

REPUBLIC OF NAMIBIA
**MINISTRY OF AGRICULTURE, WATER AND RURAL
DEVELOPMENT**

**TECHNICAL AND ECONOMIC FEASIBILITY STUDY OF THE
TANDJIESKOPPE IRRIGATION PROJECT**
PRELIMINARY REPORT

ANNEX - I
RECONNAISSANCE SOIL SURVEY

VOLUME - 2

PROFILE DESCRIPTION, LABORATORY ANALYSES AND MAPS

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RECONNAISSANCE SOIL SURVEY

SUMMARY

ANNEX I
RECONNAISSANCE SOIL SURVEY
SUMMARY

01. The reconnaissance soil survey of Tandjieskoppe Project covered an area of 55 976 hectares extending from Noordoewer settlement in the south to north of Aussenkehr settlement over a distance of 65 kilometers. It is encompassed between longitudes 17°:20' to 17°:42' E and latitudes 28°:15' to 28°:45' S between contour line 350 meters a.s.l. on the Namibian bank of Orange River excluding the cropped and presently under development areas.

02. The project area lies within a very dry and hot climate, too dry for rainfed agriculture; with an underlying geology of shales and mudstones over surface gravel and stones, scanty vegetation, low population density and limited infrastructure.

03. The soils are covered with gravel and stones on the surface as well as within the calcareous soil profiles. These soils have high pH values, high sand content, poor fertility, low available moisture holding capacity, high infiltration rates and subject to wind erosion.

04. Twelve soil mapping units with subdivisions of deep, shallow and very shallow soils were identified and classified according to the American and FAO systems. The land suitability classification was also modified to suit the project area local conditions. Suitability of some selected crops was assessed.

05. The survey identified the following areas with various soil kinds:

5978 ha (D) (10.68%): of deep soils (61 cm to 150+ cm) which were classified into nine mapping units.

3801 ha (S) (6.79%): of shallow soils (30 cm - 60 cm) which were classified into three mapping units (S1 to S3).

6487 ha (VS) (11.59%): of shallow soils (<30 cm) which were classified into two mapping units (VS1 and VS2).

39710 ha (M) (70.94%): of non-agricultural land (miscellaneous land types).

06. Land evaluation was made based on the results of the soil survey, topography, proximity to irrigation water source and other relevant factors prevailing in the surveyed area. The results of land evaluation were used to classify land into various classes according to their current suitability for irrigated production of high value tree and field crops which are proposed for the Project. Land of classes S1 (currently highly suitable land) and S2 (currently moderately suitable land) were not identified. The following land classes were identified:

Class S3; (2160 ha; 3.86% of the total land area).

This is currently marginally suitable land consisting of three land sub-classes according to the prevailing limitations in each sub-class. The subclasses and limitations are;

- ⇒ S3 mfp; with limitations of: moisture deficiency (m), low fertility (f) and adverse physical conditions particularly presence of gravel, stones and boulders (p). The area of this sub-class is 868 ha occurring in three adjacent locations close to Noordoewer settlement.
- ⇒ S3 mps; with limitations of moisture deficiency, adverse physical conditions and salinity (s). The area of this sub-class is 344 ha occurring in two adjacent locations about mid-way between Noordoewer and Aussenkehr Farm, designated the Tandjieskoppe location.
- ⇒ S3 mfa; with limitations of moisture deficiency, low fertility and sodicity (a). The area of this sub-class is 948 ha in one large location in Aussenkehr Farm.
- ⇒ All class S3 land has been selected for inclusion in the Project. It is proposed to carry out land improvement operations before any cropping takes place including removal of stones and boulders, addition of organic matter and leaching. These improvements would upgrade the land to Class S2; moderately suitable

Class N1: 7377 ha; (13.18% of the total land area).

This is currently unsuitable land and includes five locations of deep soils with a combined area of 3 576 ha. In addition all

shallow soils (S type); 3 801 ha; were assessed as N1. The major limitations leading to unsuitability of land are:

- ⇒ Sub-class N1 lmf; with severe limitations of distant location from the irrigation source (l), moisture deficiency and low fertility. This sub-class covers an area of 250 ha of deep soils.
- ⇒ Sub-class N1 tle; with severe limitations of topography (t), distant location from the irrigation source and subject to erosion (e). This sub-class is given to two locations of deep soils with a combined area of 1 538 ha.
- ⇒ Sub-class N1 lma; with limitations of distant location from the irrigation source, moisture deficiency and sodicity. This sub-class covers an area of 666 ha of deep soils.
- ⇒ Sub-class N1 kmp; with limitations of land tenure dispute (k), moisture deficiency and adverse physical conditions. The total area of this sub-class is 1 122 ha of deep soils.
- ⇒ Sub-class N1 ldm; with severe limitations of distant location from the irrigation source, shallow soil depth (d) and moisture deficiency. This sub-class includes all locations with shallow soils, (3 801 ha).

It should be borne in mind that class N1 land (currently unsuitable land) could be upgraded to Class S3 land (marginally suitable land) if ameliorated to substantially reduce the limitations. However, reduction of the severe limitations is usually very expensive and must be preceded by detailed technical and economic studies.

Class N2; (46 439 ha 82.96% of the total land area).

This is permanently unsuitable land usually designated “non-agricultural land” because of very severe limitations which render land permanently unsuitable for cropping. This class includes 242

ha of deep soils which are eroded and subject to uncontrollable wind erosion; 6 487 ha of very shallow soils and 39710 ha of miscellaneous land types- such as mountains, hills, rock outcrops and severely dissected terrain.

07. Accordingly only land currently of Class S3 designation is recommended for the Project; total area 2 160 ha.

Crop Suitability Rating:

08. Crop suitability (CS) is a rating of the different kinds of soils according to their suitability for the production of specific crops. Well suited soils are designated CS1, moderately suited soils are CS2, poorly suited soils are CS3 and unsuited soils are designated CS4. The crop suitability rating for the selected soils under the current condition of the land is:

- ⇒ S3 mfp (868 ha, Noordoewer location), have CS2 rating for all proposed crops.
- ⇒ S3 mps (344 ha, Tandjieskoppe location) have CS2 rating for all crops except tomatoes and onions which have CS3 rating.
- ⇒ S3 mfa (948 ha, Aussenkehr location) have CS2 rating for grapes, dates, mango, lucerne, sweet melon and sweet potato, and CS2-3 rating for tomatoes and onions.

09. After amelioration of soils, the land classification and crop suitability potentials would be raised as follows:

Land Classification Potential:

- ⇒ Mapping Unit D2 (S3 mfp); would be up-graded to sub-class S2 m.
- ⇒ Mapping Unit D3 (S3 mps); would be up-graded to S2 m.
- ⇒ Mapping unit D4 (S3 mfa); would be up-graded to S2 m.

Crop Suitability Potential:

- ⇒ Mapping Unit D2 (potential land class S2 m) would have a potential crop suitability rating of CS1 for all crops; (area 868 ha, Noordoewer State Irrigation Unit).
- ⇒ Mapping Unit D3 (potential land class S2 m) would have a potential crop suitability rating of CS1 for grapes, dates, mangoes, lucerne, sweet melon and sweet potatoes, and potential crop suitability rating CS2 for tomato and onion (area 344 ha, Tandjieskoppe State Irrigation Unit).
- ⇒ Mapping Unit D4 (potential land class S2 m) would have a potential crop suitability rating of CS1 for grapes, dates, mango, lucerne, sweet melon and sweet potato; and potential crop suitability rating of CS1-2 for tomato and onion (area 948 ha, Aussenkehr Irrigation Unit).

10. Likewise land suitability classification and crop suitability rating would be upgraded for class N1 (currently unsuitable land) if the main limitations of irrigation water accessibility, land tenure and topography are removed or reduced. The anticipated up-grading of Class N1 would be as follows:

<u>Mapping Unit</u>	<u>Area Ha</u>	<u>Classification Current State</u>	<u>Classification Potential State</u>
D1	250	N1 l m f	S3 l m
D21	372	N1 t m f	S3 t m
D31	1166	N1 t l e	S3 t l e
D41	666	N1 l m a	S3 l m
D5	1122	N1 k m p	S3 l m
S1	740	N1 l d m	S3 l d m
S2	2399	N1 l d m	S3 l d m
S3	662	N1 l d m	S3 l d m
Total	7377	-	-

11. Crop suitability rating would be CS3 for all crops for mapping units D1, D21, D31, D41 and D5. Mapping units S1, S2 and S3 would be unsuited for all tree crops and lucerne (CS4) and poorly suited (CS3) for all vegetable crops.

ANNEX I

RECONNAISSANCE SOIL SURVEY - THE TANDJIESKOPPE IRRIGATION PROJECT

VOLUME 2 - APPENDICES

INTRODUCTION

0.1 This volume contains the detailed technical information of the reconnaissance soil survey. Appendix I-II-1 includes profile descriptions which are portrayed according to international soil survey procedures and format.. Appendix I-II-2 contains the soil analysis results. Maps are contained in appendix I-II-3.

APPENDIX I-II-1

SOIL PROFILE DESCRIPTIONS

APPENDIX I – II – 1
SOIL PROFILE DESCRIPTIONS
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S2	T26, T32, T42, T48, T49, T52, T60, T71, T76	54
S3	T55	72
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Soil Profile Description

I. Information on the site:

- a) Profile number: T39
- b) Soil name: D1
- c) Classification: Soil Taxonomy: Typic Petrogypsid
FAO : Petric Gypsisol
- d) Location: 28:43:28 S
17:39:57 E
- e) Elevation: 270 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Flat.
 - 2. Land form of surrounding country: Some ridges.
- g) Slope on which profile is sited: 2%
- h) Vegetation and / or landuse: Common grasses

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Common to abundant gravel
and few to common stones.
- f) Evidence of erosion: None

III. Brief general description of the profile:

Relatively deep dark brown (moist) gritty loamy sands over yellowish brown sandy clay loam calcareous soils. Weathering rock at about 70 cm depth.

IV. Detailed description of the soil profile:

- 0-5 cm Dark brown (10YR 3/3) moist; gritty loamy coarse sand; single grains; loose moist, slightly sticky slightly plastic wet; slightly calcareous; clear smooth boundary; Sample No. T39-1.
- 5-20 cm Dark brown (10YR 3/3) moist; gritty loamy coarse sand; granular structure; loose dry, loose moist, slightly sticky slightly plastic wet; about 60% fine gravel; slightly calcareous; smooth abrupt boundary; Sample No. T39-2.
- 20-40 cm Dark yellowish brown (10YR 4/4) moist; sandy clay loam to clay loam; moderate fine subangular blocky; slightly hard dry, friable moist, sticky and plastic wet; about 20% shales; strongly calcareous; clear wavy boundary; Sample No. T39-3.
- 40-57 cm Dark grayish brown (10YR 4/2) moist; sandy loam to clay loam; fine and medium moderate subangular blocky; slightly hard dry, friable moist, slightly sticky, slightly plastic wet; strongly calcareous, very few secondary carbonates on gravel faces; smooth clear boundary; Sample No. T39-4.
- 57-70 cm Dark brown (7.5 YR 3/2) moist; petrogypsic horizon.
- 70+ cm Weathering rock.

Soil Profile Description

I. Information on the site:

- a) Profile number: T8
- b) Soil name: D2
- c) Classification: Soil Taxonomy: Fluventic Haplocambid
FAO: Fluvic Cambisol
- d) Location: 28:42:24 S 17:37:15 E
- e) Elevation: 180 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Flat.
 - 2. Land form of surrounding country: Flat, partly as air strip
- g) Slope on which profile is sited: 1%
- h) Vegetation and / or landuse: Abundant grasses.

II. General information on the soil:

- a) Parent material: Alluvial - colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Moist to a depth of 15 cm due to rain on previous day.
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Abundant gravel and very few stones.
- f) Evidence of erosion: None

III. Brief general description of the profile:

Flat deep dark grayish brown sandy loam with some gravel and few stones on surface and within the profile. Slightly calcareous at surface and strongly calcareous below. Next to Noordoewer air strip.

IV. Detailed description of the soil profile:

- 0-3 cm Dark yellowish brown (10YR 4/4) moist; gritty sandy texture; structureless; loose dry, loose moist, none sticky and none plastic wet; few to common medium and fine roots; slightly calcareous; diffuse boundary; Sample No. T8-1.
- 3-17 cm Dark yellowish brown (10YR 4.5/4) moist; sandy; structureless; loose dry, loose moist, none sticky and none plastic wet; few fine roots; strongly calcareous; gradual smooth boundary; Sample No. T8-2.
- 17-49 cm Dark yellowish brown (10YR 4.5/4) moist, sandy with few stones; weak fine subangular blocky; firm dry, friable moist, none sticky and none plastic wet; very few fine roots; very strongly calcareous; gradual smooth boundary; Sample No. T8-3.
- 49-79 cm Dark yellowish brown (10YR 4.5/4) moist; sandy with common stones; weak coarse subangular blocky; hard dry, friable moist, slightly sticky and slightly plastic wet; very strongly calcareous; gradual wavy boundary; Sample No. T8-4.
- 79-125+cm Dark yellowish brown (10YR 4.5/4) moist; sandy with common stones; hard dry, friable moist, slightly sticky and slightly plastic wet; very strongly calcareous; Sample No. T8-5.

Soil Profile Description

I. Information on the site:

- a) Profile number: T10
- b) Soil name: D2
- c) Classification: Soil Taxonomy = Fluventic Haplocambid
FAO = Fluvic Cambisol
- d) Location: 28:41:45 S
17:38:31E
- e) Elevation: 220 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Broad water course (bed).
 - 2. Land form of surrounding country: Gently sloping.
- g) Slope on which profile is sited: 2%
- h) Vegetation and / or landuse: Common green bushes.

II. General information on the soil:

- a) Parent material: Colluvial - alluvial.
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Common stones and few boulders on the surface.
- f) Evidence of erosion: None

III. Brief general description of the profile:

Deep brown to dark brown (moist) gritty sandy loam, none calcareous but with secondary carbonates on stones surfaces, common stones in the profile.

