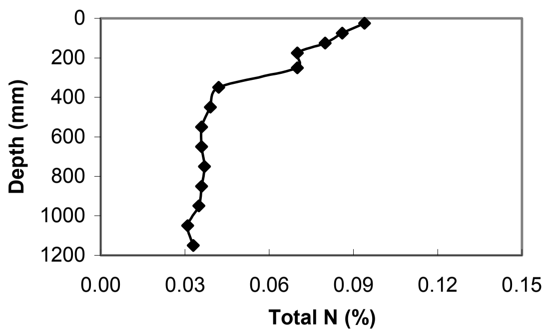
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 450	Orthic A
B	450 - 1200	Yellow-brown apedal B

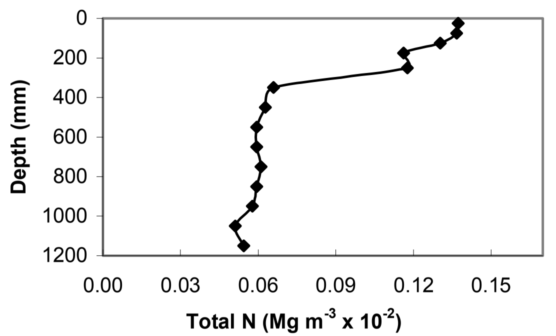


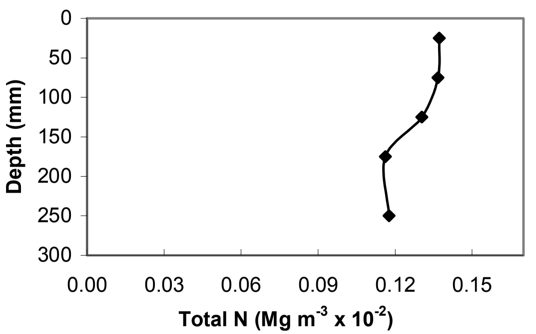






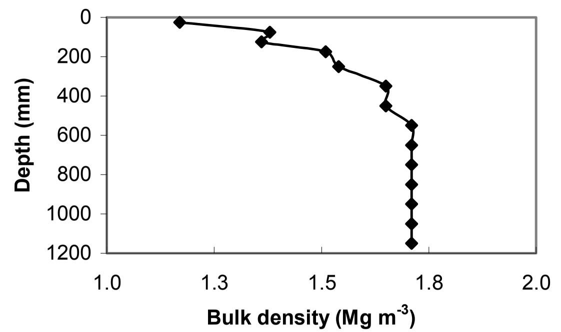


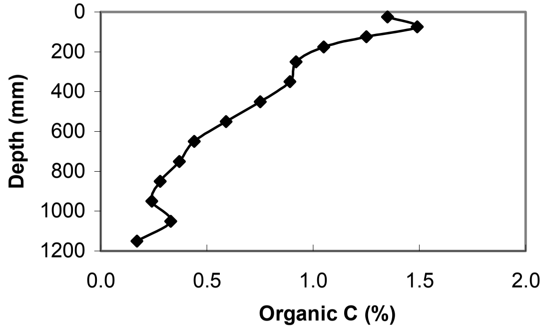


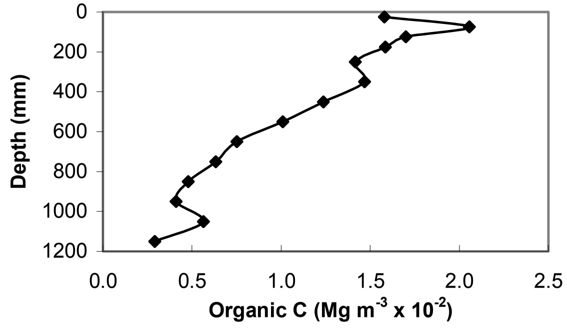


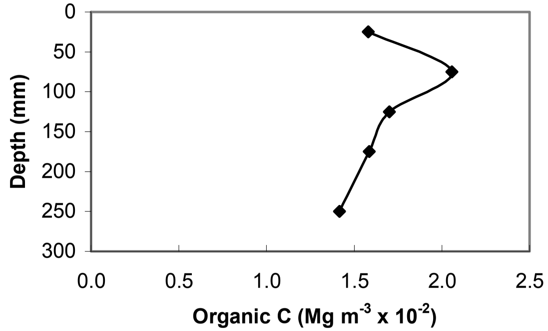
Kroonstad 2000 **252**

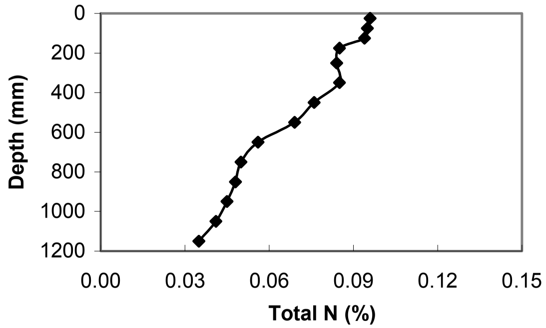
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 250	Orthic A
E	250 - 500	E
G	500 - 1200	G

