GUIDELINES
for
SITE & SOIL DESCRIPTION
OF ESTUARINE TIDAL MUD FLATS AND MARSHES




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Introduction

After an initial period of fieldwork where knowledge specific about the Scheldt estuary were gained, adapted field guidelines for this environment were composed. These guidelines are based on the guidelines created for BioSoil an EU project wherein characterisation through Europe of forest soils was an essential task. The BioSoil Forest Soil Guideline was strongly inspired by the FAO 2006 guidelines for soil description. This means that these concise guidelines follow to the extent possible the international terminology applied in the fields of soil science.

More detail information about some parameters included in the field guidelines a further explained in following appendixes:

Appendix **A**: Parent material codes
Appendix **B**: Detailed definitions, rules and conventions on relevant master and sub-horizon symbols
Appendix **C**: Field recording forms
Appendix **D**: Database codes and forms

1. General site information, registration and location

1.1. Site name [PLOT]

The name of the site. Usually a topographical name e.g. nearest village, nature reserve etc. is taken over.
Example*:* Schor van Ouden Doel (SOD)

1.2. Observation number and total depth [P_NO; P_DEP]

The observation identification number. The observation may be a soil profile, an auger observation, a geomorphological observation point etc. The depth of the observation is provided in cm.
Example*:* Profile number [P12]; Auger observation [A7]; Kreek 3, transect observation 17 [K3T17]
Example: Profile depth [145 cm]

1.3. Date and time of field description (UN-ECE, 2004) [DATE; TIME]

The date of description is given as ddmmyy (6 digits). When field information are collected in an environment under tidal influence recording the time of description, and the most recent low and high tides, is recommended.
Example*:* 160504 (16 May 2004), 14:30

1.4. Author(s) [AUT]

The person(s) who perform(s) the field description is acknowledged here. If the person validating the data is different from the field person, his or her name should appear as well.

1.5. Site location (optional) [LOCA]

The site location included the location within administrative entities, such as region, province, municipality etc. A good description where the site is located enables an outsider to find the site based on the description alone. Use road maps, topographical maps etc. to achieve this, and link the description with permanent features such as permanent infrastructure, buildings, … as reference points.

1.6. Profile latitude-/ longitude coordinates [LAT; LONG]

The latitude and longitude coordinates of the observation is measured in degrees, minutes, seconds and centi-seconds. For soil profiles the centre of the front wall is taken as the reference point. For transects Global Positioning System (GPS) readings are performed at the begin and at the end.
For GPS readings, the reported results should not be more detailed than the GPS system enables. If GPS readings are not possible (e.g. below trees), the distance (in metres and centimetres) and direction (in degrees) from any fixed observation point in the neighbourhood is measured.
If using a GPS system the location of the observation is reported as:
Latitude geographic coordinates (+/- degrees, minutes, seconds, centi-seconds) [WGS84]
Longitude geographic coordinates (+/- degrees, minutes, seconds, centi-seconds) [WGS84]

Example*:*	Latitude:	51° 23´ 31´´ N ; is reported as +512331
	Longitude:	11° 52´ 40´´ E ; is reported as: +115240

2. Soil forming factors

2.1. Present weather conditions [WETH_PR]

Additional climatic data to be collected but not in the field are listed in chapter 4.1.
While describing the profile, consider the weather conditions and use following classes (after BBC weather):

PW01 sunny
PW02 partly cloudy
PW03 overcast
PW04 light rain
PW05 heavy rain
PW06 thunder
PW07 sleet [1)]
PW08 hail [2)]
PW09 snow
PW10 misty
PWX no data

[1)] Sleet refers to snow that has partially melted on its fall to the ground, due to surrounding air that is sufficiently warm to partially melt it while falling, but not warm enough to fully melt droplets into rain. Thus it refers to partially melted droplets, a mixture of snow and rain. It does not tend to form a layer on the ground, unless the ground has a temperature that is below freezing, when it can form a dangerous layer of invisible ice on surfaces known as 'black ice'. This similarly occurs when rain freezes upon contact with the ground (freezing rain) (http://en.wikipedia.org/).
[2)] Hail is a type of graupel, a form of precipitation, composed of spears or irregular lumps of ice. It occurs when supercooled water droplets (remaining in a liquid state despite being below the freezing point, 0 °C) in a storm cloud aggregates around some solid object, such as a dust particle or an already-forming hailstone. The water then freezes around the object. Depending on the wind patterns within the cloud, the hailstone may continue to circulate for some time, increasing in size. Eventually, the hailstone falls to the ground, when the updraft is no longer strong enough to support its weight (http://en.wikipedia.org/).

2.2. Landforms and topography

2.2.1. Meso-scale landform [LND_FRM]

On a meso scale the landscape position can be allocated within one of following categories.

ML10 Stream channel (stroomkanaal)
ML20 Tidal mud flat (slik)
  ML21 Tidal mud flat, lower part
  ML22 Tidal mud flat, central part
  ML23 Tidal mud flat, upper part
ML30 Transition tidal mud flat to marsh (pioneer vegetation)
ML40 Tidal marsh
  ML41 Tidal marsh, ridge (kreekrug)
  ML42 Tidal marsh, lower landscape position (komgronden)
  ML43 Tidal marsh, intermediate landscape position
  ML44 Tidal marsh, higher landscape position
ML50 Creeks and gullies (kreken en geulen)
  ML51 Main creek bank (hoofdkreekrand)
  ML52 Tributary creek bank (zijkreekrand)
  ML53 Creek stream bed (kreekbodem)

2.2.2. Slope position (after FAO, 2006) [TERR]

The position of the observation point on the slope is important. Not only has the slope position an influence on the external and internal drainage, but also the subsurface runoff is affected. A division is made between flat or almost flat (slopes of <2%) and more undulating terrains (slopes >2%):

Position in flat or almost flat terrain		**Position in undulating terrain**	
SP01	Higher part (rise)	**SP07**	Middle slope
SP02	Intermediate part	**SP08**	Lower slope (foot slope)
SP03	Lower part (and dip)	**SP09**	Toe slope
SP04	Bottom (drainage line)	**SP10**	Bottom (flat)
SP05	Crest (summit)	**SP11**	Complex

SP06	Upper slope (shoulder)	**SPX**	No data

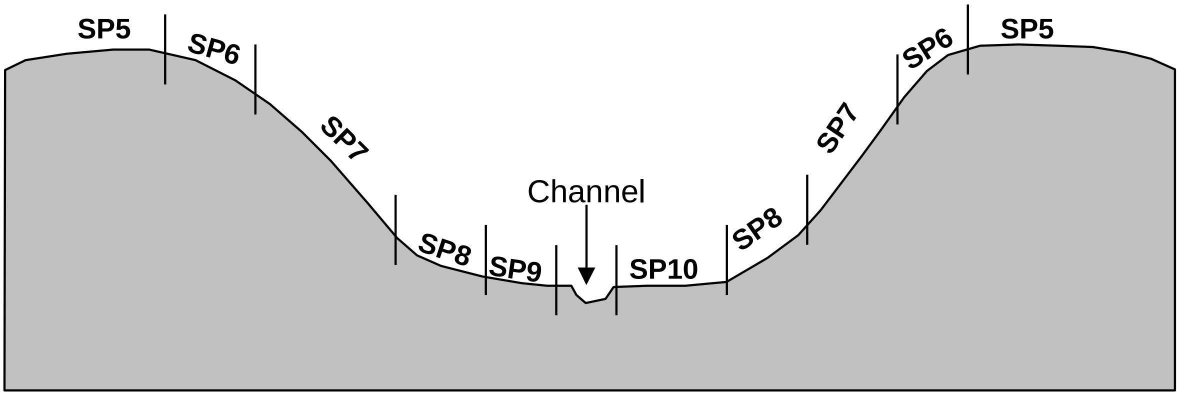


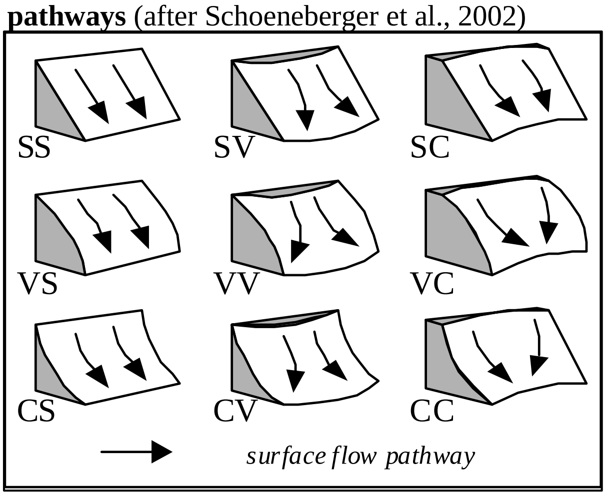
Figure 1: Slope positions in undulating and mountainous terrain (After Ruhe, 1975; Schoeneberger et al., 2002; FAO, 2006)

2.2.3. Slope form (after Schoeneberger et al., 2002; FAO, 2006) [SLP_FRM]

The shape of the slope is described in two directions, 1) up and down slope, which is perpendicular to the contour, and 2) across slope, which is along the horizontal contour. In figure 2 the slope classes are listed.