IV. Detailed description of the soil profile:

- 0-12 cm Brown to dark brown (10YR 4/3) moist; gritty coarse sandy loam with many gravel and nodules; weak platy with single grains and fine nodules and stones; loose dry, loose moist, none sticky and none plastic wet; none calcareous; clear smooth boundary; Sample No. T10-1.
- 12-42 cm Brown to dark brown (10YR 4/2) moist; platy tendency structure; gritty coarse sandy loam with common to many gravel and few stones; none sticky and none plastic; none calcareous but has secondary carbonates on stones surfaces; diffuse boundary; Sample No. T10-2.
- 42-65 cm Same colour and texture as above but stones are more; hard dry, friable moist none sticky and none plastic wet; none calcareous but contains secondary carbonates on stones surfaces; diffuse boundary; Sample No. T10-3.
- 65-88 cm Same colour and texture but no stones; firm dry, friable moist slightly sticky and slightly plastic; tendency to platiness; none calcareous; clear smooth boundary; Sample No. T10-4.
- 88-110 cm Same colour and texture with common stones, many gravel; massive; very hard dry, friable moist, slightly sticky and slightly plastic wet; none calcareous but with secondary carbonates on stones surfaces; Sample No. T10-5.

Soil Profile Description

I. Information on the site:

- a) Profile number: T11
- b) Soil name: D2
- c) Classification: Soil Taxonomy = Fluventic Haplocambid.
FAO = Fluvisol Cambisol
- d) Location: 28:41:26 S
17:38:53 E
- e) Elevation: 230 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Wide water coarse (bed).
 - 2. Land form of surrounding country: Sloping from mountains.
- g) Slope on which profile is sited: 2%
- h) Vegetation and / or landuse: Common green shrubs.

II. General information on the soil:

- a) Parent material: Colluvial - alluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table; Deep
- e) Presence of surface stones or rock outcrops: Abundant gravel and stones
and few boulders.
- f) Evidence of erosion: None

III. Brief general description of the profile:

Deep brown to dark brown (moist) coarse gritty loam, none calcareous, with many stones inside the profile.

IV. Detailed description of the soil profile:

- 0-13 cm Brown to dark brown (10YR 4/3) moist; coarse gritty loamy sand with many gravel; very weak fine subangular blocky; loose dry, loose moist, none sticky and none plastic wet; few to common medium roots; none calcareous; clear wavy boundary; Sample No. T11-1.
- 13-50 cm Same colour and texture as above but with few boulders and common to many stones; same consistence as above; none calcareous; clear smooth boundary; Sample No. T11-2.
- 50-85 cm Same colour, texture and consistence as above with stones more than 70% inside the profile; none calcareous; diffuse boundary; Sample No. T11-3.
- 85-135cm Same as above but with abundant stones; none calcareous; Sample No. T11-4.

Soil Profile Description

I. Information on the site:

- a) Profile number: T15
- b) Soil name: D2
- c) Classification: Soil Taxonomy = Fluventic Haplocambid
FAO = Fluvisol Cambisol
- d) Location: 28:41:27 S
17:35:54 E
- e) Elevation: 170 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Almost flat.
 - 2. Land form of surrounding country: Almost flat.
- g) Slope on which profile is sited: 1%
- h) Vegetation and / or landuse: Many green bushes.

II. General information on the soil:

- a) Parent material: Colluvial - alluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Common stones.
- f) Evidence of erosion: Small water channels.

III. Brief general description of the profile:

Deep brown over dark brown sandy soil with abundant gravel within the profile, slightly calcareous at surface and strongly calcareous below, platy tendency.

IV. Detailed description of the soil profile:

- 0-36 cm Dark brown (10YR 3/3) moist; gritty sandy texture; platy tendency and weak medium subangular blocky structure with many gravel and abundant shales fragments; loose dry, loose moist, none sticky and none plastic wet; common fine and few medium roots; calcareous matrix; clear wavy boundary; Sample No. T15-1.
- 36-64 cm Brown to dark brown (10YR 4/3) moist; sandy loam; platy tendency with abundant gravel (40%); firm dry, friable moist, sticky and plastic wet; strongly calcareous; diffuse boundary; Sample No. T15-2.
- 64-102 cm Brown to dark brown (10YR 4/3) moist; loamy fine sand; platy structure with abundant gravel (50%); hard dry, friable moist, slightly sticky and slightly plastic wet; strongly calcareous; clear smooth boundary; Sample No. T15-3.
- 102-130 cm Brown to dark brown (10YR 4/3) moist; gravelly loamy sand; massive with abundant gravel and common stones; hard dry, friable moist, none sticky and none plastic wet; strongly calcareous matrix; Sample No. T15-4.

Soil Profile Description

I. Information o the site:

- a) Profile number: T16
- b) Soil name: D2
- c) Classification: Soil Taxonomy : Fluventic Haplocambid
FAO : Fluvic Cambisol
- d) Location: 28:41:14 S
17:35:20 E
- e) Elevation: 185 m.a.s.l.
- f) Land form:
 - 1. .Physiographic position of site: Ridge
 - 2. Land form of surrounding country: Sloping with few ridges.
- g) Slope on which profile is sited: 3-4%
- h) Vegetation and / or landuse: Very few bushes.

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Abundant stones and gravel
and common boulders.
- f) Evidence of erosion: Small water channels

III. Brief general description of the profile:

Dark brown loamy sand with common gravel over dark yellowish brown loamy sand over stoney layer under which loamy sand layers with gravel occur.

IV. Detailed description of the soil profile:

- 0-7 cm Dark brown 7.5YR 3/2 moist; loamy sand with common gravel; weak fine subangular blocky parting into fine crumbs; slightly hard dry, very friable moist, slightly sticky and slightly plastic wet; strongly calcareous matrix, secondary carbonates on gravel surfaces; gradual smooth boundary;
- 7-22 cm Dark brown 7.5YR 3/2) moist; loamy sand with few gravel; same consistence as above; same calcareousness reaction; clear wavy boundary;
- 22-54 cm Dark yellowish brown 10YR 4/4 moist; loamy sand with abundant gravel, stones and consolidated shales plates, few boulders; strongly calcareous matrix with secondary carbonates;

Soil Profile Description

I. Information on the site:

- a) Profile number: T59
- b) Soil name: D2
- c) Classification: Soil Taxonomy: Fluventic Haplocambid
FAO : Fluvis Cambisol
- d) Location: 28:31:19 S
17:28:31E
- e) Elevation: 310 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Gently sloping
 - 2. Land form of surrounding country: Flat with small ridges of stones and boulders.
- g) Slope on which profile is sited: 2%
- h) Vegetation and / or landuse: Common grasses.

II. General information on the soil:

- a) Parent material: Colluvial - alluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Abundant gravel, common stones and few boulders on small ridges.
- f) Evidence of erosion: Small water channels.

III. Brief general description of the profile:

Deep dark brown (moist) gritty coarse sandy loam, calcareous, no secondary carbonates, with few boulders and stones in the profile and abundant gravel on surface.

IV. Detailed description of the soil profile:

- 0-17 cm Dark brown (10YR 3/3) moist; gritty coarse sandy loam; weak fine subangular blocky with few stones (5%); loose dry, loose moist, none sticky and none plastic wet; slightly calcareous; few fine roots; clear smooth boundary; Sample No. T59-1.
- 17-35 cm Dark brown (10YR 3/3) moist; gritty coarse sandy loam; very weak fine subangular and angular blocky structure with few stones and boulders; loose, none sticky and none plastic wet; clear wavy boundary; Sample No. T59-2.
- 35-78 cm Brown to dark brown (10YR 4/3) moist; gritty coarse sandy loam; very weak coarse and medium subangular blocky parting into fine subangular blocky; very hard dry, firm moist, slightly sticky and slightly plastic wet; calcareous matrix, secondary carbonates on stones surfaces; diffuse boundary; Sample No. T59-3.
- 78-100 cm Brown to dark brown (10YR 4/3) moist; gritty coarse sandy loam; massive with few boulders and stones; hard dry, friable moist, slightly sticky and slightly plastic wet; strongly calcareous, secondary carbonates on stones surfaces; diffuse boundary; Sample No. T59-4.
- 100-125 cm Dark brown (10YR3/3) moist; gritty coarse sandy loam; massive, few boulders and stones; calcareous, secondary carbonates on stones surface; Sample No. T59-5.

Soil Profile Description

I. Information on the site:

- a) Profile number: T24
- b) Soil name: D3
- c) Classification: Soil Taxonomy: Typic Haplocalcid
FAO : Aridic Calcisol
- d) Location: 28:40:47 S
17:32:30 E
- e) Elevation: 240 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Sloping
 - 2. Land form of surrounding country: Sloping, small ridges.
- g) Slope on which profile is sited: 6%
- h) Vegetation and / or landuse: Common bushes.

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Common to many stones
- f) Evidence of erosion: Small water channels particularly between ridges

III. Brief general description of the profile:

Deep dark yellowish brown gravelly sandy soil, slightly calcareous at surface and very strongly calcareous below, resting on rock at 100 cm depth.

IV. Detailed description of the soil profile:

- 0-19 cm Dark yellowish brown (10YR 3/4) moist; gritty sandy and gravelly sandy texture; structureless; loose dry, loose moist, none sticky and none plastic wet; few medium and fine roots; slightly calcareous; clear wavy boundary; Sample No. T24-1.
- 19-38 cm Dark yellowish brown (10YR 4/4) moist; gravelly loamy sand; weak fine subangular blocky with about 15% gravels; firm dry, friable moist, slightly sticky and slightly plastic wet; few fine and medium roots; very strongly calcareous; diffuse boundary; Sample No. T24-2.
- 38-63 cm Dark yellowish brown (10YR 4/4) moist; gravelly loamy sand; weak fine subangular blocky with about 25% gravel; firm dry, friable moist, slightly sticky and slightly plastic wet; very few medium roots; very strongly calcareous; diffuse boundary; Sample No. T24-3.
- 63-100 cm Dark yellowish brown (10YR 4/4) moist; gravelly loamy sand with about 25% gravel and stones; massive; very hard dry, friable moist, slightly sticky and slightly plastic wet, very strongly calcareous; clear smooth boundary; Sample No. T24-4.
- 100 cm Rock

Soil Profile Description

I. Information on the site:

- a) Profile number: T34
- b) Soil name: D3
- c) Classification: Taxonomy: Typic Haplocalcid
FAO: Aridic Calcisol
- d) Location: 28:40:21 S
17:30: 53 E
- e) Elevation: 203 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Sloping
 - 2. Land form of surrounding country: Sloping small stoney ridges.
- g) Slope on which profile is sited: 2%
- h) Vegetation and / or landuse: Common grasses.

II. General information on the soil:

- a) Parent material: Colluvial - alluvial
- b) Drainage: Well drained.
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Abundant gravel and many stones.
- f) Evidence of erosion: Small water channels.

III. Brief general description of the profile:

Relatively deep dark yellowish brown sandy soils over weathering shales at about 50 cm depth on consolidated stones on rock. Slightly calcareous at surface and strongly calcareous at subsoil.

IV. Detailed description of the soil profile:

- 0-9 cm Dark yellowish brown (10YR 3/4) moist; gritty sand; structureless; loose dry, loose moist, none sticky and none plastic wet; very few fine and medium roots; slightly calcareous; diffuse boundary; Sample No. T34-1.
- 9-18 cm Dark yellowish brown (10YR 3 / 4) moist; gritty sand; coarse columnar and prismatic structure extending down through the weathering shales horizon and breaking into fine and medium strong subangular blocks; hard dry, friable moist, slightly sticky and slightly plastic wet; strongly calcareous; clear wavy boundary; Sample No. T34-2.
- 18-49 cm Dark yellowish brown (10YR 4/4) moist; loamy gritty sand with common weathering shales (40%); massive; very hard dry, very firm moist, sticky and plastic wet; strongly calcareous; diffuse boundary; Sample No. T34-3.
- 49-87 cm Weathering shales (95%)
- 87-96 cm Consolidated stones.
- 96 cm Rock

Soil Profile Description

I. Information on the site:

- a) Profile number: T78
- b) Soil name: D3
- c) Classification: Soil Taxonomy: Typic haplocalcid
FAO : Aridic Calcisol
- d) Location: 28:17:00 S
17:26:46 E
- e) Elevation: 304 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Bottom of sand dune
 - 2. Land form of surrounding country: Sand dunes.
- g) Slope on which profile is sited: 3-4%
- h) Vegetation and / or land use: Common shrubs and abundant grasses.

II. General information on the soil:

- a) Parent material: Aeolian
- b) Drainage: Perfectly drained.
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Very few stones.
- f) Evidence of erosion: Wind erosion.

III. Brief general description of the profile:

Deep dark grayish brown over olive brown coarse sandy soil, slightly calcareous at surface and very strongly calcareous below. Rock at about 97 cm depth.

IV. Detailed description of the soil profile:

- 0-26 cm Dark grayish brown (2.5Y 4/2) moist; coarse sand; structureless; (single grains); loose dry, loose moist, none sticky and none plastic wet; slightly calcareous; clear smooth boundary; Sample No. T78-1.
- 26-52 cm Dark grayish brown (2.5 Y 4/2) moist; coarse sand; weak platy tendency; loose dry, loose moist, none sticky and none plastic wet; very strongly calcareous; diffuse boundary; Sample No. T78-2.
- 52-75 cm Olive brown (2.5 Y4/4) moist; coarse sand; massive; hard dry, friable moist, none sticky and none plastic wet; very strongly calcareous; clear wavy boundary; Sample No. T78-3.
- 75-97 cm Olive brown (2.5Y4/4) moist; coarse sand; massive; hard dry, friable moist, none sticky and none plastic wet; very strongly calcareous; clear wavy boundary to rock; Sample No. T78-4.
- 97 cm Rock

Knoll

Soil Profile Description

I. Information on the site:

- a) Profile number: T79
- b) Soil name: D3
- c) Classification: Soil Taxonomy: Typic Haplocalcid
FAO : Aridic Calcisol
- d) Location: 28:16:00 S
17:25:41 E
- e) Elevation: 225 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Sloping
 - 2. Land form of surrounding country: Small ridges
- g) Slope on which profile is sited: 3-4%
- h) Vegetation and / or land use: Few small grasses and shrubs

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry.
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Few stones, common to many gravel
- f) Evidence of erosion: None

III. Brief general description of the profile:

Deep olive brown soil, extremely hard (cemented) dry, flaking and friable when moist. Slightly calcareous at surface and strongly calcareous at subsoil. Hard enough to be dug by pick-axe when dry.