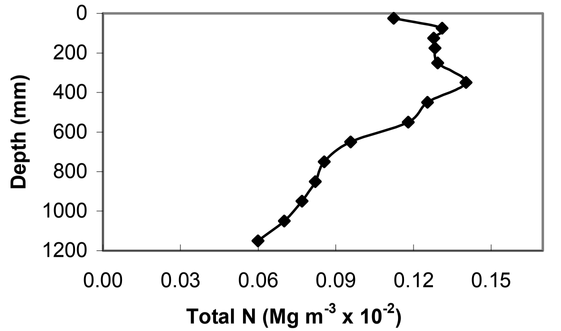


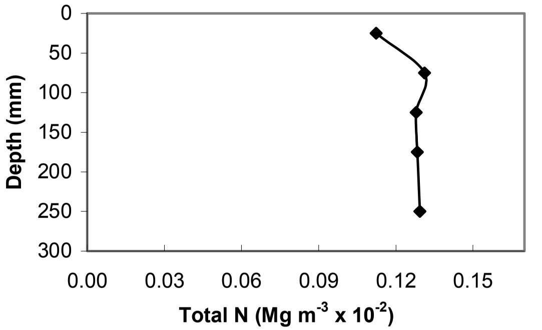






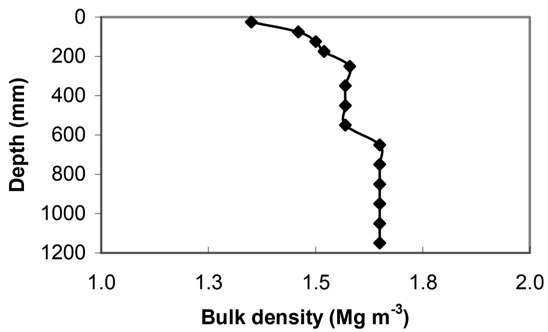


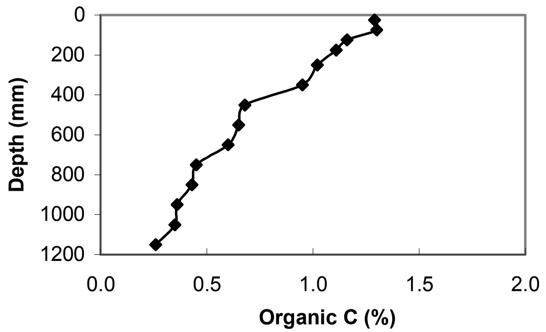


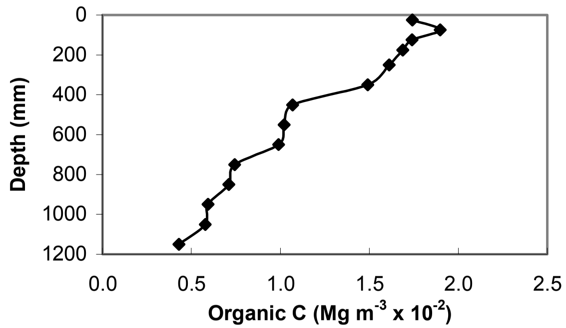


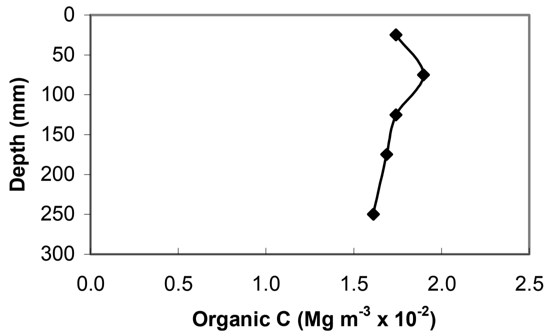
Klapmuts 1120 **253**

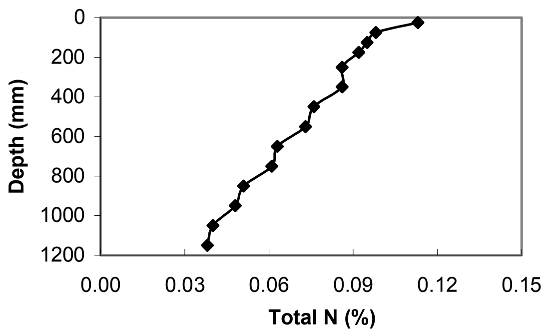
Horizon	Depth(mm)	Diagnostic horizon
A	0 - 400	Orthic A
E	400 - 900	E
B	900 - 1200	Pedocutanic B

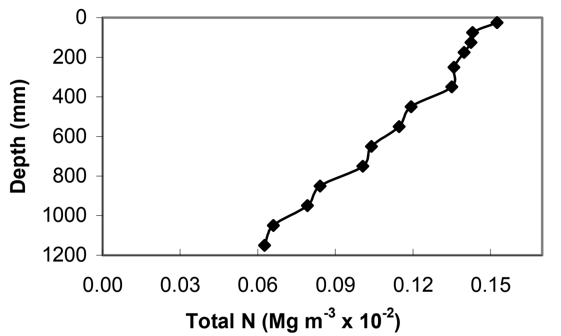


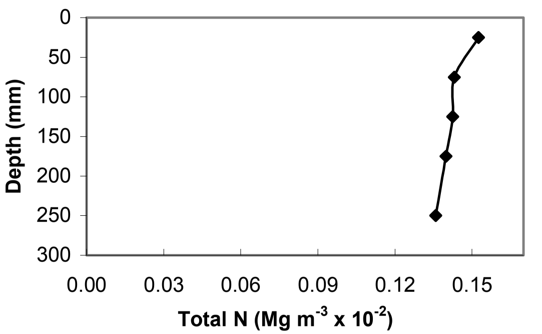












Hutton 2100 **254**

Horizon	Depth(mm)	Diagnostic horizon
A	0 - 600	Orthic A
B	600 - 1200	Red apedal B