Figure 2: Slope forms and surface drainage pathways (after Schoeneberger et al., 2002)

SF01	SS	Straight, straight
SF02	SV	Straight, convex
SF03	SC	Straight, concave
SF04	VS	Convex, straight
SF05	VV	Convex, convex
SF06	VC	Convex, concave
SF07	CS	Concave, straight
SF08	CV	Concave, convex
SF09	CC	Concave, concave
SF10		Terraced
SF11		Slope dominated by drainage channels
SF12		Complex (irregular)
SFX		Not possible to determine



2.2.4. Slope gradient (Modified from FAO, 2006) [SLP_GRD]

The slope gradient in the immediate surrounding of the soil profile canbe measured using a clinometer, an abney level or a similar instrument. If field measurements are not possible, the gradient can be interpolated from contour lines on detailed topographical maps.

In practice, measuring slopes can be problematic especially if the slope gradient is very gentle because of the longer stretch necessary to make an accurate measurement. If the slope inclination is less than <2%, topographical map readings are recommended.

Slope gradient measured in degrees should be calculated into percent as well, knowing that 45° equals 100%. .

Code	Description	Sloping (%)	Sloping (°)
SG01	Flat	0 - 0.2 %	0-0.09°
SG02	Level	0.2 - 0.5 %	0.09-0.23°
SG03	Nearly level	0.5 - 1.0 %	0.23-0.45°
SG04	Very gently sloping	1.0 - 2 %	0.45-0.9°

SG05	Gently sloping	2 - 5 %	0.9-2.25°
SG06	Sloping	5 - 10 %	2.25-4.5°
SG07	Strongly sloping	10 - 15 %	4.5-6.75°
SG08	Moderately steep	15 - 30 %	6.75-13.5°
SG09	Steep	30 - 60 %	13.5-27°
SG10	Very steep	60 - 100 %	27-45°
SG11	Extremely steep	>100 %	>45°
SGX	Not known		

*2.2.5. **Slope length** (FAO, 2006)* ***[SLP_LGT]***

The slope length, particularly above the observation point, is recorded in meters.

*2.2.6. **Slope orientation** (UN-ECE, 2004)* ***[SLP_ORI]***

The slope orientation, from the observation point and upslope, is measured using a 360° compass. The exact figure is recorded as well as the orientation class:

N	North	338-23°
NE	North East	23-68°
E	East	68-113°
SE	South East	113-158°
S	South	158-203°
SW	South West	203-248°
W	West	248-293°
NW	North West	293-338°
F	Flat	
XX	Not known	

Example*:* The slope dips towards the profile in south-west direction (210°)

2.3. Tidal mud flat morphology

The general surface morphology, special surface morphology and more detailed aspects of the surface morphology are recorded. More than one code may apply.

Example*:* A tidal mud flat composes of regular current ripples covering most of the surface on the lower half and a smooth surfaced upper part. This complex is coded SM3: RM1, RB3; SM1.

2.3.1. Surface morphology ***[MUD_MOR]***

SM1	Smooth	The surface morphology lacks visible depressions, rill or ripple marks
SM2	Irregular	The surface is covered with small depressions
SM3	Rippled	Surface dominated with current ripples [stroomribbels]
SM4	Layered	Layers of different lithology and sensitivity to erosion results in a layered surface morphology
SM5	Complex	Mix of different surface characteristics

Depending on the surface morphology , additional information that can be collected, are:

Irregular: depth of depressions [DEP_D]

ID1	<5 cm
ID2	5-10 cm
ID3	10-20 cm
ID4	>20 cm

Irregular: Size (diameter) of depressions [DEP_SIZE]

IM1	>20 cm

IM2 20-50 cm
IM3 50-100 cm
IM4 100-200 cm
IM5 >200 cm

Current ripples: general morphology [RIP_MOR]
RM1 Homogeneous
RM2 Heterogeneous
RM3 Other

Current ripples: abundance (coverage of complete surface) [RIP_ABU]
RB1 <40%
RB2 40-80%
RB3 >80%

Current ripples: height [RIP_ELEV]
RH1 <1 cm
RH2 1-2 cm
RH3 2-5 cm
RH4 5-10 cm
RH5 >10 cm

Current ripples: wideness [RIP_WID]
RI1 <10 cm
RI2 10-20 cm
RI3 20-50 cm
RI4 >50 cm

Current ripples: length [RIP_LGT]
RL1 <5 cm
RL2 5-10 cm
RL3 10-20 cm
RL4 >20 cm

2.3.2. Micro cliffs

When on the tidal mud flat the substratum composes of layers of different texture and the tidal flat is subject for lateral water flow micro cliffs may develop (De Smedt, 1967, p. 64). The micro cliffs can be described concerning the height above the surrounding landscape and the positon on the tidal mud flat. The categories applying are:

Micro cliffs: height [MCLIF_ELEV]
CH1 <10 cm
CH2 10-20 cm
CH3 20-30 cm
Notice: If the cliff is higher than 30 cm it should be described as a cliff and not a micro cliff.

Micro cliffs: Location on the tidal mud flat [MCLIF_LOCA]
CL1 Lower part
CL2 Central part
CL3 Upper part

2.3.3. Drainage channels: rills and creeks [CRE_TYP]

On the tidal mud flat and tidal marsh a drainage pattern may develop. On the tidal mud flat, rills and creeks can develop, the difference is merely a question of dimensions. Categories to be considered in the field description of rills and creeks are defined with the help and inspiration of the work made by De Smedt (1967).

DM1 Rills, confined to the tidal mud flat
DM2 Creek primarily drains the tidal marsh and is a continuation of a tidal marsh creek. Morphologically they are typically deep incised and have steep banks
DM3 Creek only drains the tidal mud flat. The morphology of the creek depends on the length, the inclination and the textural composition of the tidal mud flat. Following subdivisions can be made:

Drainage channel form (in drainage direction): *[CRE_FRM]*
DF1 Straight
DF2 Meandering
DF3 Irregular

Drainage channel, transect form (perpendicular to the drainage direction) *[CRE_TOPO]*
DT1 Vertical
DT2 Sloping
DT3 Concave
DT4 Convex
DT5 Complex

Drainage channel, bedding (form of the bottom of the drainage channel) *[CRE_BED]*
DB1 Flat
DB2 V-shaped
DB3 U-shaped

Drainage channel, wideness [CRE_WID]

DW1	<2 cm	Rill
DW2	2-5 cm	Rill
DW 3	5-10 cm	Rill
DW 4	10-20 cm	Rill
DW 5	20-50 cm	Creek
DW 6	50-100 cm	Creek
DW 7	100-200 cm	Creek
DW 8	>200 cm	Creek
DW X	Data missing	

Drainage channel, mutual distance [CRE_DIS]
DD1 <0.2 m
DD2 0.2-0.5 m
DD3 0.5-2 m
DD4 2-5 m
DD5 5-10 m
DD6 10-25 m
DD7 25-50 m
DD8 >50 m
DDX No information

2.4. Tidal marsh Cliff

2.4.1. Height *[CLIF_ELEV]*

Measured from the footslope to the top of the cliff

CH4 30-50 cm
CH5 50-100 cm
CH6 100-150 cm
CH7 >150 cm
Notice: for cliff heights less than 30 cm, the cliff is described as a micro cliff

2.4.2. Gradient *[CLIF_SLP]*

Describe the general gradient of the cliff

CG1	<45°	Gentle to moderate steep
CG2	45-80°	Steep to very steep
CG3	>80°	Vertical

2.4.3. Cliff form *[CLIF_FRM]*

CF1	Straight	Cliff type 2 (De Smedt, 1967)
CF2	Convex	Cliff type 2 (De Smedt, 1967)
CF3	Concave	Cliff type 2 (De Smedt, 1967)
CF4	Incised	Cliff type 3 (De Smedt, 1967)
CF5	Irregular	
CF6	Stepwise	Cliff type 1 (De Smedt, 1967)
CF7	Other (define)	

Degree of incision *[CLIF_DEG]*

If the tidal marsh cliff is incised at the bottom part, the undermining of the vertical wall should be measured.

CODE	Degree of incision	Incision measured
CI1	Notable	0-10 cm
CI2	Small	10-25 cm
CI3	Moderate	25-50 cm
CI4	Strong	50-75 cm
CI5	Extreme	>75 cm

2.4.4. Tidal marsh cliff: coarse surface fragments *[CLIF_STO]*

Any obstacles at the foot and until a few meters from the marsh cliff should be described with respect to material type, surface cover and size. For surface cover apply the scale and codes presented in chapter 2.11.1 (Coarse surface fragments) and for size consult chapter 2.11.2.