IV. Detailed description of the soil profile:

0-18 cm Olive brown (2.5Y 4/4) moist; sandy loam; strong fine and medium subangular blocky structure; extremely hard dry, friable moist, none sticky and none plastic wet; slightly calcareous matrix; diffuse boundary,

18-40 cm Olive brown (2.5Y 4/4) moist; sandy loam; strong medium subangular blocky structure; extremely hard dry; friable moist; none sticky and none plastic wet; strongly calcareous matrix; diffuse boundary.

40-70 cm Olive brown (2.5Y 4/4) moist; same texture and structure and consistency as second horizon.

70-95 cm Olive brown (2.5Y 4/4) moist; sandy loam; massive; extremely hard dry, friable moist, none sticky and none plastic wet; strongly calcareous.

95 cm Consolidated stones.

Soil Profile Description

I. Information on the site:

- a) Profile number: T81
- b) Soil name: D3
- c) Classification: Soil Taxonomy: Typic Haplocalcid

FAO : Aridic Calcisol

- d) Location: 28:15:30 S
17:26:34 E

e) Elevation: m.a.s.l.

f) Land form:

- 1. Physiographic position of site: Ridge
- 2. Land form of surrounding country: Ridges and sand dunes

g) Slope on which profile is sited: 5%

h) Vegetation and / or land use: Common shrubs.

II. General information on the soil:

- a) Parent material: Colluvial - aeolian
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Common to many stones
- f) Evidence of erosion: None.

III. Brief general description of the profile:

Deep olive brown soil, extremely hard and cemented when dry, hardly breakable by pick-axe, when moist it flakes and becomes friable, surface slightly calcareous and subsurface layers strongly calcareous.

IV. Detailed description of the soil profile:

- 0-20 cm Olive brown (2.5Y4/4) moist; sandy loam; strong fine and medium subangular blocky structure; extremely hard dry, friable moist, none sticky and none plastic wet; slightly calcareous; smooth boundary.
- 20-57 cm Olive brown (2.5 Y 4/4) moist; sandy loam; massive; extremely hard dry, friable moist, none sticky and none plastic wet; strongly calcareous; diffuse boundary.
- 57-93 cm Same as second horizon.
- 93 cm Consolidated stones.

Soil Profile Description

I. Information on the site:

- a) Profile number: T51
- b) Soil name: D4
- c) Classification: Soil Taxonomy: Typic Torrifuvent
FAO : Aridic Fluvisol
- d) Location: 28:37:35 S
17:28:27 E
- e) Elevation: 305 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Gently sloping eastwards
 - 2. Land form of surrounding country: Almost flat.
- g) Slope on which profile is sited: 1-2%
- h) Vegetation and / or landuse: Abundant short and common tall grasses.

II. General information on the soil:

- a) Parent material: Colluvial - alluvial
- b) Drainage: Well drained.
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Few stones and gravel.
- f) Evidence of erosion: None.

III. Brief general description of the profile:

Deep light brown (7.5YR 6/4) moist, gritty coarse sandy loam over reddish heavy sandy loam, none calcareous at surface and strongly calcareous at lower horizons.

IV. Detailed description of the soil profile:

- 0-12 cm Light brown (7.5YR 6/4) dry, brown to dark brown (7.5YR 4/4) moist; gritty coarse sandy loam; structureless; loose dry, soft moist, slightly sticky and slightly plastic wet; common to many fine fragments; none calcareous matrix; common fine and few medium roots; animal pores; clear smooth boundary; Sample No. T51-1.
- 12-45 cm Reddish yellow (7.5YR 6/6) dry and dark brown to strong brown (7.5YR 4/5) moist; gritty heavy sandy loam; weak medium subangular blocky structure; few gravel and very few stones; very hard dry, friable moist, sticky and plastic wet; strongly calcareous matrix; very few fine roots; diffuse boundary; Sample No. T51-2.
- 45-140 cm Brown to strong brown (7.5YR 4/5) moist; heavy sandy loam; massive; common gravel and few stones; very hard dry, friable moist, sticky and plastic wet; strongly calcareous matrix, common to abundant calcium carbonate concretions; Sample No. T51-3.

Soil Profile Description

I. Information on the site:

- a) Profile number: T53
- b) Soil name: D4
- c) Classification: Soil Taxonomy: Typic Torrifuvent
FAO : Aridic Fluvisol
- d) Location: 28:34:00 S
17:28:00 E
- e) Elevation: 310 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Gently sloping towards east
 - 2. Land form of surrounding country: Flat.
- g) Slope on which profile is sited: 1%
- h) Vegetation and / or land use: Abundant to many short grasses

II. General information on the soil:

- a) Parent material: Colluvial-alluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops:
- f) Evidence of erosion: None.

III. Brief general description of the soil profile:

Deep brown to dark brown (75YR 4/4)moist gritty coarse sandy loam, none calcareous at surface and strongly calcareous at the subsoil layers.

IV. Detailed description of the soil profile:

- 0-24 cm Brown to dark brown (7.5YR 4/4) moist; gritty coarse sandy loam; weak coarse subangular blocky parting into weak granular structure; hard dry, friable moist, slightly sticky and slightly plastic wet; few to common medium roots; none calcareous matrix; gradual wavy boundary; Sample No.T53-1.
- 24-44 cm Brown to dark brown (7.5YR 4/4) moist; gritty sandy loam; very weak coarse subangular blocky structure; very hard dry, friable moist, slightly sticky and slightly plastic wet; very few fine roots; few gravel; strongly calcareous; diffuse boundary; Sample No. T53-2.
- 44-77 cm Brown to dark brown (7.5 YR 4/4) moist; gritty sandy loam; massive; common gravel and few stones; strongly calcareous, common calcium carbonate concretions; diffuse boundary; Sample No. T53-3.
- 77-150 cm Brown to dark brown (7.5YR 4/4) moist; gritty sandy loam, massive; strongly calcareous; common calcium carbonate concretions; Sample No T53-4.

Soil Profile Description

I. Information on the site:

- a) Profile number: T54
- b) Soil name: D4
- c) Classification: Soil Taxonomy: Typic Torrifuvent
FAO : Aridic Fluvisol
- d) Location: 28:34:00 S
17:28:00 E
- e) Elevation: 300 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Almost flat
 - 2. Land form of surrounding country: Mountains
- g) Slope on which profile is sited: 1%
- h) Vegetation and / or landuse: Common green bushes and dry grasses

II. General information on the soil:

- a) Parent material: Colluvial - alluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry.
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Abundant gravel.
- f) Evidence of erosion: None.

III. Brief general description of the soil profile:

Deep brown to dark brown (7.5YR 4/4)moist gritty loamy coarse sand throughout, none calcareous, gravel and stones within the profile.

IV. Detailed description of the soil profile:

- 0-15 cm Brown to dark brown (10YR 4/3) moist; gritty loamy coarse sand; single grains; loose dry, loose moist, none sticky and none plastic wet; none calcareous matrix; abrupt smooth boundary; Sample No. T54-1.
- 15-36 cm Brown to dark brown (10YR 4/3) moist; loamy coarse sand with abundant fragments (about 50%); very hard dry, friable moist, none sticky and none plastic wet; none calcareous matrix; abrupt smooth boundary; Sample No. T54-2.
- 36-57 cm Brown to dark brown (10YR 4/3) moist; loamy coarse sand with abundant fragments (about 90%) and few to common stones; none calcareous matrix; diffuse boundary; Sample No. T54-3.
- 57-130+ cm Brown to dark brown (10YR 4/3) moist; loamy coarse sand with few stones and common gravel alternating with soil layer; very hard dry, friable moist, none sticky and none plastic wet; none calcareous matrix; Sample No. T54-4.

Soil Profile Description

I. Information on the site:

- a) Profile number: T57
- b) Soil name: D4
- c) Classification: Soil Taxonomy: Typic Torrifuvent
FAO : Aridic Fluvisol
- d) Location: 28:31:05 S
17:26:49 E
- e) Elevation: 245 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Flat.
 - 2. Land form of surrounding country: Flat broad valley
- g) Slope on which profile is sited: 1%
- h) Vegetation and / or land use: Abundant grasses and common green shrubs

II. General information on the soil:

- a) Parent material: Alluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Few stones
- f) Evidence of erosion: Small water channels.

III. Brief general description of the profile:

Deep reddish brown (7.5YR 5/4) moist,. gritty loamy sand over yellowish red gravelly clay loam, slightly calcareous at top and strongly calcareous with accumulation of calcium carbonate concretions in subsoil layers.

IV. Detailed description of the soil profile:

- 0-8 cm Reddish brown (5YR 4/4) moist; gritty loamy sand; structureless; loose dry, loose moist, none sticky and none plastic wet; few fine and medium roots; slightly calcareous; diffuse boundary; Sample No. T57-1.
- 8-36 cm Reddish brown (5YR 4/4) moist; gritty loamy sand; weak to moderate fine subangular blocky; loose dry, friable moist, slightly sticky and slightly plastic wet; few fine roots; strongly calcareous matrix; clear smooth boundary; Sample No. T57-2.
- 36-58 cm Yellowish red (5YR 4/6) moist; gravelly clay loam with common gravel and few stones; massive; hard dry, friable moist, sticky and plastic wet; very strongly calcareous matrix with accumulation of white calcium carbonate concretions; diffuse boundary; Sample No. T57-3.
- 58-125+ cm Yellowish red (5YR 4/6) moist; gravelly clay loam; massive with common gravel and few stones; very hard dry, friable moist, sticky and plastic wet; very strongly calcareous matrix with accumulation of white calcium carbonate concretions; Sample No. T57-4.

Soil Profile Description

I. Information on the site:

- a) Profile number: T73
- b) Soil name: D4
- c) Classification: Soil Taxonomy: Typic Torrifuvent
FAO : Aridic Fluvisol
- d) Location: 28:36:38 S
17:28:15 E
- e) Elevation: 250 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Flat.
 - 2. Land form of surrounding country: Flat broad valley
- g) Slope on which profile is sited: 1%
- h) Vegetation and / or land use; Common green bushes, shrubs + abundant grasses.

II. General information on the soil:

- a) Parent material: Alluvial - Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Abundant stones.
- f) Evidence of erosion: Water channels.

III. Brief general description of the profile:

Deep brown to dark brown gritty sandy soil with abundant fine gravel, none calcareous at top and strongly calcareous below.

IV. Detailed description of the soil profile:

- 0-16 cm Brown to dark brown (7.5YR 4/4) moist; gritty sandy with few stones and common to abundant gravel; loose dry, loose moist, none sticky and none plastic wet; abundant fine and medium roots; none calcareous matrix; clear smooth boundary; Sample No. T73-1.
- 16-38 cm Brown to dark brown (7.5YR 4/4) moist; gritty sandy texture with abundant fine gravel; hard dry, friable moist, none sticky and none plastic wet; common fine and medium roots; none calcareous matrix; clear smooth boundary; Sample No. T73-2.
- 38-77 cm Brown to dark brown (7.5YR 4/4) moist; sandy loam with common stones (about 30%); very hard dry, friable moist, slightly sticky and slightly plastic wet; strongly calcareous matrix; secondary carbonates on stones surfaces; diffuse boundary; Sample No. T73-3.
- 77-119 cm Brown to dark brown (7.5YR 4/4) moist; sandy loam with gravel (about 40%); very hard dry, friable moist, slightly sticky and slightly plastic wet; strongly calcareous matrix; secondary carbonates on gravel surface; Sample No. T73-4.
- 119+ cm Consolidated stones

Soil Profile Description

I. Information on the site:

- a) Profile number: T68
- b) Soil name: D5
- c) Classification: Soil Taxonomy: Typic Haplocambid
FAO : Aridic Cambisol
- d) Location: 28:24:57 S
17:26:11 E
- e) Elevation: 180 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Gently sloping
 - 2. Land form of surrounding country: Flat, Government Mangoes orchard, Aussenkchr.
- g) Slope on which profile is sited: 2%
- h) Vegetation and / or land use: Mangoes trees

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Moderately well drained.
- c) Moisture conditions in the soil: Moist at 30 cm due to pivot irrigation
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Cleared
- f) Evidence of erosion: None.

III. Brief general description of the profile:

Deep dark brown (moist) gritty sandy soil over brown to dark brown gritty sandy with soapy feeling when moist, slightly calcareous throughout, few stones inside the profile.

IV. Detailed description of the soil profile:

- 0-7 cm Dark brown (10YR 3/3) moist; gritty sandy soil; fine crumby structure; loose dry, loose moist, none sticky and none plastic wet; few medium and fine roots; slightly calcareous matrix with secondary carbonates on the few gravel surfaces; clear smooth boundary; Sample No. 68-1.
- 7-37 cm Dark brown (10YR 3/3) moist; gritty sandy soil; weak subangular blocky structure; firm dry, friable moist, none sticky and none plastic wet; few to common gravel and few stones; slightly calcareous matrix with secondary carbonates on stone surfaces; clear wavy boundary; Sample No. 68-2.
- 37-65 cm Brown to dark brown (10YR 4/3) moist; gritty sandy soil with soapy feeling when moist; and about 10% stones; massive; very hard dry, firm moist, slightly sticky and slightly plastic wet; slightly calcareous with secondary carbonates on stones surfaces; clear irregular to wavy boundary; Sample No. T68-3.
- 65-90 cm Colours, texture, structure and consistence as horizon above; about 20% stones; same calcareous reactions as above; diffuse boundary; Sample No. T68-4.
- 90-130+ cm Same colour, texture, structure, consistence, calcareousness as horizons above; very few stones; Sample No. T68-5.