CO0 None
CO1 Soil lumps with many roots, which forms a resistant bloc against erosion
CO2 Organic matter debris
CO3 Anthropogenic material either deliberately dumped (e.g. stones…) or deposited in function of the tidal cyclus
CO4 Others (explain)

2.5. Tidal Marsh

2.5.1. Vegetation *[MARSH_VEG]*

Dominant specie(s) are listed:

MV1 Reed (*Phragmites australis*)
MV2 Willow (*Salix*)
MV3 Grass
MV4 Other (define)

MV5 Bare ground, no vegetation

2.5.2. Thickness root layer *[THK_ROO]*

Measured from the surface of the soil to the lower depth of the bulk of the living roots. The erosion resistant part of the soil is what should be measured, not the maximum root depth.

TR1 <10 cm
TR2 10-20 cm
TR3 20-40 cm
TR4 40-80 cm
TR5 >80 cm

2.6. Land use (partly after Schoeneberger et al., 2002) [USE; WILDLIFE; GRAZING]

The current land use should be described according to following list:

LU10 Barren land; <5% vegetative cover naturally or from construction
- LU11 Culturally induced
- LU12 Quarries
- LU13 Salt flats
- LU14 Mud flats
- LU15 Gullies, rills etc.

LU20 Grass/herbaceous; >50% grass, grass-like, or forb cover, mosses, lichens, ferns, non-woddy
- LU21 Hay land
- LU22 Marshland
- LU23 Pastureland
- LU24 Rangeland, grassland
- LU25 Rangeland, shrubby
- LU26 Other grass & herbaceous cover

LU30 Shrub cover; >50% shrub canopy cover

LU40 Tree cover; >25% canopy cover by woody plants, natural or planted
- LU41 Coniferous: spruce, pine, fir, ….
- LU42 Deciduous: oak, elm, aspen, ….
- LU43 Intermixed deciduous and conifers
- LU44 Swamp: trees, shrubs
- LU45 Other tree cover

- Is hunting allowed?
  - (**Y/N/X;** where X stands for no information)
- Is grazing by domesticated animals (e.g. cattle, sheep…) practised?
  - (**Y/N/X**; where X stands for no information)

<u>Example</u>: LU22; Y; N; (Marshland; hunting is practised; no grazing by domesticated animals)

2.7. Human influence (modified from FAO, 2006) [HUM_DEG]

Any evidence of human activity, which is likely to have <u>affected the landscape</u> or the <u>physical and chemical properties of the soil</u> (not erosion) should be noticed. Below are the most common examples of human influences with their recommended codes listed. <u>One or more (if applicable) of these codes can be selected</u>, or additional codes can be defined to facilitate local needs. Observations on human impact achieved from the soil profile is reported in chapter 3.16 (Man Made Materials) and 3.17 (Human Transported materials). Here only observations observed in the landscape on meso and micro scale is recorded.

HI01 No influence
HI02 Vegetation disturbed (not specified)
HI03 Vegetation slightly disturbed
HI04 Vegetation moderately disturbed
HI05 Vegetation strongly disturbed

2.7.1. Type of human influence *[HUM_TYP]*

HI07 Sand additions
HI08 Organic additions (not specified)
HI09 Ploughing (not specified)
HI13 Traces of spade marks
HI17 Land fill
HI18 Levelling
HI19 Artificial drainage
HI21 Clearing
HI23 Surface compaction
HI24 Traffic traces
HI26 Pollution
HI27 Dike boulders (breukstenen)
HI28 Quarries (for e.g. dike construction)
HI29 Remains of old dikes
HI30 Others (explain)

2.8. Parent material (originating from SG-DBEM, 2003) [PAR_MAT]

The parent material is the material from which the soil has been derived. There are two groups of parent material: either unlithified materials (mostly sediments), or weathering materials overlying the hard rock from which they originate. There are also restored natural soil materials or sediments as well as man-made (technogenic) materials.
The detailed table on parent material applied by the Soil Geographical Data Base (SG-DBEM, 2003) is presented in appendix A. The parent material should be described at least on the major class level. The 9 major classes summarised below are not listed hierarchically:

Code	**Major Class level**
0000	No information
5000	Unconsolidated deposits (alluvium, weathering residuum and slope deposits)
7000	Aeolian deposits
8000	Organic materials
9000	Anthropogenic deposits

2.9. Natural Drainage Classes (Soil Survey Staff, 1993) [DRA_CLAS]

Soil drainage is usually reflected by soil colour, but relict features may persist after natural or artificial changes in drainage. The depth of occurrence and intensity of gley features usually indicate the drainage status of the soil but not always: some soil materials will not develop strong features of gleying because of their specific chemical composition, texture, structure or porosity, other mottles may be the results of weathering minerals, rather than an impact of drainage conditions.

DC1	Excessively drained	Water is removed from the soil very rapidly. Internal free (“gravitational”) water commonly is very rare or very deep. The soils are commonly coarse-textured, and have very high saturated hydraulic conductivity, or are very shallow.

DC2	Somewhat excessively drained	Water is removed from soil rapidly. Internal free water occurrence commonly is very rare or very deep. The soils are commonly coarse-textured, and have high saturated hydraulic conductivity or are very shallow.
DC3	Well drained	Water is removed from the soil readily, but not rapidly. Internal free water occurrence commonly is deep or very deep; annual duration is not specified. Wetness does not inhibit growth of roots for significant periods during most growing seasons. The soils are mainly free of the deep to redoximorphic features that are related to wetness.
DC4	Moderately well drained	Water is removed from the soil somewhat slowly during some periods of the year. Internal free water commonly is moderately deep and may be transitory or permanent. The soil is wet for only a short time within the rooting depth during the growing season, but long enough that most mesophytic crops are affected. The soil commonly has a moderately low or lower saturated hydraulic conductivity within 1 m of the surface, or periodically receives high rainfall, or both.
DC5	Somewhat poorly drained	Water is removed slowly so that the soil is wet at a shallow depth for significant periods during the growing season. Internal free water is commonly shallow to moderately deep and transitory to permanent. Unless the soil is artificially drained, the growth of most mesophytic plants is markedly restricted. The soil commonly has a low or very low saturated hydraulic conductivity or a high water table, or receives water from lateral flow, or persistent rainfall, or some combination of these factors.
DC6	Poorly drained	Water is removed so slowly that the soil is wet at shallow depths periodically during the growing season or remains wet for long periods. Internal free water is shallow to very shallow and common or persistent. Unless the soil is artificially drained, most mesophytic crops cannot be grown, unless the soil is artificially drained. The soil, however, is not continuously wet directly below ploughing depth (±25 cm). Free water at shallow depth is usually present. The water table is commonly the result of low or very low saturated hydraulic conductivity or persistent rainfall, or a combination of both factors.
DC7	Very poorly drained	Water is removed from the soil so slowly that free water remains at or near the soil surface during much of the growing season. Internal free water is very shallow and persistent or permanent. Unless the soil is artificially drained, most mesophytic crops cannot be grown. The soils are commonly level or depressed and frequently ponded. If rainfall is persistent or high, the soil can be very poorly drained even on gentle slopes.
DCX	Not known	

2.10. **External drainage** (FAO, 1990) **[EXT_DRA]**

The external drainage of a site refers to its relative position in the landscape. Is the site in a landscape position where it will overall receive water from upslope or rather shed water downslope, and if shedding, by which speed is the water lost. The following classes are defined:

EX1 Ponded (run-on site)
EX2 Neither receiving nor shedding water
EX3 Slow run-off
EX4 Moderately rapid run-off
EX5 Rapid run-off

2.11. **Flooding** (FAO, 1990)

Flooding is described according to its frequency, duration and depth. At most sites it is difficult to assess flooding accurately. Information may be obtained from records of past flooding or from local enquiry. The frequency and duration classes give an indication of the average occurrence of flooding. It is very important to evaluate if the flooding is a relict or if it is still active at present.

2.11.1. Frequency *[FLO_FRQ]*

FF01 Daily
FF02 Weekly
FF03 Monthly
FF04 Annually
FF05 Biennially
FF06 Once every 2-4 years
FF07 Once every 5-10 years
FF08 Rare (less than once in 10 years)
FF09 Inactive today, but has been active in historical time
FF10 Inactive today, but has ones been active (ancient time)
FF11 None
FFX Not known

2.12. **Coarse surface fragments** (FAO, 2006)

Coarse surface fragments- boulders and stones, including those that are partly buried, should be described in terms of percentage of surface cover and size of the fragments. Remember, a stone or boulder partly buried is only included in the coverage and class estimate based on the visible part, it is not the purpose to uncover partly or completely buried coarse fragments. The classes of coverage and size handled are:

2.12.1. Surface cover *[STO_COV]*

RC0	None	0 %
RC1	Very few	0 - 2 %
RC2	Few	2 - 5 %
RC3	Common	5 - 15 %
RC4	Many	15 - 40 %
RC5	Abundant	40 - 80 %
RC6	Dominant	>80 %
RCX	Not determined	

2.12.2. Size classes *[STO_SIZE]*

Size classes according to the greatest dimension:

RS1	Fine gravel	0.2 - 0.6 cm
RS2	Medium gravel	0.6 - 2.0 cm
RS3	Coarse gravel	2 - 6 cm
RS4	Stones	6 - 20 cm
RS5	Boulders	20 - 60 cm
RS6	Large boulders	60 - 200 cm
RSX	Not determined	

Example: RC4, RS1-3 and RC2, RS4 (common fine to coarse gravel and very few stones)
Notice: The size classes are similar to those used for gravels and stones found below the surface.