Soil Profile Description

I. Information on the site:

- a) Profile number: T69
- b) Soil name: D5
- c) Classification: Soil Taxonomy: Typic Haplocambid
FAO : Aridic Cambisol
- d) Location: 28:22:42 S
17:25:41 E
- e) Elevation: 145 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Gently sloping
 - 2. Land form of surrounding country: Gently sloping.
- g) Slope on which profile is sited: 2%
- h) Vegetation and / land use: Many small grasses and few bushes.

II. General information on the soil:

- a) Parent material: Alluvial - colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Abundant gravel and many stones.
- f) Evidence of erosion: None.

III. Brief general description of the profile:

Deep brown to dark brown (moist) sandy soil with gravel and few stones, throughout, moderately and strongly calcareous.

IV. Detailed description of the soil profile:

- 0-15 cm Brown to dark brown (10YR 4/3) moist; sandy soil with common to many gravel and stones (about 40%); structureless; loose dry, loose moist, none sticky and none plastic wet; few fine roots; moderately calcareous; clear wavy boundary; Sample No. T69-1.
- 15-67 cm Brown to dark brown (10YR 4/3) moist; sandy soil with few stones and some pockets of gravel; strong fine and medium subangular blocky structure; very hard dry, friable moist, none sticky and none plastic wet; strongly calcareous; diffuse boundary; Sample No. T69-2.
- 67-150+ cm Brown to dark brown (10YR 4/3) moist; sandy soil with few stones; strong fine and medium subangular blocky structure; very hard dry, firm moist, none sticky and none plastic wet; strongly calcareous; Sample No. T69-3 (67-100 cm) and T69-4 (100-150cm).

Soil Profile Description

I. Information on the site:

- a) Profile number: T70
- b) Soil name: D5
- c) Classification: Soil Taxonomy: Typic Haplocambid
FAO : Aridic Cambisol
- d) Location: 28:22:30 S
17:25:29 E
- e) Elevation: 145 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Sloping
 - 2. Land form of surrounding country: Small ridges, boulders and stones.
- g) Slope on which profile is sited: 3%
- h) Vegetation and / or landuse: Common to many small grasses

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage : Well drained.
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Abundant stones and gravel.
- f) Evidence of erosion: None.

III. Brief general description of the profile:

Deep dark brown (moist) over dark yellowish brown gritty sandy soil with gravel at the upper layers and stones below, strongly calcareous throughout.

IV. Detailed description of the soil profile:

- 0-10 cm Dark brown (10YR 3/3) moist; gritty sandy texture; weak fine subangular blocky structure; loose dry, loose moist, none sticky and none plastic wet; strongly calcareous; diffuse boundary;
- 10-28 cm Dark brown (10YR 3/3) moist; gritty sandy texture with few gravel and stones; weak fine and medium subangular blocky structure; firm dry, friable moist, none sticky and none plastic wet; strongly calcareous; diffuse boundary.
- 28-77 cm Dark yellowish brown (10YR 4/4) moist; gritty sandy soil with common gravel; weak fine subangular blocky structure; very hard dry, firm moist, slightly sticky and slightly plastic wet; strongly calcareous; clear smooth boundary.
- 77-137+ cm Dark yellowish brown (10YR 4/4) moist; gritty sandy soil with common stones; extremely hard dry, very firm moist, slightly sticky and slightly plastic wet; strongly calcareous matrix.

Soil Profile Description

I. Information on the site:

- a) Profile number: T74
- b) Soil name: D5
- c) Classification: Soil Taxonomy: Typic Haplocambid
FAO : Aridic Cambisol
- d) Location: 28:22:17 S
17:26:36 E
- e) Elevation: 218 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Sloping
 - 2. Land form of surrounding country: Gently sloping.
- g) Slope on which profile is sited: 4%
- h) Vegetation and / or land use: Common small dry grasses,

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Abundant gravel and common stones.
- f) Evidence of erosion: None.

III. Brief general description of the profile:

Deep dark brown (moist) sandy soil with common platy shales on gravel and stones gritty sandy layers, slightly to moderately calcareous, with secondary carbonates.

IV. Detailed description of the soil profile:

- 0-8 cm Dark brown (10YR 3/3) moist; sandy soil with common platy shales and gravel and stones; platy tendency; loose dry, loose moist, none sticky and none plastic wet; few medium roots; slightly to moderately calcareous and secondary carbonates; gradual wavy boundary; Sample No. T74-1.
- 8-53 cm Dark brown (10YR 3/3) moist; sandy soil with common gravel and few stones; structure and consistency as above; secondary carbonates; gradual smooth boundary; Sample No. T74-2.
- 53-97 cm Similar to horizon above except with abundant gravel and common stones; Sample No. T74-3.
- 97-120 cm Dark brown (10YR 3/3) moist; very gritty sandy texture with gravel and stones and secondary carbonates, Sample No. T74-4.

Soil Profile Description

I. Information on the site:

- a) Profile number: T75
- b) Soil name: D5
- c) Classification: Soil Taxonomy: Typic Haplocambid
FAO: Aridic Cambisol
- d) Location: 28:22:51 S
17:26:17 E
- e) Elevation: 180 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Sloping
 - 2. Land form of surrounding country: Small ridges with stones.
- g) Slope on which profile is sited: 4%
- h) Vegetation and / or land use: Very few dry shrubs.

II. General information on the soil:

- a) Parent material: Colluvial with signs of alluviation (alternating layers)
- b) Drainage: Well drained.
- c) Moisture conditions in the soil: Dry.
- d) Depth of ground water table: Deep.
- e) Presence of surface stones or rock outcrops: Dominant gravel and many stones.
- f) Evidence of erosion: None.

III. Brief general description of the profile:

Deep dark brown (moist) throughout, sandy soil with many gravel over loamy sand with gravel and very few boulders, none to slightly calcareous matrix.

IV. Detailed description of the soil profile:

- 0-16 cm Dark brown (10YR 3/3) moist; sandy soil with common to abundant (about 20%) gravel; structureless; loose dry, loose moist, none sticky and none plastic wet; none to slightly calcareous matrix; clear smooth boundary; Sample No. T75-1.
- 16-58 cm Dark brown (10YR 3/3) moist; sandy soil with abundant gravel (35%); structureless; hard dry, friable moist, none sticky and none plastic wet; slightly calcareous, with secondary carbonates on gravel surfaces; clear smooth boundary; Sample No. T75-2.
- 58-72 cm Dark brown (10YR 3/3) moist; sandy with very fine gravel; structureless; loose dry, loose moist, none sticky and none plastic wet; slightly calcareous with secondary carbonates on gravel surfaces; clear smooth boundary; Sample No. T75-3.
- 72-99 cm Dark brown (10YR 3.5/3) moist; loamy sand with common gravel (15%) and very few boulders; platy tendency; hard dry, friable moist, slightly sticky and slightly plastic wet; calcareous matrix with secondary carbonates; clear smooth boundary; Sample No. T75-4.
- 99-130 cm Dark brown (10YR 3.5/3) moist; loamy sand with common fine and medium gravel (5%); massive; slightly hard dry, friable moist, slightly sticky and slightly plastic wet; slightly calcareous with secondary carbonates; Sample No. T75-5.

Soil Profile Description

I. Information on the site:

- a) Profile number: T66
- b) Soil name: D6
- c) Classification: Soil Taxonomy: Typic Torripsamment

FAO : Calcaric Arenosol

- d) Location: 28:20:58 S
17:24:13 E

e) Elevation: 110 m.a.s.l.

f) Land form:

- 1. Physiographic position of site: Sloping
- 2. Land form of surrounding country: Sand dunes and mountains.

a) Slope on which profile is sited: 3%

b) Vegetation and / or land use: Bare

II. General information on the soil:

- a) Parent material: Aeolian
- b) Drainage: Perfectly drained.
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Common stones and abundant gravel.
- f) Evidence of erosion: Wind erosion.

III. Brief general description of the profile:

Deep brown to dark brown (moist) gritty loamy sand over strong brown very fine sand, none calcareous at surface and slightly then strongly calcareous with depth.

IV. Detailed description of the soil profile:

- 0-24 cm Brown to dark brown (7.5YR 4/4) moist; gritty loamy coarse sand; platy tendency on whitish thin layer of soil; hard dry, loose moist, none sticky and none plastic wet; none calcareous matrix; slightly calcareous on shales surfaces (secondary carbonates); very few medium and fine roots; clear wavy boundary; Sample No. T66-1.
- 24-59 cm Brown to dark brown (7.5 YR 4/4) moist; loamy fine sand; (stones about 5%) structureless; loose dry, loose moist, slightly sticky and slightly plastic wet; few fine roots; slightly calcareous matrix, calcareous on stones surfaces (secondary carbonates); clear wavy boundary; Sample No. T66-2.
- 59-85 cm Strong brown (7.5YR 4/6) moist; very fine sand to loamy very fine sand; structureless; very hard dry, friable moist, sticky and plastic wet; a layer of platy - shaped fine sized stones and gravel at the bottom of the horizon; strongly calcareous matrix; Sample No. T66-3.
- 85-150+ cm Strong brown (7.5YR 4/6) moist; very fine sand with few stones; structureless; loose dry, loose moist, none sticky and none plastic wet; strongly calcareous matrix; Sample No. T66-4.

Soil Profile Description

I. Information on the site:

- a) Profile number: T67
- b) Soil name: D6
- c) Classification: Soil Taxonomy: Typic Torripsamment
FAO : Calcaric Arenosol
- d) Location: 28:20:16 S
17:23:38 E
- e) Elevation: 130 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Sloping
 - 2. Land form of surrounding country: Gravel and stones over-wash and sand dunes.
- g) Slope on which profile is sited: 4%
- h) Vegetation and / or landuse: Few shrubs and grasses.

II. General information on the soil :

- a) Parent material: Alluvial - colluvial
- b) Drainage: Perfectly drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Abundant gravel and common stones.
- f) Evidence of erosion: Severe wind erosion.

III. Brief general description of the profile:

Deep yellowish brown (moist) gravelly loamy sand over sandy loam over alternating layers, none calcareous at surface layer and strongly calcareous under layers.

IV. Detailed description of the soil profile:

- 0-40 cm Yellowish brown (10YR5/4) moist; gravelly loamy sand with gravel and stones (about 40%); structureless; loose dry, loose moist, slightly sticky and slightly plastic wet; none calcareous matrix but with secondary carbonates; clear smooth boundary; Sample No. T67-1.
- 40-73 cm Yellowish brown (10YR 5/4) moist; alternating layers of sandy loam and loamy sand with few gravel; structureless; strongly calcareous matrix; clear smooth boundary; Sample No. T67-2.
- 73-100 cm Yellowish brown (10YR 5/4) moist; alternating layers of loamy sand and sandy loam; structureless; strongly calcareous; clear wavy boundary; Sample No. T67-3.
- 100-120+cm Yellowish brown (10YR 5/4) moist; alternating layers as above but with few gravel; structureless; strongly calcareous; Sample No. T67-4.

Soil Profile Description

I. Information on the site:

- a) Profile number: T19
- b) Soil name: S1
- c) Classification: Soil Taxonomy: Typic Haplocalcid
FAO : Aridic Calcisol
- d) Location: 28:39:24 S
17:40:06 E
- e) Elevation: 400 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Near small ridge
 - 2. Land form of surrounding country: Small ridges
- g) Slope on which profile is sited: 5%
- h) Vegetation and / or land use: Common grasses and small shrubs

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Common gravel and stones
- f) Evidence of erosion: None.

III. Brief general description of the profile:

Shallow dark grayish brown (moist) sandy loam with fine shales, slightly calcareous surface and strongly calcareous subsoil over rock at about 49 cm depth.

IV. Detailed description of the soil profile:

- 0-27 cm Dark grayish brown (10YR 4/2) moist; coarse sandy loam with fine shales; very weak subangular blocky structure; loose dry, loose moist, slightly sticky and slightly plastic wet; few medium roots; slightly calcareous matrix; clear wavy boundary; Sample No. T19-1.
- 27-49 cm Dark grayish brown (10YR 4/2) moist; coarse sandy loam with fine shales; moderate to strong medium and fine subangular blocks; very hard dry, friable moist, sticky and plastic wet; strongly calcareous on shales surfaces; Sample No. T19-2.
- 49 cm Rock.

Soil Profile Description

I. Information on the site:

- a) Profile number: T22
- b) Soil name: S1
- c) Classification: Soil Taxonomy: Typic Haplocalcid

FAO : Aridic Calcisol

- d) Location: 28:38:43 S
 17:39:21 E
- e) Elevation: 315 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Sloping, near small ridges
 - 2. Land form of surrounding country: Sloping
- g) Slope on which profile is sited: 4%
- h) Vegetation and / or land use: Few grasses

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Many stones and gravel, within area of ridges of different sizes and lengths.
- f) Evidence of erosion: None.

III. Brief general description of the profile:

Shallow dark grayish brown (moist) sandy loam with few gravel and stones in the profile, slightly calcareous surface soil and strongly calcareous subsoil.