2.13. **Erosion & sedimentation** (modified from FAO, 2006)

2.13.1. Type of erosion/sedimentation *[ERO]*

Erosion and sedimentation can be described according to the agency - water, wind, mass movements (landslides and related phenomena). Description should also include deposition of transported material:

ES00 No evidence of erosion
ES01 Water erosion and sedimentation
ES02 Water erosion, not specified

ES03 Sheet erosion by water
ES04 Rill erosion by water
ES05 Gully erosion by water
ES06 Tunnel erosion by water
ES07 Mass movement (landslides and similar phenomena)
ES08 Sedimentation by water
ES09 Wind erosion and sedimentation
ES10 Erosion by wind
ES11 Sedimentation by wind
ES12 Shifting sands
ES13 Salt deposition
ES14 Other erosion/sedimentation, related to human activity
ESX Not known

2.13.2. Area affected *[ERO_AREA]*

The proportion of the total area affected by erosion/sedimentation is estimated:

EA0 0 %
EA1 0 - 5 %
EA2 5 - 10 %
EA3 10 - 25 %
EA4 25 - 50 %
EA5 > 50 %
EA6 Erosion of vertical cliff

2.13.3. Degree *[ERO_DEG]*

It is difficult to define classes on the degree of erosion, which are equally appropriate for all soils, environments, and according to the various types of erosion. Classes may have to be defined further for each type or combination of erosion and sedimentation and specific environment. For example, in the case of gully and rill erosion, the depth and spacing may be recorded; for sheet erosion the loss of topsoil. The following classes are recommended:

ED0	None	No erosion nor sedimentation
ED1	Heavy sedimentation	Soils buried below >50 cm of accumulated sediment
ED2	Considerable sedimentation	Soils buried below 5-50 cm of accumulated sediment
ED3	Noticeable sedimentation	Soils buried below <5 cm of accumulated sediment, continuously distributed
ED4	Traces sedimentation	Soils buried below <5 cm of accumulated sediment, discontinuously distributed
ED5	Slight erosion	Some evidence of damage to the topsoil; original biotic functions largely intact
ED6	Moderate erosion	Removal of topsoil; original biotic functions partly destroyed
ED7	Severe erosion	Surface layers completely removed and subsurface layers exposed
ED8	Extreme erosion	Substantial removal of deeper subsurface horizons (badlands)

2.13.4. Activity *[ERO_ACT]*

The period of activity of accelerated erosion, or sedimentation, may be described as follows:

EY0 Accelerated and natural erosion not observed
EY1 Period of activity not known
EY2 Active in historical times
EY3 Active in recent past (previous 50 - 100 years)
EY4 Active at present

2.14. **Surface cracks** (FAO, 2006)

Mineral Surface cracks develop in many clay-rich soils during drying. The width (average, or average width and maximum width) of the cracks, and the average spacing between cracks are variables measured.

2.14.1. Size (Width) *[CRK_SIZE]*

SW0	No cracks observed	
SW1	Fine	<1 cm
SW2	Medium	1 - 2 cm
SW3	Wide	2 - 5 cm
SW4	Very wide	5 - 10 cm
SW5	Extremely wide	>10 cm

2.14.2. Distance between cracks *[CRK_DIS]*

SD1	Very closely spaced	<0.2 m
SD2	Closely spaced	0.2 - 0.5 m
SD3	Moderately widely spaced	0.5 - 2 m
SD4	Widely spaced	2 - 5 m
SD5	Very widely spaced	>5 m

2.14.3. Crack pattern *[CRK_PTR]*

PP1	Individual	Individual cracks not part of a polygonal cracking pattern
PP2	Irregular polygonal, incomplete	Idem, but the cracks are not always connecting
PP3	Irregular polygonal, complete	Polygonal pattern of irregular size and form. The cracks are connecting
PP4	Regular polygonal, incomplete	Idem but the cracks are not always connecting
PP5	Regular polygonal, complete	Polygonal pattern of regular size and form. The cracks are connected

2.15. **Salt** (FAO, 2006)

The occurrence of surface salt may be described in terms of cover and appearance. Classes for the percentage of surface cover and thickness are:

2.15.1. Cover *[SALT_COV]*

SV0	None	0 %
SV1	Very low	0 – 2 %
SV2	Low	2 – 15 %
SV3	Moderate	15 – 40 %
SV4	High	40 – 80 %
SV5	Dominant	>80 %

2.15.2. Thickness *[SALT_THK]*

SN1	Thin	<2 mm
SN2	Medium	2 - 5 mm
SN3	Thick	5 - 20 mm
SN4	Very thick	>20 mm

3. Soil horizon description

In the following chapter, the variables forming the soil horizon description are presented.

The soil can compose of mineral and organic horizons, stones, bedrock etc., which together forms the soil profile. In the following chapter a series of variables are listed, but not all of them are equal relevant to particular organic horizons. The definition of organic material is (IUSS, Working Group WRB, 2006; Soil Survey Staff, 1999):

Organic soil material either:

1. is saturated with water for long periods (or has been artificially drained), ***AND*** has
   a. ≥18% organic carbon (by weight; corresponds to ≥30% organic matter) if the soil contains at least 60% clay, ***OR***
   b. ≥12% organic carbon (by weight; corresponds to ≥20% organic matter) if the soil contains no clay, ***OR***
   c. a proportional content of organic carbon between 12 and 18%, if the clay content of the mineral fraction is between zero and 60%, ***OR***
2. is never saturated with water for more than a few days, ***AND*** has ≥20% organic carbon (by weight; corresponds to ≥34% organic matter)

In principle knowledge of the content of organic matter is required to differentiate between organic and mineral materials. In the field anyhow, organic horizons are usually easy to recognise, only border cases will need analytical data to check for the content of organic carbon.

After having selected the most representative spot for the soil profile, the profile is opened and cleaned. A list of field equipments suggested to bring along, is presented in appendix B. The recommended sequence of description is as follows:

a. delineation and description of the horizon boundaries,
b. photographic recordings of the soil in general and of special features in detail,
c. colour measurements,
d. from this stage on, the profile wall is gently broken apart to record texture, rock fragments, structure, consistence, porosity, cutans, cementations and nodules, this is followed by
e. roots and other biological activity, and by
f. carbonates, gypsum and salts,
g. each horizon is designated one or more horizon master and subordinate symbols, and
h. the necessary samples are collected (see also appendix C).

3.1. Horizon boundary (modified from FAO, 2006)

The nature of the boundaries between soil layers, or horizons, may indicate the processes that have formed the soil. In some cases, they reflect anthropogenic impacts. Horizon boundaries are described in terms of depth, distinctness and topography.

3.1.1. Number [HOR_NO]

After delineation of the horizon boundaries each horizon is labelled with a "H" (from "horizon") and a number: H1, H2, H3 etc. While the horizon symbols may change according to new information, the horizon number is not to be changed at any point of the further profile description and sampling. The numbering starts from the interface between air and soil no matter if the surface horizon is an organic or a mineral horizon (see Figure 3).
If at a later stage, it is necessary to subdivide a horizon, it should by preference be done without loosing the original number, e.g. H2 becomes H2a and H2b or H2.1 and H2.2. If later a very different

new horizon is discovered between H2 and H3, it is given a horizon number not yet in use, e.g. the vertical sequence becomes H1, H2, H10, H3.

3.1.2. Depth *[D_HOR_L]*

The depth of the lower boundary of each horizon is measured in centimetres from the surface of the mineral soil.

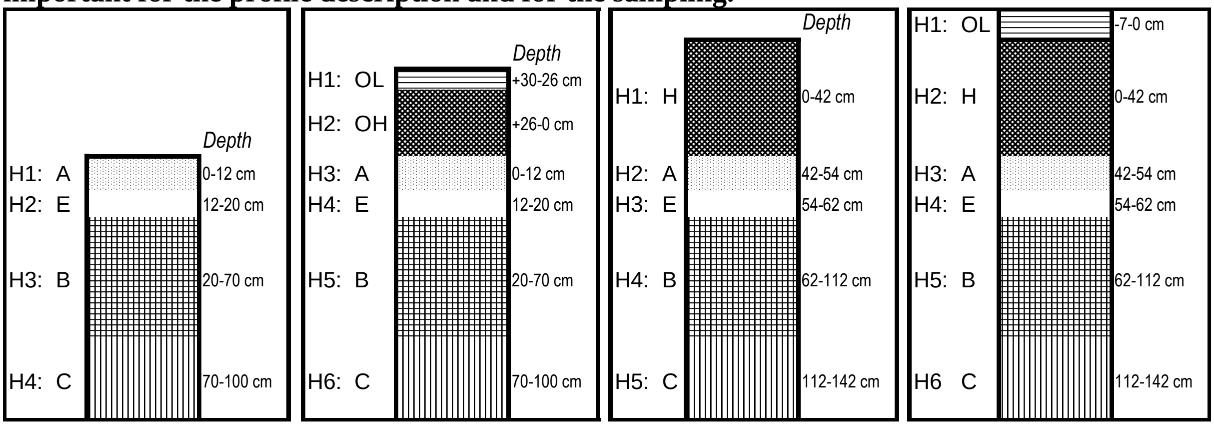
If the soil is covered by (an) organic layer(s), either:

a. 10 cm or more thick from the soil surface to a lithic or paralithic contact, or

b. 40 cm or more thick,

then the depth is measured from the surface of the organic cover. The depth requirements correspond to the limit for organic soils (Histosols).

Figure 3: Examples on how the horizon depth should be recorded in the field. These depths are important for the profile description and for the sampling.



- If the organic layer(s) is (are) too shallow to fulfil the above depth requirement(s), then its depth is recorded from the zero-point and upwards (see Figure 3), using negative depths.
- The depth is measured perpendicular to the slope the profile is situated upon.
- Most horizon boundaries are zones of transition rather than sharp breaks.
- If required, ranges in depth should be given in addition to the average depth, for instance 28 (25-31) cm to 45 (39-51) cm.

3.1.3. Distinctness *[HOR_DIST]*

The distinctness of the lower horizon boundary refers to the thickness of the boundary zone in between adjacent horizons.

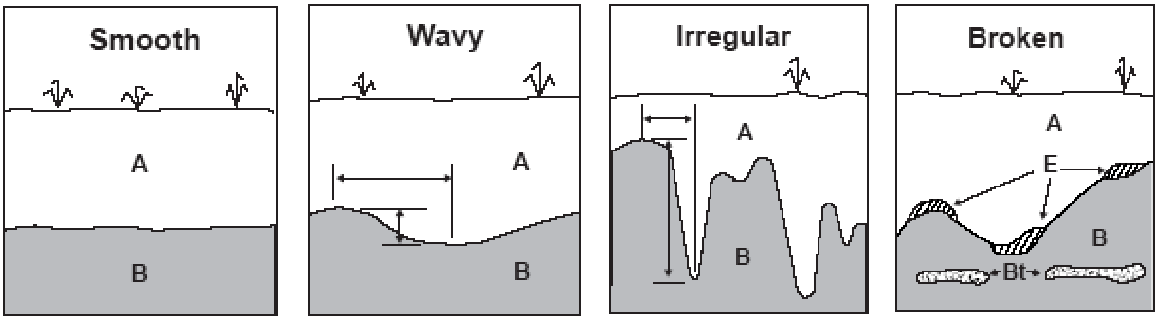
BD1	Abrupt	<2 cm
BD2	Clear	2 - 5 cm
BD3	Gradual	5 - 15 cm
BD4	Diffuse	>15 cm

3.1.4. Topography *[HOR_TOPO]*

The topography of the boundary indicates its shape (see Figure 4).

BT1	Smooth	Nearly plane surface
BT2	Wavy	Pockets shallower than they are wide
BT3	Irregular	Pockets deeper than they are wide
BT4	Broken	Discontinuous
BT5	Complex	

Figure 4: Illustration of the most common horizon topographies, which is the lateral undulation and continuity of the boundary between horizons (after Schoeneberger et al., 2002)



3.2. Photographic recordings

Quality photographs are essential for the soil database. A scale is needed on all photos, preferentially a bicoloured centimetre-scale. The use of tools for scaling should be avoided. If a tool e.g. a spade is used the length of the spade should be clearly stated in the photo legend.
Partly shading of the profile wall should at any cost be avoided, use eventual a dark and uniform coloured umbrella to shade the profile. If possible avoid the use of a camera flash eventually by using a tripod or a monopod. If using a digital camera, use a high resolution (5 Mega Pixels or more) and a camera with a good quality lens. The photographic database <u>should</u> include following images:

- Photo of the immediate vicinity of the profile
- The profile after cleaning and before indication of the soil horizons on the profile wall.

And <u>may</u> include following images:
- General photo illustrating the geomorphology and vegetation of the area surrounding the profile
- The profile after the soil horizons are outlined gently on the profile wall with e.g. a knife
- The profile with partly visible structure partly with a cleaned surface
- The profile with indications where to sample
- Close-up of the organic topsoil horizon(s)
- Horizontal sections, e.g. in de depths where the bulk density (BD) is sampled
- Special features

3.3. Soil colour [M_COL; D_COL; W_COL]

The colour of the soil matrix in each horizon should be recorded in moist and dry condition using the Munsell notation (e.g. Munsell, 2000). The colour notation is composed of hue, value and chroma. Hue is the dominant spectral colour (red, yellow, green, blue, violet), value is the lightness or darkness of colour ranging from 1 (dark) to 8 (light), and chroma is the purity or strength of colour ranging from 1 (pale) to 8 (bright). If there is no dominant colour, the horizon is described as mottled and two or more colours are given. In addition to the colour notations, the standard Munsell colour names should be given.

<u>Example</u>: Greyish brown 10YR 5/2 (moist) and light brownish grey 10YR 6/2 (dry);
where 10YR (yellowish red) is the hue, 5 (or 6) is the value and 2 the chroma.

<u>Example</u>: Dark greyish brown to greyish brown 2.5Y 4.5/2 (moist) and light brownish grey 2.5Y 6/2 (dry);
Notice that interpolation between colours are possible both for hue, value and chroma

<u>Example</u>: Dark greenish grey 5GY 4/1 (moist) and greenish grey 10GY 5/1 (dry);
where 5GY or 10GY (greenish yellow) is the hue, 4 (or 5) is the value and 1 is the chroma.

3.4. Mottling (FAO, 2006)

Mottles are spots of different colours interspersed with the dominant colour of the soil. They commonly indicate that the soil has been subject to alternate wet (reducing) and dry (oxidizing) conditions. Other mottles can be a result of rock weathering, clay (+iron) migration and accumulation, selective decay by fungi of organic matter etc.
Mottling is described in terms of abundance, size, contrast, boundary and colour. In addition, the shape, position or any other feature may be recorded.

3.4.1. Abundance *[MOT_ABU]*

Abundance is described as an exact figure or in classes indicating the percentage of the exposed surface occupied by the mottles. When mottles are so abundant that distinction of matrix and mottle colour is not possible, the predominant colours should be described as soil matrix colours.

MA0	None	0 %
MA1	Very few	0 - 2 %
MA2	Few	2 - 5 %
MA3	Common	5 - 15 %
MA4	Many	15 - 40 %
MA5	Abundant	40 – 80 %
MA6	Dominant	>80 %

3.4.2. Colour *[MOT_COL]*

Measure the colours using the Munsell Soil Colour Charts.
If the colour changes after exposure to the air, measure both the colours before and after oxidation.

3.4.3. Size *[MOT_SIZE]*

The following classes are used to indicate the approximate diameters of individual mottles.

MS1	Very fine	< 2 mm
MS2	Fine	2 - 6 mm
MS3	Medium	6 - 20 mm
MS4	Coarse	20 - 40 mm
MS5	Very coarse	40 - 80 mm
MS6	Extremely coarse	> 80 mm

3.4.4. Contrast *[MOT_CNT]*

The colour contrast between mottles and soil matrix can be described as:

MC1 Faint: mottles are evident only on close examination. Soil colours in both the matrix and mottles are similar.

MC2 Distinct: although not striking, the mottles are readily seen. The hue, chroma or value of the matrix is easily
distinguished from the mottles. They may vary by as much as 2.5 units of hue or several units in chroma or value.

MC3 Prominent: the mottles are conspicuous. Hue, chroma and value, alone or in combination, are several units apart.

3.4.5. Boundary *[MOT_BDR]*

The boundary between mottle and matrix is described according to the width of the transition zone.

MB1	Sharp	<0.5 mm
MB2	Clear	0.5-2 mm
MB3	Diffuse	2-5 mm
MB4	Very diffuse	>5 mm

3.5. Redoximorphic properties (IUSS Working Group WRB, 2006)

Redoximorphic features concerns a colour pattern observed in the soil, which is the result of depletion or concentration compared to the matrix colour, formed by oxidation/reduction of iron and/or manganese.

3.5.1. Reducing conditions [RED]

If reducing conditions prevails in a soil horizon, it can be tested in following ways:

1. Are Fe^{2+} ions present, as tested by spraying the freshly exposed soil surface with a 0.2% (M/V) α,α dipyridyl solution in 10% (V/V) acetic acid solution. The test yields a striking reddish colour in the presence of Fe^{2+} ions (be careful, the chemical is slightly toxic). Did a reddish colour (almost like red wine) appear on the tested soil surface after a few minutes?
2. Is iron sulphide present?
3. Is methane present?