IV. Detailed description of the soil profile:

- 0-15 cm Dark grayish brown (10YR 4/2) moist; sandy loam with few gravel; weak medium subangular blocky structure; hard dry, friable moist, slightly sticky and slightly plastic wet; few medium roots; slightly calcareous matrix; gradual wavy boundary; Sample No. T22-1.
- 15-42 cm Dark grayish brown (10YR 4/2) moist; sandy loam with few stones and gravels; moderate medium and coarse subangular blocky structure; strongly calcareous matrix; clear smooth boundary to rock; Sample No. T22-2
- 42 cm Rock

Soil Profile Description

I. Information on the site:

- a) Profile number: T26
- b) Soil name: S2
- c) Classification: Soil Taxonomy: Typic Haplocambid
FAO : Aridic Cambisol
- d) Location: 28:40:57 S
 17:32:12 E
- e) Elevation: 218 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Sloping
 - 2. Land form of surrounding country: Small ridges
- g) Slope on which profile is sited: 4%
- h) Vegetation and / or land use: Few to common shrubs

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Many stones and abundant gravel.
- f) Evidence of erosion: Water channels (near mountains)

III. Brief general description of the profile:

Shallow dark yellowish brown soil, very strongly calcareous throughout with abundant shales at subsurface horizon which rests on consolidated stones at 55 cm depth.

IV. Detailed description of the soil profile:

0-24 cm Dark yellowish brown (10YR 3/4) moist; sandy loam with common gravel; weak fine and medium subangular blocky structure; firm dry, friable moist, slightly sticky and slightly plastic wet; strongly calcareous matrix; clear smooth boundary; Sample No. T26-1.

24-50 cm Dark yellowish brown (10YR 3/4) moist; gritty sandy texture with abundant weathering shales (90%); platy structure; loose dry, friable moist, slightly sticky and slightly plastic wet; strongly calcareous matrix; clear smooth boundary to consolidated stones; Sample No. T26-2.

50+ cm Consolidated stones.

Soil Profile Description

I. Information on the site:

- a) Profile number: T32
- b) Soil name: S2
- c) Classification: Soil Taxonomy: Typic Haplocambid
FAO : Aridic Cambisol
- d) Location: 28:40:18 S
17:31:15 E
- e) Elevation: 230 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Sloping
 - 2. Land form of surrounding country: Small ridges
- g) Slope on which profile is sited: 3%
- h) Vegetation and / or land use: Few small grasses.

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Abundant gravel and stones.
- f) Evidence of erosion: Small water channels between ridges.

III. Brief general description of the profile:

Shallow brown to dark brown (moist) throughout, gritty sandy loam over gravelly sandy loam with common gravel and stones, strongly calcareous throughout.

IV. Detailed description of the soil profile:

- 0-5 cm Brown to dark brown (7.5 YR 4/2) moist; gritty sandy loam with abundant gravel on surface; structureless; loose dry, loose moist, sticky and plastic wet; strongly calcareous matrix; secondary carbonates on gravel surfaces; clear smooth boundary; Sample No. T32-1.
- 5-15 cm Brown to dark brown (7.5 YR 4/2) moist; gritty sand loam, with few stones; coarse strong subangular blocks, in places large dry columnar structure extending to 35 cm depth; very hard dry, friable moist, sticky and plastic wet; strongly calcareous matrix; secondary carbonates; clear wavy boundary; Sample No. T32-2.
- 15-37 cm Brown to dark brown (7.5YR 4/3) moist; gravelly sandy loam with few stones; massive; very hard dry, friable moist, sticky and plastic wet; strongly calcareous matrix; secondary carbonates; clear wavy boundary; Sample No. T32-3.
- 37-58 cm Brown to dark brown (7.5YR 4/3) moist; gravelly sandy loam with common gravel and stones; massive; strongly calcareous; diffuse boundary; Sample No. T32-4.
- 58+ cm Consolidated stones.

Soil Profile Description

I. Information on the site:

- a) Profile number: T42
- b) Soil name: S2
- c) Classification: Soil Taxonomy: Typic Haplocambid
FAO : Aridic Cambisol
- d) Location: 28:41:36 S
17:39:58 E
- e) Elevation: 300 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Almost flat.
 - 2. Land form of surrounding country: Moderately sloping
- g) Slope on which profile is sited: 2%
- h) Vegetation and / or land use: Abundant tufted small grasses

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Abundant gravel, very few stones.
- f) Evidence of erosion: Small water channels.

III. Brief general description of the profile:

Shallow dark brown gritty loamy sand throughout with stones and gravel increasing with depth, slightly calcareous at surface increasing with depth also.

IV. Detailed description of the soil profile:

- 0-8 cm Dark brown (7.5 YR 3.5/4) moist; gritty loamy sand with abundant gravel on surface and few to common stones; structureless; loose dry, loose moist, none sticky and none plastic wet; few to common fine and medium roots; slightly calcareous matrix; secondary carbonates; clear smooth boundary; Sample No. T42-1.
- 8-21 cm Dark brown (7.5 YR 3.5/4) moist; gritty sandy loam with stones and gravel about 50%; structureless; few fine roots; slightly calcareous at the top of the horizon then strongly calcareous at its bottom, secondary carbonates on gravel and stone surfaces; clear wavy boundary; Sample No. T42-2.
- 21-48 cm Same colour, texture and structure as second horizon but stones are about 70%; strongly calcareous matrix; secondary carbonates on stone surfaces; diffuse boundary; Sample No. T42-3.
- 48+ cm Consolidated stones.

Soil Profile Description

I. Information on the site:

- a) Profile number: T48
- b) Soil name: S2
- c) Classification: Soil Taxonomy: Typic Haplocambid

FAO : Aridic Cambisol

- d) Location: 28:38:08 S
17:28:54 E
- e) Elevation: 240 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Flat.
 - 2. Land form of surrounding country: Flat with some ridges
- g) Slope on which profile is sited: 2%
- h) Vegetation and / or land use: Abundant short grasses.

II. General information on the soil:

- a) Parent material: Alluvial - Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Common stones and very small rocks.
- f) Evidence of erosion: None

III. Brief general description of the profile:

Shallow brown to dark brown gritty sand of weak subangular blocky structure over stratified platy shale fragments. Strongly calcareous over consolidated stones at 55 cm depth.

IV. Detailed description of the soil profile:

- 0-5 cm Brown to dark brown (10YR 4/3) moist; gritty sandy texture; weak fine subangular blocky structure with crumbs; loose dry, loose moist, slightly sticky and slightly plastic wet; common gravel; strongly calcareous; clear wavy boundary; Sample No. T48-1.
- 5-17 cm Brown to dark brown (10YR 4/3) moist; gritty loamy sand with stratified shales plates; slightly hard dry, firm moist, slightly sticky and slightly plastic wet; strongly calcareous, secondary carbonates on shales surfaces; clear wavy boundary; Sample No. T48-2.
- 17-26 cm Brown to dark brown (10YR 3/3) moist; sandy texture with about 40% stones; strongly calcareous matrix, secondary carbonates on stones and gravel surfaces,
- 26-55 cm Same as horizon above except that stones are abundant; clear smooth boundary to rock.
- 55+ cm Rock

Soil Profile Description

I. Information on the site:

- a) Profile number: T49
- b) Soil name: S2
- c) Classification: Soil Taxonomy: Typic Haplocambid
FAO : Aridic Cambisol
- d) Location: 28:38:32 S
17:29:08 E
- e) Elevation: 215 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Gently sloping
 - 2. Land form of surrounding country: Flat broad valley
- g) Slope on which profile is sited: About 2%
- h) Vegetation and / or land use: Common short grasses

II. General information on the soil:

- a) Parent material: Alluvial - Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Common stones
- f) Evidence of erosion: Somewhat water erosion.

III. Brief general description of the profile:

Shallow dark brown (moist) loamy sand over sandy clay loam over sandy loam over rock, moderately calcareous, few boulders inside the profile.

IV. Detailed description of the soil profile:

- 0-10 cm Dark brown (10YR 3/3) moist; loamy sand; structureless; loose dry, loose moist, none sticky and none plastic wet; moderately calcareous; clear smooth boundary; Sample No. T49-1.
- 10-50 cm Dark brown (10YR 3/3) moist; sandy clay loam; weak fine and medium subangular blocky structure; hard dry, friable moist, slightly sticky and slightly plastic wet; strongly calcareous matrix; clear smooth boundary; Sample No. T49-2.
- 50-70 cm Brown to dark brown (10YR 4/3) moist; sandy loam, few boulders; moderate medium subangular blocky structure; firm dry, friable moist, slightly sticky and slightly plastic wet; calcareous matrix; clear smooth boundary; Sample No. T49-3.

Soil Profile Description

I. Information on the site:

- a) Profile number: T52
- b) Soil name: S2
- c) Classification: Soil Taxonomy: Typic Haplocalcid
FAO : Aridic Calcisol
- d) Location: 28:39:00 S
17:31:06 E
- e) Elevation: 265 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Sloping
 - 2. Land form of surrounding country: Mountains eastwards, sloping land westwards.
- g) Slope on which profile is sited: 3%
- h) Vegetation and / or land use: Abundant grasses.

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Abundant gravel and common stones.
- f) Evidence of erosion: None

III. Brief general description of the profile:

Shallow brown to dark brown sandy loam throughout, slightly calcareous at surface and strongly calcareous below, with gravel inside the profile.

IV. Detailed description of the soil profile:

- 0-22 cm Brown to dark brown (10YR 4/3) moist; sandy loam with common gravel; weak medium subangular blocky structure; loose dry, loose moist, slightly sticky and slightly plastic wet; large pores; few calcium carbonate concretions; slightly calcareous matrix; smooth abrupt boundary; Sample No. T52-1.
- 22-40 cm Brown to dark brown (10YR 4/3) moist; coarse sandy loam with few gravel; very loose dry, very loose moist, slightly sticky and slightly plastic wet; few to common pores; few calcium carbonate concretions, strongly calcareous matrix; clear wavy boundary; Sample No. T52-2.
- 40-65 cm Brown to dark brown (10YR 4/3) moist; coarse sandy loam with common cm to many gravel; fine subangular blocky structure; hard dry, friable moist, slightly sticky and slightly plastic wet; strongly calcareous matrix; diffuse boundary; Sample No. T52-3.
- 65-140 cm Brown to dark brown (10YR 4/3); coarse sandy loam with 80% gravel; very hard dry, friable moist, slightly sticky and slightly plastic wet; few calcium carbonate concretions, strongly calcareous matrix; Sample No. T52-4.

Soil Profile Description

I. Information on the site:

- a) Profile number: T60
- b) Soil name: S2
- c) Classification: Soil Taxonomy: Typic Haplocambid
FAO : Aridic Cambisol
- d) Location: 28:30:10 S
17:28:30 E
- e) Elevation; 300 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Sloping
 - 2. Land form of surrounding country: Small stones and boulder ridges,
few rock outcrops.
- g) Slope on which profile is sited: 4%
- h) Vegetation and / or land use: Common green bushes.

II. General information on the soil:

- a) Parent material: Colluvial - alluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Abundant gravel and stones,
few boulders and rock outcrops.
- f) Evidence of erosion: Water channels.

III. Brief general description of the profile:

Shallow dark brown gritty coarse loamy sand over sandy loam with pockets of weathering rock, strongly calcareous.

IV. Detailed description of the soil profile:

- 0-12 cm Dark brown (10YR 3/3) moist; gritty coarse loamy sand with few gravel and stones; weak to moderate medium subangular blocky structure; loose dry, loose moist, slightly sticky and slightly plastic wet; strongly calcareous, secondary carbonates; diffuse boundary; Sample No. T60-1.
- 12-34 cm Dark brown (10YR 3/3) moist; gritty coarse loamy sand with common gravel and stones; weak to moderate medium subangular blocky structure; loose dry, loose moist, slightly sticky and slightly plastic wet; strongly calcareous, secondary carbonates; clear broken boundary; Sample No. T60-2.
- 34-55 cm Dark brown (10YR 3/3) moist; sandy loam with pockets of weathering rock (about 15%); massive; very hard dry, friable moist, sticky and plastic wet; slightly calcareous; Sample No. T60-3.

Soil Profile Description

I. Information on the site:

- a) Profile number: T71
- b) Soil name: S2
- c) Classification: Soil Taxonomy: Typic Haplocambid
FAO : Aridic Cambisol
- d) Location: 28:39:01 S
17:29:35 E
- e) Elevation: 238 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Sloping
 - 2. Land form of surrounding country: Almost flat with ridges
- g) Slope on which profile is sited: 2%
- h) Vegetation and / or land use: Very few shrubs

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Many to abundant stones
- f) Evidence of erosion: Small water channels.

III. Brief general description of the profile:

Shallow dark grayish brown gritty sandy loam with stones and gravel on gritty sand with many gravel, strongly calcareous throughout.

IV. Detailed description of the soil profile:

0-24 cm Dark grayish brown (10YR 4/3) moist; sandy loam with few stones and common gravel; platy tendency; hard dry, friable moist, slightly sticky and slightly plastic wet; few medium and fine roots; strongly calcareous matrix; Sample No. T71-1.

24-45 cm Dark grayish brown (10YR 4/3) moist; gritty sandy soil with many gravel; weak coarse subangular blocky structure; very hard dry, friable moist, none sticky and none plastic wet; strongly calcareous matrix; Sample No. T71-2.

45+ cm Consolidated stones with secondary carbonates on their surfaces.

Soil Profile Description

I. Information on the site:

- a) Profile number: T76
- b) Soil name: S2
- c) Classification: Soil Taxonomy: Typic Haplocambid
FAO : Aridic Cambisol
- d) Location: 28:18:08 S
17:25:53 E
- e) Elevation: 264 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Flat.
 - 2. Land form of surrounding country: Small ridges
- g) Slope on which profile is sited: 1%
- h) Vegetation and / or land use: Common shrubs and grasses.

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Many gravel.
- f) Evidence of erosion: Small water courses.

III. Brief general description of the profile:

Shallow olive brown throughout, fine sand over coarse sand, common gravel in the profile, slightly calcareous matrix.

IV. Detailed description of the soil profile:

- 0-12 cm Olive brown (2.5YR 4/4) moist; fine sandy soil with common gravel; weak platy structure; loose dry, loose moist, slightly sticky and slightly plastic wet; few fine and medium roots; slightly calcareous matrix; clear smooth boundary; Sample No. T76-1.
- 12-34 cm Olive brown (2.5YR 4/4) moist; coarse sandy soil with few to common gravel; platy tendency and weak subangular blocky structure; loose dry, loose moist, slightly sticky and slightly plastic wet; slightly calcareous; clear wavy boundary; Sample No. T76-2.
- 34-50 cm Olive brown (2.5YR 4/4) moist; coarse sandy soil; massive; very hard dry, firm moist, slightly sticky and slightly plastic wet; slightly calcareous; clear smooth boundary to rock; Sample No. T76-3.
- 50+cm Rock

Soil Profile Description

I. Information on the site:

- a) Profile number: T55
- b) Soil Name: S3
- c) Classification: Soil Taxonomy: Lithic Torriorthent
FAO : Aridic Leptosol
- d) Location: 28:33:35 S
17:28:50 E
- e) Elevation: 295 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Almost flat.
 - 2. Land form of surrounding country: Boulders and stones
- g) Slope on which profile is sited: 2%
- h) Vegetation and / or land use: Few bushes

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry.
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Abundant gravel and stones
and common boulders.
- f) Evidence of erosion: None.

III. Brief general description of the profile:

Shallow yellowish brown (moist) gritty sandy loam with abundant gravel throughout, strongly calcareous over consolidated stones at 50 cm depth.

IV. Detailed description of the soil profile:

- 0-24 cm Light brown (10YR 4.5/4) moist; gritty sandy loam with abundant gravel (70%); weak fine subangular blocky structure; hard dry, friable moist, slightly sticky and slightly plastic wet; strongly calcareous; gradual wavy boundary; Sample No. T55-1.
- 24-50 cm Light brown (10YR 4.5/4) moist; gritty sandy loam with abundant gravel (more than 70%); massive; strongly calcareous; weathering shales resting on consolidated stones.
- 50+ cm Consolidated stones.

Soil Profile Description

I. Information on the site:

- a) Profile number: T2
- b) Soil name: VS1
- c) Classification: Soil Taxonomy: Fluventic Torriorthent
FAO : Aridic Leptosol
- d) Location: 28:43:08 S
17:38:48 E
- e) Elevation: 225 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Gently sloping
 - 2. Land form of surrounding country: Flat with flat stoney ridges.
- g) Slope on which profile is sited; 1%
- h) Vegetation and / or land use: Few to common shrubs and grasses

II. General information on the soil:

- a) Parent material: Colluvial - alluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Common stones.
- f) Evidence of erosion: None.

III. Brief general description of the profile:

Very shallow dark yellowish brown (moist) strongly calcareous gravelly sandy loam throughout over consolidated stones at 28 cm depth over sandy layer at 69 cm depth.

IV. Detailed description of the soil profile:

- 0-6 cm Dark yellowish brown (10YR 4/4) moist; gravelly sandy loam; strong fine subangular blocky structure; very hard dry, friable moist, slightly sticky and slightly plastic wet; few fine roots; strongly calcareous matrix; diffuse boundary; Sample No. T2-1.
- 6-28 cm Dark yellowish brown (10YR 4/4) moist; gravelly sandy loam with common stones (20%); very hard dry, friable moist, slightly sticky and slightly plastic wet; strongly calcareous matrix; diffuse boundary; Sample No. T2-2.
- 28-69 cm Consolidated stones.
- 69-93 cm Sandy layer with about 30% stones.
- 93+ cm Rock

Soil Profile Description

I. Information on the site:

- a) Profile number: T6
- b) Soil name: VS2
- c) Classification: Soil Taxonomy: Lithic Torriorthent

FAO : Aridic Leptosol

- d) Location: 28:42:00 S
17:39:03 E
- e) Elevation: 240 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Between ridge (2-3 high)
 - 2. Land form of surrounding country: Ridges
- g) Slope on which profile is sited: 2%
- h) Vegetation and / or land use: Few shrubs and grasses.

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Common gravel and stones and few boulders.
- f) Evidence of erosion: Fixed sandy hummocks around bushes.

III. Brief general description of the profile:

Very shallow soil (about 20 cm depth) with abundant shales, none calcareous matrix but secondary carbonate on shales surfaces.

IV. Detailed description of the soil profile:

0-20 cm Dark brown moist (10YR 3/3); sandy with more than 90% shale fragments; structureless (single grains); loose dry, loose moist, none sticky and none plastic wet; none calcareous matrix but strongly calcareous on shales surfaces (secondary carbonates); clear smooth boundary; Sample No. T6-1.

Soil Profile Description

I. Information on the site:

- a) Profile number: T7
- b) Soil name: VS2
- c) Classification: Soil Taxonomy: Lithic Torriorthent
FAO : Aridic Leptosol
- d) Location: 28:41:47 S
17:39:10 E
- e) Elevation: 260 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Sloping
 - 2. Land form of surrounding country: Few ridges
- g) Slope on which profile is sited: 2%
- h) Vegetation and / or land use: Few bushes and grasses.

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained.
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Many stones.
- f) Evidence of erosion: Fixed sand around small bushes between the ridges.

III. Brief general description of the profile:

Very shallow soils of sandy texture on shales and rock. None calcareous matrix but strongly calcareous shale surfaces (secondary carbonates).

IV. Detailed description of the soil profile:

0-16 cm 10YR 3/3 dark brown moist; gritty loamy sand; structureless; loose dry, ooze moist, slightly sticky and slightly plastic; none calcareous matrix but calcareous on surfaces of the gravel it contains; gradual wavy boundary; Sample No. T7-1.

16+ cm Shales on rock, strongly calcareous shales surfaces.

Soil Profile Description

I. Information on the site:

- a) Profile number: T37
- b) Soil name: VS2
- c) Classification: Soil Taxonomy: Lithic Torriorthent
FAO : Aridic Leptosol
- d) Location: 28:39:48 S
17:29:58 E
- e) Elevation: 220 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Gently sloping westwards
 - 2. Land form of surrounding country: Almost flat about 700 M to mountains
- g) Slope on which profile is sited: 1-2%
- h) Vegetation and / or landuse: Bare except for some small dry grasses

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained.
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Many stones and gravel (pavement).
- f) Evidence of erosion: Wind erosion.

III. Brief general description of the profile:

Light yellowish brown and dark yellowish brown very shallow loamy very fine sand of weak subangular blocky structure and very hard consistence when dry. Strongly calcareous matrix.

IV. Detailed description of the soil profile:

- 0-25 cm Light yellowish brown (10YR 6/4) dry and dark yellowish brown (10YR 4/4) moist; loamy fine sand; coarse weak subangular blocky parting into fine weak subangular blocks; very hard dry, friable moist, slightly sticky and slightly plastic wet; few gravel and very few stones; strongly calcareous matrix; clear wavy boundary;
- 25+ cm Gravel and few stones.

Soil Profile Description

I. Information on the site:

- a) Profile number: T47
- b) Soil name; VS2
- c) Classification: Soil Taxonomy: Lithic Torriorthent
FAO : Aridic Leptosol
- d) Location: 28:37:49 S
17:29:23 E
- e) Elevation: 250 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Almost flat.
 - 2. Land form of surrounding country: Ridges.
- g) Slope on which profile is sited: 1-2%
- h) Vegetation and / or landuse: Few small grasses.

II. General information on the soil:

- a) Parent material: Colluvial - in situ
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground watertable: Deep
- e) Presence of surface stones or rock outcrops: Common stones and boulders
neighbouring ridges.
- f) Evidence of erosion: None.

III. Brief general description of the profile:

Very shallow dark brown gritty sand of weak subangular blocky structure and loose consistence. None to slightly calcareous matrix but with secondary carbonates.

IV. Detailed description of soil profile:

0-20 cm Dark brown (10YR 3/3) moist; gritty sand; weak moderate subangular blocky; loose dry, loose moist none sticky and none plastic wet; fine platy shale fragments; slightly calcareous matrix but strongly calcareous shales surfaces; clear wavy boundary.

20-27cm Dark brown (10YR 3/3) moist; gritty sand with abundant shales; moderate medium subangular blocky; slightly calcareous matrix but strongly calcareous shales.

27 cm + Rock.

Soil Profile Description

I. Information on the site:

- a) Profile number: T61
- b) Soil name: VS2
- c) Classification: Soil Taxonomy: Lithic Torriorthent

FAO : Aridic Leptosol

- d) Location: 28:28:55 S
17:28:10 E
- e) Elevation: 305 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Flat.
 - 2. Land form of surrounding country: Flat with small ridges
- g) Slope on which profile is sited: 1-2%
- h) Vegetation and / or land use: Common grasses

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Common to many gravel and stones, few boulders.
- f) Evidence of erosion: None.

III. Brief general description of the profile:

Very shallow dark yellowish brown sandy loam with stones, slightly calcareous over strongly calcareous loam with weathering shales over weathering rock at 38 cm depth.

IV. Detailed description of the soil profile:

- 0-26 cm Dark yellowish brown (10YR 4/4) moist; sandy loam with few to common stones; weak fine subangular blocky structure; medium and fine roots; slightly calcareous matrix; secondary carbonates on stones surfaces; clear wavy boundary; Sample No. T61-1.
- 26-38 cm Dark yellowish brown (10YR 4/4) moist; loam with partially weathering shales (50%); platy tendency; strongly calcareous; clear wavy boundary to rock; Sample No. T61-2.
- 38+ cm Weathering rock.

Soil Profile Description

I. Information on the site:

- a) Profile number: T65
- b) Soil name: VS2
- c) Classification: Soil Taxonomy: Lithic Torriorthent
FAO : Aridic Leptosol
- d) Location: 28:27:59 S
17:27:55 E
- e) Elevation: 300 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Near ridges.
 - 2. Land form of surrounding country: Gently sloping, ridges and rock outcrops.
- g) Slope on which profile is sited: 2%
- h) Vegetation and / or land use: Common to many shrubs and grasses.

II. General information on the soil:

- a) Parent material: Colluvial
- b) Drainage: Well drained
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Few ridges and rock outcrops.
- f) Evidence of erosion: Small water channels.

III. Brief general description of the profile:

Very shallow dark brown sandy soil of moderate and fine subangular blocky structure with stones (few). None calcareous.

IV. Detailed description of the soil profile:

0-22 cm Dark brown (10YR 3/2) moist, sandy; weak moderate and fine subangular blocky structure with few stones; none calcareous matrix; gradual wavy boundary;

22+ cm Rock.

Soil Profile Description

I. Information on the site:

- a) Profile number; T80
- b) Soil name: VS2
- c) Classification: Soil Taxonomy: Lithic Torriorthent
FAO : Aridic Leptosol
- d) Location: 28:15:27 S
17:25:38 E
- e) Elevation: 220 m.a.s.l.
- f) Land form:
 - 1. Physiographic position of site: Sloping
 - 2. Land form of surrounding country: Ridges
- g) Slope on which profile is sited: 2-4%
- h) Vegetation and / or land use: Common to many grasses

II. General information on the soil:

- a) Parent material: Colluvial - in situ
- b) Drainage: Well drained.
- c) Moisture conditions in the soil: Dry
- d) Depth of ground water table: Deep
- e) Presence of surface stones or rock outcrops: Few to common stones, many gravel
- f) Evidence of erosion: Common sand dunes.

III. Brief general description of the profile:

Very shallow olive brown fine sand with common gravel, weak platy structure.
Loose dry and moist, slightly sticky, none to slightly calcareous.

IV. Detailed description of the soil profile:

0-20 cm Olive brown (2.5 Y 4/4) moist; fine sand with common gravel; structureless; loose dry and moist, none sticky and none plastic wet; slightly calcareous; clear smooth boundary.

20+ cm Rock

APPENDIX I-II-2
SOIL ANALYSIS RESULTS

APPENDIX I - II - 2
SOIL PROFILE DESCRIPTIONS
CONTENTS

Map Unit	Soil Profile No.	Page
D1	T39	90
D2	T1, T5, T8, T9, T10, T11, T12, T14, T15, T16, T17, T59	90
D3	T24, T25, T34, T78	94
D4	T51, T53, T54, T57, T73	95
D5	T68, T69, T74, T75	97
D6	T66, T67	98
S1	T19	99
S2	T22, T23, T26, T32, T42, T48, T49, T52, T60, T61, T71, T76	99
S3	T55	101
VS1	T2, T3, T4	101
VS2	T6, T7, T37, T47	102

Appendix I-II (1)

SOIL ANALYSES

Soil Mapping Unit	Sample No.	Depth (cm)	pH _w	EC _w μS/cm	ECe dS/m	Extractable cations (ppm)				Exchangeable cations (ppm)				CEC Cmol/kg	ESP	O.C %	N %	Texture			Estimated AWHC	
						P	K	Ca	Mg	Na	K	Ca	Mg					Na	Sand%	Silt %		Clay %
D1	T39-1	0-5	8.88	36	0.1	1.0	111	1600	20	45					0.16			93.0	1.9	5.1		
	T39-2	5-20	9.14	51	0.1	1.5	77	1800	16	62					0.14			94.7	1.0	4.3		
	T39-3	20-40	8.92	142	0.3	1.4	102	5290	26	120					0.12			68.6	10.6	20.8		
	T39-4	40-57	8.60	235	0.6	2.2	84	6360	24	126					0.22			69.7	10.8	19.5		
	T39-5	57-70	Petrogypsic horizon not analysed																			
D2	Average		8.89		0.28	1.5	94	3763	22	88					0.16			81.5	6.1	12.4		
	T1-1	0-7	9.25	119	0.3	0.7	100	1400	40	180					0.07			93.4	5.1	1.5		
	T1-2	7-20	9.44	190	0.5	0.4	160	4400	100	400					0.19			83.3	9.9	6.8		
	T1-3	20-46	9.45	186	0.5	0.7	80	2600	20	340					0.13			90.1	5.1	4.7		
	T1-4	46-73	8.86	858	2.1	0.9	20	2200	20	540					0.08			94.2	3.5	2.3		
	T1-5	73-107	8.54	1508	3.6	0.0	40	4800	80	880					0.08			85.2	6.1	8.7		
	T5-1	0-20	8.90	60	0.1	0.1	60	1200	40	40					0.07			97.5	1.4	1.1		
	T5-2	20-42	9.50	117	0.4	0.9	80	3400	60	520					0.10			79.0	7.2	13.9		
	T5-3	42-64	9.50	112	0.4	0.4	60	4080	40	141					0.06			82.6	7.4	10.0		
	T5-4	64-100	9.50	119	0.4	0.6	46	3760	40	149					0.05			87.7	4.9	7.3		

Note: Blank cells = Parameter not determined.