If the answer to any of above 4 questions is yes, report: **Y**
If none of the tests above are positive report : **N**
If data for some reason are missing or impossible to collect, indicate: **X**

3.5.2. Reductimorphic and oximorphic colours [COL_REDU; COL_OXIM]

If oximorphic and/or reductomorphic mottles as present they are first of all described according to the chapter on mottling (see chapter 3.4). Note that gleyic mottles should be recorded as fast as possible after the profile has been prepared, sometimes even while digging the profile, due to the fast oxidation of certain minerals.

- Are <u>redu</u>ctimorphic colours, reflecting permanently wet conditions, present on more than 90% of the soil surface? Reductimorphic colours are neutral white to black (Munsell N1/ to N8/) or bluish to greenish (Munsell 2.5Y, 5Y, 5G, 5B).

Y/N/X (Yes/No/Not known)

- <u>Oxim</u>orphic colours reflect alternating reducing and oxidizing conditions, as is the case in the capillary fringe and in the surface horizons with fluctuating groundwater levels. They and comprise any colour, excluding reductimorphic colours (see above). Are 5% or more of the soil surface cover by oximorphic coloured mottles?

Y/N/X (Yes/No/Not known)

The above described field tests may to some degree illustrate the actual redoximorphic conditions at the moment of fieldwork, rather than the general condition of the soil. For the same reason it is strongly recommended in case of gley soils to give special attention to:

- roots (presence/absence), and
- the soil water (indications of a fluctuating or permanent water tables etc.)

3.5.3. Stagnic and gleyic colour pattern

Depending on the origin of the water, which is either the groundwater table, either surface water that is (at least temporarily) saturating the soil layer, two different colour patterns will develop. It is <u>important to distinguish</u> between both type of colour patterns <u>during</u> the profile description.

Note: When a stagnic colour pattern is identified in a genetic horizon, it is designated by the horizon subordinate symbol ‘g’. When a gleyic colour pattern is seen, the horizon received the subordinate symbol ‘l’.

Stagnic colour pattern

General description

Soil materials develop a stagnic colour pattern if they are, at least temporarily, saturated with surface water (or were saturated in the past, if now drained) for a period long enough that allows reducing conditions to occur.

Diagnostic criteria
A stagnic colour pattern shows mottling in such a way that the surfaces of the peds (or parts of the soil matrix) are lighter (at least one Munsell value unit more) and paler (at least one chroma unit less), and the interiors of the peds (or parts of the soil matrix) are more reddish (at least one hue unit) and brighter (at least one chroma unit more) than the non-redoximorphic parts of the layer, or than the mixed average of the interior and surface parts.
Additional characteristics
If a layer has a stagnic colour pattern in 50 percent of its volume the other 50 percent of the layer are non-redoximorphic (neither lighter and paler nor more reddish and brighter).

Gleyic colour pattern
General description
Soil materials develop a gleyic colour pattern if they are saturated with groundwater (or were saturated in the past, if now drained) for a period that allows reducing conditions to occur.
Diagnostic criteria
A gleyic colour pattern shows one or both of the following:
1. 90 percent or more (exposed area) reductimorphic colours, which comprise neutral white to black (Munsell hue N1/ to N8/) or bluish to greenish (Munsell hue 2.5Y, 5Y, 5G, 5B); or
2. 5 percent or more (exposed area) mottles of oximorphic colours, which comprise any colour, excluding reductimorphic colours.
Field identification
A gleyic colour pattern results from a redox gradient between groundwater and capillary fringe causing an uneven distribution of iron and manganese (hydr)oxides. In the lower part of the soil and/or inside the peds, the oxides are either transformed into insoluble Fe/Mn(II) compounds or they are translocated; both processes lead to the absence of colours with a hue redder than 2.5Y. Translocated Fe and Mn compounds can be concentrated in the oxidized form (Fe[III], Mn[IV]) on ped surfaces or in biopores (rusty root channels), and towards the surface even in the matrix. Manganese concentrations can be recognized by strong effervescence using a 10-percent H_2O_2 solution.
▪

3.6. Texture of the fine-earth fraction (simplified from FAO, 2006) [TEX_CLAS]

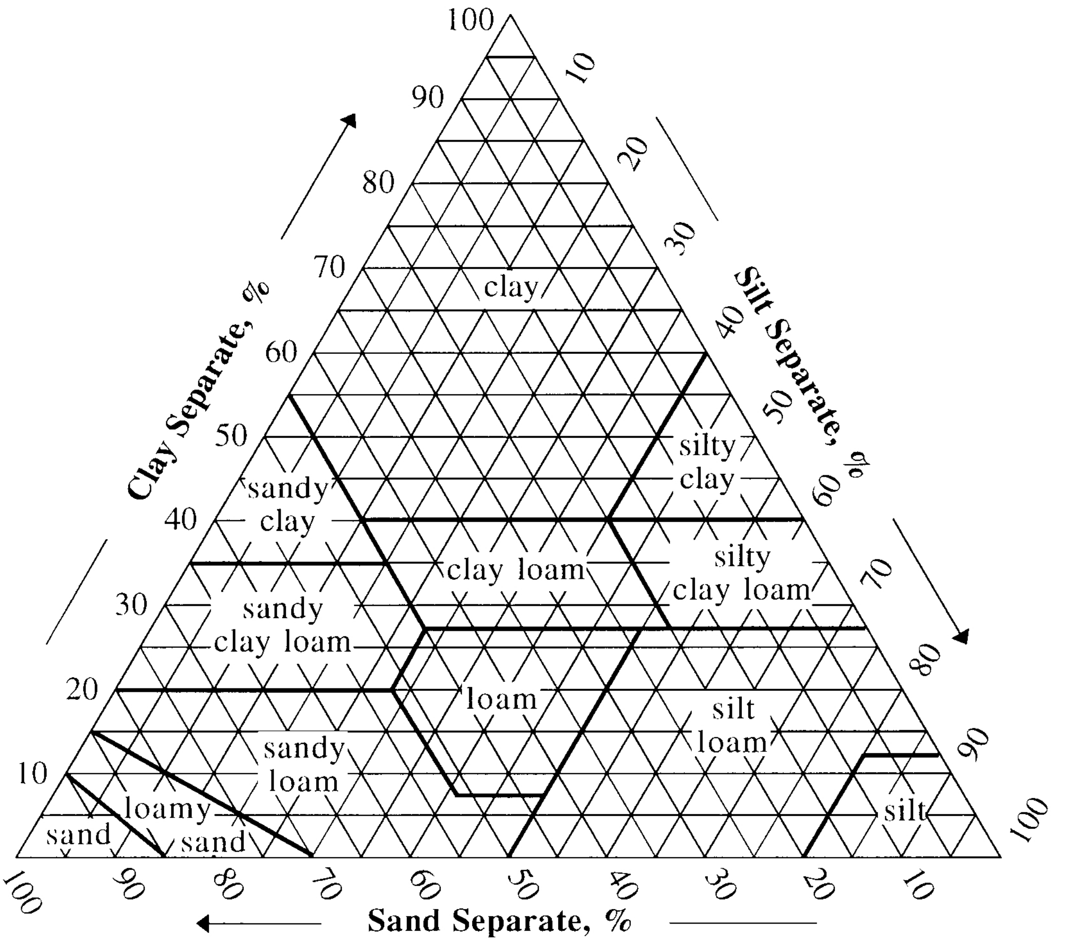
Soil texture refers to the proportion of the various particle-size classes in a given soil volume and is described as soil textural classes (see Figure 5). The 2000–63–2 µm system for particle-size fractions is used.

Textural classes:

S	Sand	**CL**	Clay loam
LS	Loamy sand	**L**	Loam
SL	Sandy loam	**Si**	Silt
SCL	Sandy clay loam	**SC**	Sandy clay
SiL	Silt loam	**SiC**	Silty clay
SiCL	Silty clay loam	**C**	Clay

The names of the textural classes, which describe combined particle-size classes, are coded as in Figure 5.

Figure 5: The fine earth by size and defining textural classes



3.7. **Rock fragments** (modified from FAO, 2006)

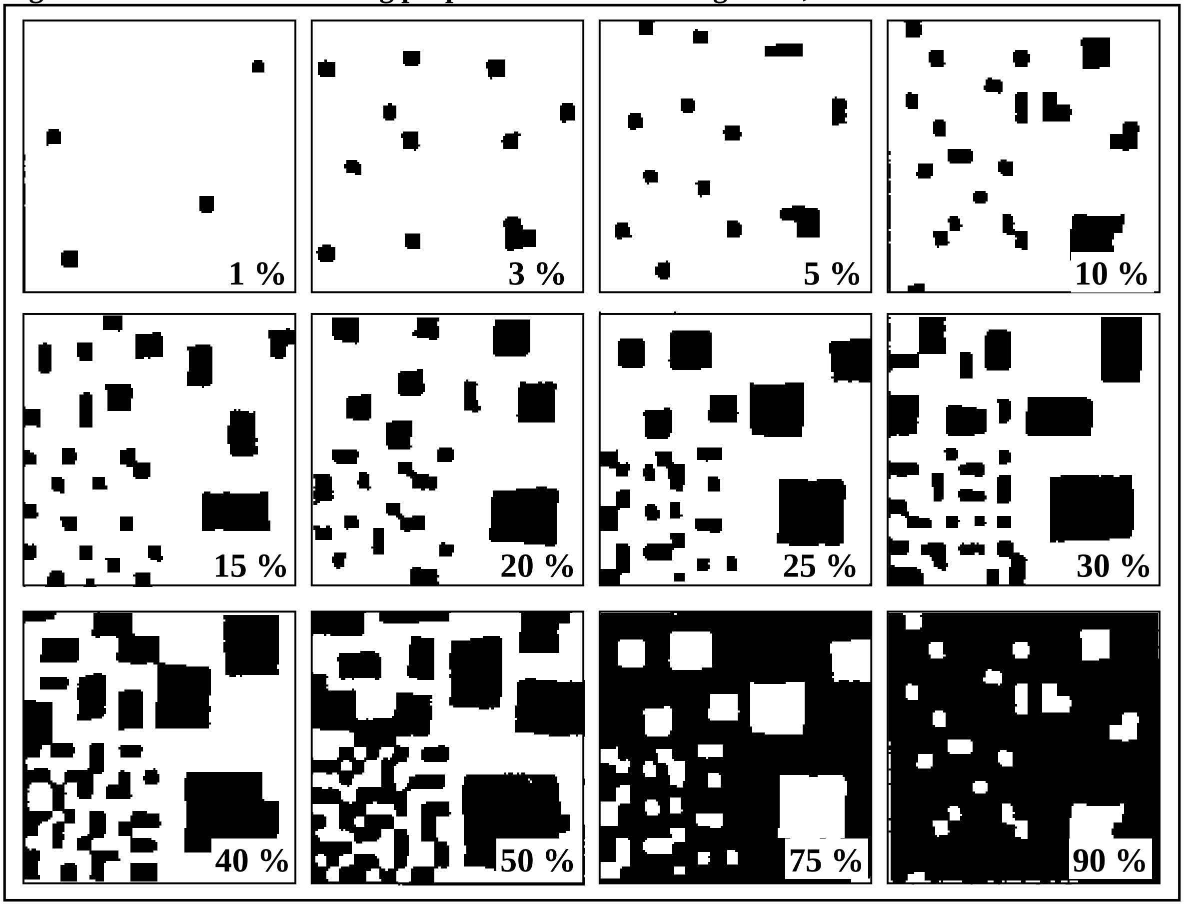
Large fragments (>2 mm) are described according to abundance, size, shape, state of weathering and nature of the fragments. The abundance classes correspond with those for surface coarse fragments and mineral nodules.

3.7.1. Abundance *[GRAVEL_ABU]*

The abundance of rock fragments is estimated (Figure 6) and expressed as a percent (by volume) of the total soil. By preference, the exact figure is provided rather than abundance classes.

RA0	None	0 %
RA1	Very few to few	0 - 5 %
RA2	Common	5 - 15 %
RA3	Many	15 - 40 %
RA4	Abundant	40 - 80 %
RA5	Dominant	>80 %

Figure 6: Charts for estimating proportions of coarse fragments, mottles or other elements



3.7.2. Size of rock fragments *[GRAVEL_SIZE]*

Code	Classes	Size range
RS1	Fine gravel	0.2 - 0.6 cm
RS2	Medium gravel	0.6 - 2 cm
RS3	Coarse gravel	2 - 6 cm
RS4	Stones	6 - 20 cm
RS5	Boulders	20 - 60 cm
RS6	Large boulders	60 - 200 cm

Notice: the size classes are similar to those applying for surface gravels and stones (chapter 2).

3.7.3. Dominant shape of rock fragments *[GRAVEL_SHP]*

The shape may be described as:

RF1 Flat
RF2 Angular
RF3 Sub-rounded
RF4 Rounded

3.7.4. State of weathering of rock fragments *[GRAVEL_WTH]*

The state of weathering is described as:

RW0 Fresh or slightly weathered: fragments show little or no signs of weathering

RW1 Weathered: partial weathering is indicated by discolouration and loss of crystal form in the outer parts of the fragments while the centres remain relatively fresh; fragments have lost little of their original strength.

RW2 Strongly weathered: all but the most resistant minerals are strongly discoloured and altered throughout; the fragments tend to disintegrate under hand pressure.

3.7.5. Nature (type) of rock fragments ***[GRAVEL_TYP1; GRAVEL_TYP2; GRAVEL_TYP3]***

The nature of rock fragments is described by the same terminology as for the parent material (see appendix A).

3.8. Soil structure (modified from FAO, 2006)

Soil structure relates to the grouping or arrangement of soil particles into discrete soil units (peds). The aggregates are separated from each other by pores or voids and are characterised primarily on basis of its dominant shape: spheroidal (granular, crumb), platy, prism (columnar- top of the prisms are rounded and prismatic- top of the prisms are level) and blocky (angular blocky and subangular blocky). Classes for physical ripening are presented in chapter 3.8.5.
With decreasing soil humidity, the soil structure becomes increasingly pronounced. In moist or wet conditions, if no clear structure is visible, a large lump of undisturbed soil material can be dried, which will possible reveal the structure if any. Another method is to take a large lump of soil on the spade and let it fall from about a meter height, and then to observe how the block of soil breaks into pieces. A third possibility is to use a knife to gentle loosen the soil material on the profile wall. Try to loosen the soil in such a way that it breaks along the natural ped faces rather than breaks through the peds (it demands a bit of practice).
Besides the structure type, also grade and size of aggregates are recorded. When a soil horizon contains aggregates of more than one grade, size or type, the different kinds of aggregates should be described separately and their relationship indicated.

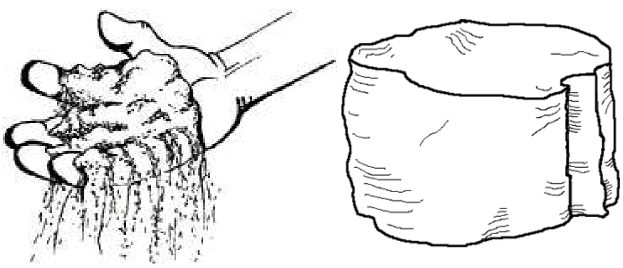
3.8.1. Type ***[STRUCT1_TYP; STRUCT2_TYP]***

The soil can be structureless or have some kind of structure. If a structure is present the degree of development and the size are further information to record.
In structureless soil, no aggregates are observable in place and there is no definite arrangement of natural surfaces of weakness. Structureless soils are subdivided into single grain and massive (see figure 7). Notice that horizons or layers with visible lamination (sedimentation) are described as having rock structure (PT12) and are further subdivided concerning colour, thickness and form.

Structureless soils:

PT1 Single grain		Soil material has a loose, soft or very friable consistence and composes on rupture of more than 50 % discrete mineral particles.
PT2 Massive		soil material has a stronger consistence and is more coherent on rupture. Massive soil material may be further defined by consistence (see section 3.10).

Figure 7: Absence of structure, either as single grain (left) or as massive (right) soil material (http://soil.gsfc.nasa.gov)**.**



The natural types of structure are defined as follows (Figure 8), remember more than one type in one horizon is possible.

Structured soils:

PT3	Granular	Spheroids or polyhedrons, having curved or irregular surfaces which are not casts of the faces of surrounding aggregates. Units do not fit into each other
PT4	Crumbs	Granular like pedality but with a very high inped porosity. Mainly created by artificial disturbance (e.g. tillage) (FAO, 2006).
	Blocky	Blocks or polyhedrons, nearly equidimensional, having flat or slightly rounded surfaces which are casts of the faces of the surrounding aggregates. Subdivision is recommended into:
PT5	Angular	with faces intersecting at relatively sharp angles, and
PT6	Subangular blocky	with rounded faces
PT7	Prismatic	the dimensions are greater in the vertical than horizontal direction; vertical faces well defined, having flat or slightly rounded surfaces which are casts of the faces of the surrounding aggregates. Faces normally intersect at relatively sharp angles
PT8	Columnar	structure are prisms with rounded caps instead of flat surfaces.
PT9	Wedge-shaped	elliptical, interlocking lenses that terminate in sharp angles, bounded by slickensides; not limited to vertic materials.
PT10	Nutty	polyhedric blocky structure with many shiny ped faces which cannot or can only partially be attributed to clay illuviation
PT11	Platy	Flat with vertical dimensions limited; generally oriented parallel to soil surface horizontally and, usually, overlapping with other structure types.
PT12	Rock structure	Rock structure includes **fine stratification in unlithified sediment**, and pseudomorphs of weathered minerals retaining their positions relative to each other and to unweathered minerals in saprolite.