Appendix I-II -(2)

SOIL ANALYSES

Soil Mapping Unit	Sample No.	Depth (cm)	pH _w	EC _w μS/cm	ECe dS/m	Extractable cations (ppm)					Exchangeable cations (ppm)					CEC Cmol/kg	ESP	O.C %	N %	Texture			Estimated AWHC
						P	K	Ca	Mg	Na	K	Ca	Mg	Na	Sand%					Silt %	Clay %		
B2	T8-1	0-3	9.5	179	0.4	2.3	20	4200	80	460	0.08	25.95	0.58	1.92	7.9	24	0.05		89.7	10.6	0.0	7.0	
	T8-2	3-17	9.5	251	0.6	1.9	200	1800	60	400	0.48	11.98	0.25	1.70	7.4	23	0.08		90.3	7.4	2.3	8.3	
	T8-3	17-49	9.3	242	0.6	2.2	100	4600	80	420	0.32	30.94	0.64	1.77	11.6	15	0.06		82.4	9.7	7.9	18.3	
	T8-4	49-79	8.3	935	2.2	1.2	200	1000	40	280	0.54	7.19	0.35	1.07	6.6	16	0.05		88.5	8.2	3.4	10.6	
	T8-5	79-105	8.0	1165	2.8	1.0	40	1000	10	600	0.15	22.75	0.74	1.98	7.7	25	0.06		82.6	10.3	7.1	10.1	
	T9-1	0-6	8.7	59	0.1	1.1	120	1400	30	10							0.04		89.2	8.6	2.2		
	T9-2	6-33	8.9	72	0.2	1.8	100	1600	50	60							0.08		92.8	4.5	2.7		
	T9-3	33-58	8.9	81	0.2	1.1	120	1200	40	60							0.03		95.2	3.5	1.2		
	T9-4	58-83	8.7	111	0.3	0.5	120	1600	60	80							0.04		93.1	3.8	3.1		
	T9-5	83-125	9.4	74	0.2	0.4	100	1400	80	60							0.04		92.3	4.8	2.9		
	T10-1	0-12	9.04	74	0.2	2.1	152	2340	80	34	0.33	7.19	0.49	0.14	5.8	2	0.18		90.0	8.0	1.9	12.3	
	T10-2	12-42	9.06	107	0.3	1.1	162	2460	80	47	0.30	5.59	0.53	0.12	5.8	2	0.11		91.6	7.2	1.2	10.8	
	T10-3	42-65	9.27	107	0.3	0.9	106	1660	100	70	0.31	6.79	0.64	0.17	7.0	2	0.11		90.5	9.5	0.0	13.0	
	T10-4	65-88	9.31	91	0.2	0.6	92	1680	140	58	0.25	6.59	0.66	0.21	5.9	4	0.09		89.6	7.4	3.0	10.8	
	T10-5	88-110	9.50	89	0.2	0.5	98	1680	160	77	0.23	6.79	0.79	0.46	7.3	6	0.08		89.8	6.7	3.5	12.6	

Note: Blank cells = Parameter not determined.

Appendix I-II -(3)

SOIL ANALYSES

Soil Mapping Unit	Sample No.	Depth (cm)	pH _w	EC _w μS/cm	ECe dS/m	Extractable cations (ppm)					Exchangeable cations (ppm)					CEC Cmol/kg	ESP	O.C %	N %	Texture			Estimated AWHC
						P	K	Ca	Mg	Na	K	Ca	Mg	Na	Sand%					Silt %	Clay %		
D2	T11-1	0-13	9.13	66	0.2	1.6	108	1980	80	30							0.12			97.2	1.6	1.2	
	T11-2	13-50	9.43	68	0.2	1.1	126	1620	240	50							0.13			97.8	0.7	1.5	
	T11-4	50-85	9.37	68	0.2	1.8	109	1660	65	68							0.06			92.9	5.1	2.0	
	T11-4	85-113	9.31	99	0.2	1.5	99	1380	70	51							0.05			91.5	6.9	1.6	
	T12-1	0-4	9.14	45	0.1	1.4	100	1000	100	50							0.06			91.0	7.4	1.6	
	T12-2	4-20	9.30	76	0.2	0.9	200	1200	180	110							0.33			89.8	8.5	1.7	
	T12-3	20-43	9.52	309	0.7	1.1	260	4600	120	420							0.55			80.1	13.7	6.2	
	T12-4	43-69	8.36	1514	3.6	1.1	120	4200	160	610							0.05			75.5	20.0	3.9	
	T12-5	69-120	8.44	1620	3.6	0.2	100	2800	180	690							0.06			87.2	4.9	8.0	
	T14-1	0-6	9.15	66	0.2	1.8	220	2000	160	130							0.08			75.5	20.6	3.9	
	T14-2	6-41	9.54	78	0.2	0.8	140	2800	1140	150							0.04			90.3	6.4	3.3	
	T14-3	41-62	9.81	121	0.5	0.4	100	3200	10	200							0.08			91.6	6.3	2.1	
	T14-4	62-88	9.70	174	0.4	0.6	8	3600	10	310							0.04			86.6	8.9	4.5	
	T14-5	88-133	8.80	693	1.7	0.9	7	3000	10	400							0.04			84.5	13.0	2.5	

Note: Blank cells = Parameter not determined.

SOIL ANALYSES

Soil Mapping Unit	Sample No.	Depth (cm)	pH _w	EC _w μS/cm	ECe dS/m	Extractable cations (ppm)						Exchangeable cations (ppm)						CEC Cmol/kg	ESP	O.C %	N %	Texture			Estimated AWHC
						P	K	Ca	Mg	Na	K	Ca	Mg	Na	Sand%	Silt %	Clay %								
																						Na	Mg	Na	
D2	T15-1	0-36	9.52	179	0.4	2.3	20	4200	80	460	0.29	10.78	0.41	0.37	8.2	4	0.05		89.7	10.6	0.0	8.7			
	T15-2	36-64	9.51	251	0.6	1.9	200	1800	60	400	0.18	12.97	0.48	0.83	10.6	8	0.08		90.3	7.4	2.3	13.6			
	T15-3	64-102	9.32	242	0.6	2.2	100	4600	80	420	0.15	24.95	0.51	1.23	12.0	10	0.06		82.4	9.7	7.9	-			
	T15-4	102-150	8.34	935	2.2	1.2	200	1000	40	280	0.09	27.75	0.43	1.33	7.9	18	0.05		88.5	8.2	3.4	10.8			
	T16-1	0-7	8.2	469	1.1	2.0	920	5740	239	337							0.67		58.8	28.8	12.4				
	T16-2	7-22	8.69	1079	2.6	2.2	840	4730	119	880							0.14		74.5	17.4	8.2				
	T16-3	22-54	7.66	3160	7.6	0.9	74	7260	70	647							0.12		86.5	10.7	2.7				
	T17-1	0-12	8.94	56	0.1	1.7	118	1700	60	25							0.17		89.7	9.0	1.4				
	T17-2	12-27	9.14	65	0.2	1.2	110	1660	80	30							0.04		94.2	4.7	1.1				
	T17-3	27-48	9.42	69	0.2	0.4	114	2180	120	54							0.05		93.2	5.2	1.6				
	T17-4	48-97	9.32	66	0.2	1.5	108	1720	60	33							0.07		93.1	4.5	2.4				
	T17-5	97-135	9.41	57	0.1	1.2	62	1780	140	49							0.06		91.4	6.2	2.4	12.0			

Note: Blank cells = Parameter not determined.

Appendix I-II -(5)

SOIL ANALYSES

Soil Mapping Unit	Sample No.	Depth (cm)	pH _w	EC _w μS/cm	ECe DS/m	Extractable cations (ppm)					Exchangeable cations (ppm)					CEC Cmol/kg	ESP	O.C %	N %	Texture			Estimated AWHC
						P	K	Ca	Mg	Na	K	Ca	Mg	Na	Sand%					Silt %	Clay %		
D2	T59-1	0-17	8.96	132	0.3	0.1	154	1660	68	8	0.32	5.99	0.71	0.40	7.7	5	0.08		90.5	8.0	1.5	14.0	
	T59-2	17-35	9.21	43	0.1	0.6	156	1640	58	16	0.34	6.79	0.71	0.10	8.3	1	0.07		95.8	4.3	1.8	14.2	
	T59-3	35-76	9.32	103	0.2	0.0	139	3780	46	85	0.30	14.57	0.58	0.33	10.1	3	0.07		83.1	9.0	7.9		
	T59-4	76-100	9.34	138	0.3	0.4	104	3780	33	130	0.17	13.97	0.49	0.50	10.2	5	0.09		81.3	9.5	9.2		
	T59-5	100-125	9.37	136	0.3	0.0	114	3840	38	160	0.17	13.97	0.51	0.55	8.8	6	0.07		83.6	7.2	9.3		
	Average		9.11		0.84	1.1	138	2647	99	240	0.26	13.87	0.56	8.00			0.10		87.9	8.1	4.0	11.7	
D3	T24-1	0-19	9.91	82	0.2	1.4	112	2480	60	47	0.02	13.97	0.26	0.53	9.8	5	1.15		92.5	6.2	1.3	12.0	
	T24-2	19-38	9.69	102	0.2	1.0	66	3640	60	123	0.12	21.76	0.28	1.09	12.6	9	0.14		83.5	14.3	2.2	15.6	
	T24-3	38-63	9.80	186	0.4	1.3	55	4860	33	531	0.07	27.54	0.25	1.92	14.7	13	0.11		79.2	12.8	7.9		
	T24-4	63-100	9.34	714	1.7	2.2	36	960	40	340	0.04	32.53	0.23	3.10	11.5	27	0.09		83.9	8.7	7.3		
	T25-1	0-19	8.65	115	0.3	1.9	110	2720	60	37									88.0	9.0	2.2		
	T25-2	19-38	8.73	277	0.7	2.2	104	1190	40	113									72.0	16.4	11.3		
	T25-3	38-63	8.20	2140	5.1	1.4	52	10440	20	98									67.5	20.0	11.6		
	T25-4	63-100	8.08	2340	5.6	0.1	44	10980	40	153									83.1	13.6	3.3		

Note:

Blank cells = Parameter not determined.

Appendix I-II (6)

SOIL ANALYSES

Soil Mapping Unit	Sample No.	Depth (cm)	pH _w	EC _w μS/cm	ECe dS/m	Extractable cations (ppm)					Exchangeable cations (ppm)					CEC Cmol/kg	ESP	O.C. %	N %	Texture			Estimated AWHC
						P	K	Ca	Mg	Na	K	Ca	Mg	Na	Sand%					Silt %	Clay %		
D3	T34-1	0-9	9.45	65	0.16	1.5	135	1520	57	41									92.4	5.6	2.1		
	T34-2	9-18	9.39	76	0.18	1.4	141	1780	40	140									86.7	10.2	9.1		
	T34-3	18-49	8.65	780	1.90	1.1	146	4840	51	480									66.2	15.5	18.2		
	T78-1	0-26	8.72	44	0.10	2.2	18	1510	37	34									93.9	4.8	1.3		
	T78-2	26-52	9.28	96	0.20	1.5	125	2289	22	137									89.9	7.4	2.7		
	T78-3	52-75	9.51	141	0.30	0.7	84	2407	24	307									89.1	6.8	4.1		
	T78-4	75-97	9.47	105	0.30	1.2	84	1982	21	333									90.0	6.2	3.8		
	Average			9.12		1.16	1.4	87	3573	40	194	0.06	23.95	0.26	1.66				84.0	10.5	5.5	13.8	
	D4	T51-1	0-12	8.96	64	0.20	1.9	144	1800	62	32									87.4	10.7	1.9	
		T51-2	12-45	8.84	149	0.30	0.9	114	4840	60	101	0.12	5.99	0.12	0.10	5.3	1.9	0.09		69.6	21.6	8.6	
T51-3		45-140	8.88	701	1.70	1.2	69	4400	51	171									70.9	17.4	11.7		
	T53-1	0-24	9.10	76	0.20	1.2	180	1840	74	80									83.3	13.2	1.5		
	T53-2	24-44	9.11	682	1.60	1.6	97	4820	64	140									74.9	20.1	5.0		
	T53-3	44-77	8.60	1457	3.50	2.0	66	4880	59	300									70.3	22.9	6.8		
	T53-4	77-150	8.21	3160	7.60	1.4	68	6760	77	840									78.0	15.3	6.7		

Note: Blank cells = Parameter not determined.

SOIL ANALYSES

Soil Mapping Unit	Sample No.	Depth (cm)	pH _w	EC _w μ S/cm	ECe dS/m	Extractable cations (ppm)				Exchangeable cations (ppm)				O.C %	N %	Texture			Estimated AWHC
						P	K	Ca	Mg	Na	K	Ca	Mg			Na	Sand%	Silt %	
D4	T54-1	0-15	9.09	68	0.2	1.7	129	2080	48	84						94.7	4.7	6.7	
	T54-2	15-36	9.15	62	0.1	0.6	119	1860	51	52						93.3	4.9	1.8	
	T54-3	36-57	9.20	64	0.2	0.4	102	1680	65	50						92.7	2.8	4.5	
	T54-4	57-130	9.14	55	0.1	0.6	96	1480	71	64						91.7	2.7	5.6	
	T57-1	0-8	9.38	59	0.1	2.6	158	590	73	116					0.04	83.3	14.7	2.0	10.6
	T57-2	8-36	8.79	268	0.6	1.9	131	2643	48	125					0.03	80.7	15.4	3.9	8.6
	T57-3	36-58	8.35	1324	3.2	2.7	87	2874	60	286					0.02	69.4	20.5	10.0	8.8
	T57-4	58-125	7.95	3190	7.7	1.4	93	3587	79	1005					0.02	68.3	14.0	17.7	9.6
	T73-1	0-16	8.63	39	0.1	2.2	86	566	64	294					0.35	92.8	5.4	1.8	
	T73-2	16-38	9.14	39	0.1	1.5	91	367	67	4					0.08	92.8	5.0	2.2	
	T73-3	38-77	8.94	68	0.2	2.1	120	2879	86	24					0.24	70.0	14.4	15.7	
	T73-4	77-119	8.70	141	0.3	1.8	93	3186	66	61					0.10	64.0	16.5	19.5	
	Average			8.85			1.6	108	2796	64	202				0.15	80.5	12.5	7.0	9.4

Note:

Blank cells = Parameter not determined.

Appendix I-II -(8)

SOIL ANALYSES

Soil Mapping Unit	Sample No.	Depth (cm)	pH _w	EC _w μS/cm	ECe dS/m	Extractable cations (ppm)					Exchangeable cations (ppm)					CEC Cmol/kg	ESP	O.C %	N %	Texture			Estimated AWHC
						P	K	Ca	Mg	Na	K	Ca	Mg	Na	Sand%					Silt %	Clay %		
DS	T68-1	0-7	8.73	324	0.8	2.0	138	1794	41	173							0.22			89.0	6.8	4.2	
	T68-2	7-37	7.96	826	2.0	0.9	109	1865	40	245							0.22			86.0	7.8	6.2	
	T68-3	37-65	9.12	514	1.2	1.8	118	2431	68	446							0.30			53.6	44.1	2.4	
	T68-4	65-90	8.40	929	2.2	1.3	104	2313	76	528							0.12			73.9	7.1	19.0	
	T68-5	90-130	8.34	978	2.3	0.2	89	2124	85	604							0.06			72.5	8.0	19.5	
	T69-1	0-15	9.07	56	0.1	1.4	130	968	90	100							0.10			87.9	9.5	2.5	
	T69-2	15-67	9.47	621	1.5	1.2	97	2620	99	596							0.12			81.6	8.8	9.6	
	T69-3	67-100	8.82	1406	3.4	0.6	106	2502	132	1088							0.16			74.5	11.1	14.4	
	T69-4	100-150	8.75	1929	4.6	0.3	89	2148	132	1317							0.08			85.4	7.8	6.8	
	T74-1	0-8	9.11	46	0.1	1.3	131	1227	72	12							0.13			92.6	5.8	1.6	
	T74-2	8-53	9.21	81	0.2	1.1	138	2195	89	41							0.09			89.2	7.0	3.8	
	T74-3	53-97	9.29	60	0.1	0.6	77	2053	96	78							0.01			94.8	2.2	3.0	
	T74-4	97-120	9.45	81	0.2	0.7	51	2077	95	113							0.02			94.8	3.0	2.2	

Note: Blank cells = Parameter not determined.

Appendix I-II (9)

SOIL ANALYSES

Soil Mapping Unit	Sample No.	Depth (cm)	pH _w	EC _w μS/cm	ECe dS/m	Extractable cations (ppm)						Exchangeable cations (ppm)				CEC Cmol/kg	ESP	O.C %	N %	Texture			Estimated AWHC
						P	K	Ca	Mg	Na	Na	K	Ca	Mg	Na					Samd%	Silt %	Clay %	
D5	T75-1	0-16	8.93	58	0.1	2.0	139	1322	62	28						0.14			87.2	11.1	1.7		
	T75-2	16-58	9.09	72	0.2	1.1	123	1345	70	46						0.39			91.5	6.0	2.5		
	T75-3	58-72	8.93	138	0.3	1.1	92	991	66	73						0.52			93.7	4.6	1.6		
	T75-4	72-99	8.80	146	0.4	0.9	91	2148	90	94						0.10			87.2	7.7	5.1		
	T75-5	99-130	9.19	102	0.2	0.8	64	1274	89	97						0.05			93.8	3.8	2.7		
D6	Average		8.93		1.1	1.1	105	1855	83	316						0.16			85.0	9.0	6.0		
	T66-1	0-24	8.72	40	0.1	1.2	111	1392	118	68						0.12			85.5	13.0	1.5		
	T66-2	24-59	9.38	109	0.3	1.2	35	2030	86	178						0.16			85.3	14.6	0.1		
	T66-3	59-83	9.45	212	0.5	1.8	35	3587	110	412						0.13			83.8	9.5	6.8		
	T66-4	85-100	9.17	310	0.7	0.9	20	3210	80	320						0.20			90.5	7.2	2.3		
	T67-1	0-40	9.31	176	0.4	2.6	146	2242	65	290						0.16			53.1	45.2	1.6		
	T67-2	40-73	9.16	579	1.4	2.1	37	262	59	719						0.27			55.5	41.6	2.9		
	T67-3	73-100	9.05	567	1.4	1.5	17	2502	48	635						0.16			72.7	26.9	0.3		
	T67-4	100-120	8.68	101	0.2	7.5	157	2832	140	51						0.21			80.8	10.7	8.6		
	Average			9.12		0.63	2.4	70	2257	88	334						0.18			75.9	21.1	3.0	

Note: Blank cells = Parameter not determined.

Appendix I-II -(10)

SOIL ANALYSES

Soil Mapping Unit	Sample No.	Depth (cm)	pH _w	EC _w μS/cm	ECe dS/m	Extractable cations (ppm)					Exchangeable cations (ppm)					CEC Cmol/kg	ESP	O.C %	N %	Texture			Estimated AWHC
						P	K	Ca	Mg	Na	K	Ca	Mg	Na	Sand%					Silt %	Clay %		
S1	T19-1	0-27	9.23	86	0.2	1.3	136	2080	41	64						0.11			90.4	8.2	1.4		
	T19-2	27-49	9.61	144	0.3	1.0	107	4520	36	244						0.14			83.0	6.1	10.9		
S2	T22-1	0-15	9.48	136	0.3	0.4	165	2160	53	192						0.07			89.4	10.3	0.3		
	T22-2	15-42	9.48	132	0.3	0.0	118	4160	37	181						0.02			85.5	14.9	2.4		
	T23-1	0-16	9.08	71	0.2	1.4	140	2620	32	60						0.16			86.1	12.8	1.0		
	T23-2	16-32	9.34	114	0.3	0.3	100	3820	32	136						0.20			88.7	8.4	2.9		
	T26-1	0-24	9.05	411	1.0	2.0	125	4700	32	327	0.28	17.07	0.33	1.20	10.5	0.17			82.4	10.8	6.7		
	T26-2	24-35	8.00	5042	12.1	0.5	73	11900	36	2220	0.10	45.31	0.33	47.65	13.1	0.12			74.0	15.1	10.9		
	T32-1	0-5	9.27	187	0.4	1.5	121	4220	50	268						0.23			74.5	15.5	10.0		
	T32-2	5-15	9.24	146	0.4	1.4	150	3920	63	216						0.15			72.3	14.7	13.0		
	T32-3	15-37	9.35	177	0.4	1.7	83	3660	49	321						0.19			69.6	17.1	13.3		
	T32-4	37-58	9.37	242	0.6	1.5	50	3760	40	418						0.19			72.3	15.0	12.7		
T42-1	0-8	8.66	38	0.1	1.6	119	1160	53	26						0.09			91.1	7.7	1.1			
T42-2	8-21	9.01	52	0.1	1.2	96	1440	49	39						0.14			89.7	8.2	2.1			
T42-3	21-46	9.30	81	0.2	1.1	57	3100	46	112						0.14			88.9	7.2	3.9			

Note: Blank cells = Parameter not determined.

Appendix I-II -(11)

SOIL ANALYSES

Soil Mapping Unit	Sample No.	Depth (cm)	pH _w	EC _w μS/cm	ECe dS/m	Extractable cations (ppm)					Exchangeable cations (ppm)					O.C %	N %	Texture			Estimated AWHC
						P	K	Ca	Mg	Na	K	Ca	Mg	Na	Sand%			Silt %	Clay %		
SZ	T48-1	0-5	9.12	76	0.2	2.0	73	1840	41	77	0.32	8.98	0.54	0.11	8.2	1	0.18	38.2	9.6	2.2	15.2
	T48-2	5-17	9.41	115	0.3	1.8	78	2140	34	171	0.29	9.98	0.18	0.50	6.4	8	0.10	88.9	8.4	2.7	15.6
	T48-3	17-26	9.44	100	0.2	0.6	97	1920	32	124	0.20	10.58	0.28	0.37	6.9	5	0.11	92.8	5.5	1.6	12.9
	T48-4	26-55	9.29	67	0.2	0.5	159	2171	71	289	0.18	7.98	0.38	0.19	6.4	3	0.11	94.5	4.0	1.5	11.5
	T49-1	0-10	9.13	168	0.4	1.3	148	2260	40	148							0.15	89.2	5.0	5.8	
	T49-2	10-50	7.96	2059	4.9	0.9	88	4800	54	2152							0.11	70.4	5.5	24.1	
	T52-1	0-22	9.50	869	2.1	1.0	139	4440	93	560							0.23	74.3	18.7	7.0	
	T52-2	22-40	8.19	2730	6.6	0.3	64	4760	108	680							0.16	85.2	8.4	6.3	
	T60-1	0-12	9.45	205	0.5	1.6	204	2760	53	203							0.21	81.7	14.3	4.0	
	T60-2	12-34	9.54	91	0.2	0.0	160	2780	47	91							0.12	88.4	7.4	4.3	
	T60-3	34-55	9.26	227	0.5	0.3	63	2540	40	211							0.14	74.4	12.2	13.3	
	T61-1	0-26	9.09	80	0.2	1.2	251	2740	52	48							0.12	83.6	13.2	3.2	
	T61-2	26-58	9.36	220	0.5	3.1	800	4460	65	278							0.10	58.3	25.2	16.5	

Note: Blank cells = Parameter not determined.

SOIL ANALYSES

Soil Mapping Unit	Sample No.	Depth (cm)	pH _w	EC _w μS/cm	ECe dS/m	Extractable cations (ppm)					Exchangeable cations (ppm)					CEC Cmol/kg	ESP	O.C %	N %	Texture			Estimated AWHC
						P	K	Ca	Mg	Na	K	Ca	Mg	Na	Sand%					Silt %	Clay %		
S2	T71-1	0-24	8.81	164	0.4	1.6	183	3340	49	126							1.48			78.2	8.8		
	T71-2	24-45	9.38	117	0.3	1.0	124	2720	29	166							0.56			84.0	9.3		
	T76-1	0-12	9.25	71	0.2	1.7	189	1900	21	94							0.12			90.9	1.9		
	T76-2	12-34	9.31	69	0.7	1.2	176	2020	21	123							0.03			90.5	3.7		
	T76-3	34-50	9.42	111	0.3	1.2	138	2620	24	182							0.15			78.7	14.6		
	Average		9.15		1.13	1.2	146	3311	46	330	0.23	16.7	0.34	8.34			0.20			82.5	6.7	13.8	
S3	T55-1	0-24	9.29	157	0.4	2.4	579	6850	71	212							0.14			68.7	11.0		
	T55-2	24-47	8.40	1134	2.7	1.4	450	4520	36	516							0.10			81.6	10.4		
VS1	T2-1	0-6	9.69	136	0.3	1.5	171	1580	26	200	0.37	8.18	0.21	1.15			0.12			82.4	1.5	11.4	
	T2-2	6-28	9.32	221	0.5	1.4	165	4980	51	309	0.34	31.7	0.44	1.37			0.23			78.8	13.9		
	T2-4	69-93	9.34	224	0.5	0.5	36	1820	30	243	0.08	9.58	0.21	1.90			0.06			90.9	5.1	10.2	
	T3-1	0-18	7.82	2030	1.9	1.9	471	2770	36	122							0.21			63.0	22.5	12.9	
	T4-1	0-18	-	88	0.2	1.8	123	2160	30	65							0.17			91.4	4.6		
	Average		9.04		0.68	1.4	193	2662	35	188	0.26	16.49	0.29	1.47			0.16			81.3	9.5	6.5	11.5

Note: Blank cells = Parameter not determined.

SOIL ANALYSES

Soil Mapping Unit	Sample No.	Depth (cm)	pH _w	EC _w μS/cm	ECe dS/m	Extractable cations (ppm)					Exchangeable cations (ppm)					CEC Cmo/kg	ESP	O.C %	N %	Texture			Estimated AWHC
						P	K	Ca	Mg	Na	K	Ca	Mg	Na	Sand%					Silt %	Clay %		
VS2	T6-1	0-2	9.05	46	0.1	0.4	75	1520	11	149						0.08			96.7	2.2	1.1		
	T7-1	0-16	9.05	47	0.1	0.9	85	1740	16	22						0.07			93.7	5.9	.05		
	T37-1	0-25	8.91	1282	3.1	2.1	423	4500	111	-	0.83	18.56	1.09	56.00	10.1	0.31			66.7	23.4	9.9		
	T47-1	0-20	9.22	109	0.3	1.5	97	3220	28	155	0.36	15.17	0.40	0.60	11.0	5	0.16		77.5	13.0	9.4		
	T47-2	20-27	9.40	100	0.2	1.0	42	2940	24	244	0.16	13.97	0.36	0.93	10.6	9	0.19		76.3	12.2	11.5		
	Average		9.13		0.76	1.2	144	2784	38	143	0.45	15.9	0.62	19.18		0.16			82.2	11.3	6.4		

Note: Blank cells = Parameter not determined.

APPENDIX I-II-3

**SOIL MAPS
LAND CLASSIFICATION MAP**

**3Sheets
1Sheet**