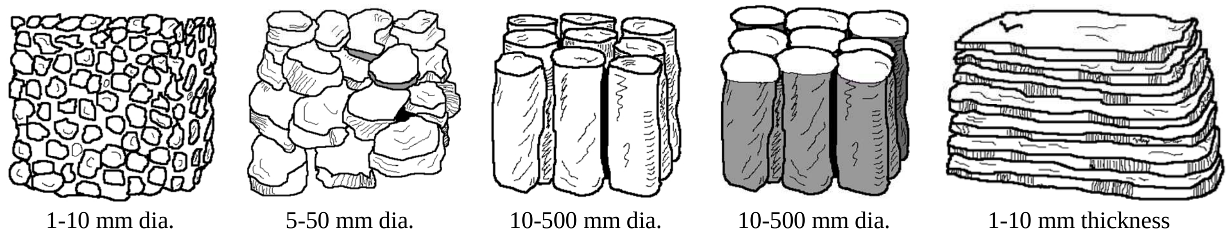


Figure 8: Illustrations of some of the most common types of soil structures. From left to right, these are granular, blocky, prismatic, columnar and platy (http://soil.gsfc.nasa.gov)**. The sizes indicated are the normal range, smaller or larger sizes are possible.**

3.8.2. Size [STRUCT1_SIZE; STRUCT2_SIZE]

If a structure is present, the size should be determined. The size classes vary with structure type. For granular, crumble and blocky structures the general size is measured (they are more or less equidimensional), for prismatic, columnar and wedged structures the size classes refer to the measurements of the smallest dimension of the aggregate. For platy structures the thickness of the plates are important, but it is recommended to notice the orientation as well.

	Symbol	**Crumbly/ Blocky** (mm)	**Granular/Prismatic/ Columnar/Wedge-shaped** (mm)	**Platy** (mm)	**Rock structure (lamination)** (mm)
PZ1	Very fine or thin	< 5	< 10	< 1	<5
PZ2	Fine or thin	5 - 10	10 - 20	1 - 2	5-10
PZ3	Medium	10 - 20	20 - 50	2 - 5	10-20
PZ4	Coarse or thick	20 - 50	50 - 100	5 - 10	20-50
PZ5	Very coarse or thick	> 50	100 - 500	> 10	50-100
PZ6	Extremely coarse	-	> 500	-	>100

3.8.3. Grade [STRUCT1_GRD; STRUCT2_GRD]

If the structure is not well developed it can be difficult to estimate the degree of development of the structure, especially if the moisture content is high. Observe if the structural units are well defined on all sides, or only on a few and how easy the units are separated from each other. Grades of structured soil materials are defined as follows:

PG0	None	Structureless, such as for single grain and massive.
PG1	Weak	Aggregates are barely observable in place and there is only a weak arrangement of natural surfaces of weakness. When gently disturbed, the soil material breaks into a mixture of few entire aggregates, many broken aggregates, and much material without aggregate faces.
PG2	Moderate	Aggregates are observable in place and there is a distinct arrangement of natural surfaces of weakness. When disturbed, the soil material breaks into a mixture of many entire aggregates, some broken aggregates, and little material without aggregates faces. Aggregates' surfaces generally show distinct differences with their interiors.
PG3	Strong	Aggregates are clearly observable in place and there is a prominent arrangement of natural surfaces of weakness. When disturbed, the soil material separates mainly into entire aggregates. Aggregates' surfaces generally differ markedly from their interiors.
PGX	Not known	The development of the structure can not be determined

Notice:
If a second type of structure is present in a horizon (e.g. prismatic breaking to angular blocks) then the second structure is reported under the codes STRUCT2_TYP, STRUCT2_SIZE and STRUCT2_GRD.

3.8.4. Rock structure (stratification): further information

Colour *[STRUCT1_COL]*

The alternating colours of the stratification is recorded either using the Munsell notation (see. Ch. 3.3) or by describing the colours. A list of colour codes are presented in ch. 3.12.7. This list may be expanded if needed.

Form *[STRUCT1_FRM]*

The form of the stratification is described:

PF0	None	No lamination or stratification visible
PF1	Broken	The layer is present in less than 50 % of the exposed profile wall
PF2	Discontinuous	The layer is present in 50 - 90 % of the exposed profile wall
PF3	Continuous	The layer is present in more than 90 % of the exposed profile wall
PF4	Wavy	Wave-rippled

Notice the same codes apply for subchapter 3.11.2: Continuity (subchapter of Cementation and compaction).

Type of disturbance *[STRUCT1_DISB]*

If the original stratification is disturbed, describe the source of this disturbance.

PD1	Primary	The discontinuous nature dates from when the sediment deposited
PD2	Erosion	After the primary deposition erosion/sedimentation took place
PD3	Roots	The lamination is disturbed by root growth
PD4	Fauna	The disturbance of the lamination is due to faunal activity (insects, mammals…)
PD5	Human	Any anthropogenic disturbance that destroys the lamination
PD6	Other	Define

3.9. Consistence (FAO, 2006)

Consistence refers to the degree of cohesion or adhesion of the soil mass - friability, plasticity, stickiness and resistance to compression. It depends on the amount and type of clay, organic matter and moisture content of the soil.
For reference descriptions, consistence is required for the soil in dry, moist and wet (both stickiness and plasticity) state. If applicable, thixotropy may be recorded. For routine descriptions, the soil consistence in the natural moisture condition of the profile is described. Wet consistence can always be described, and moist conditions if the soil is dry, by adding water to the soil sample.

3.9.1. Consistence when dry *[D_CONS]*

This is determined by breaking the air-dried soil in the hand:

CD0	Loose	Non-coherent.
CD1	Soft	Very weakly coherent and fragile; breaks to powder or individual grains under very slight pressure.
CD2	Slightly hard	Weakly resistant to pressure; easily broken between thumb and forefinger.
CD3	Hard	Moderately resistant to pressure; can be broken in the hands but not between thumb and forefinger.
CD4	Very hard	Very resistant to pressure; can be broken in the hands only with difficulty.
CD5	Extremely hard	Extremely resistant to pressure; cannot be broken in the hands.

3.9.2. Consistence when moist *[M_CONS]*

This is determined by squeezing a mass of moist soil material:

CM0	Loose	Non-coherent.
CM1	Very friable	Soil material crushes under very gentle pressure, but coheres when pressed together.
CM2	Friable	Soil material crushes easily under gentle pressure between thumb and forefinger, and coheres when pressed together.
CM3	Firm	Soil material crushes under moderate pressure between thumb and forefinger, but distinct resistance is felt.
CM4	Very firm	Soil material crushes under strong pressure; barely crushable between thumb and forefinger.
CM5	Extremely firm	Soil material crushes only under very strong pressure; cannot be crushed between thumb and forefinger.

3.9.3. Consistence when wet *[W_CONS_S; W_CONS_PL]*

Stickiness depends on water content and the extent to which soil structure is broken down. Wet consistence is described in terms of stickiness and plasticity. It should be assessed under standard conditions on a soil sample in which structure is completely destroyed and which contains just enough water to create maximum stickiness.

Stickiness is the quality of adhesion of the soil to other objects, assessed by observing its adherence when pressed between thumb and finger.

CS0	Non sticky	After release of pressure, practically no soil material adheres to thumb and finger.
CS1	Slightly sticky	After pressure, soil adheres to both thumb and finger but comes off one or the other rather cleanly; it is not appreciably stretched when the digits are separated.
CS2	Sticky	Soil adheres to both thumb and finger and tends to stretch and pull apart rather than pulling free.
CS3	Very sticky	Soil adheres strongly to both thumb and finger and is decidedly stretched when they are separated.

Plasticity is the ability of soil material to change shape continuously under stress and to retain the given shape on removal of stress. It is determined by rolling the soil into a wire about 3 mm in diameter, then bending the wire.

CP0	Non plastic	Will not form a wire.
CP1	Slightly plastic	Wire can be formed but immediately breaks if bent; soil deformed by very slight force.
CP2	Plastic	Wire can be formed but breaks if bent into a ring; slight to moderate force required for deformation of the soil mass.
CP3	Very plastic	Wire formed and can be bent into a ring; strong force required for deformation of the soil.

3.9.4. Physical soil ripening *[RIPE]*

The ripening of the soil is an important pedogenetic process in fluviatile and marine mineral soils as well as in peaty soils. To measure the degree of ripening, Pons & Zonneveld (1965) have defined the n-value, which is a factor that takes into consideration texture, organic matter and actual water content. Field classification of soil material according to the physical ripening has been defined as well (Pons & Zonneveld, 1965) based on the consistency. Notice, the categories does not apply to sandy soils with less than 8% clay.

Code	**n-value**	**Designation**	**Description of consistency**
CR1	<0.7	Ripe	Firm, does not stick to the hands or only slightly and cannot be squeezed out between fingers
CR2	0.7-1.0	Nearly ripe	Moderately firm, tends to stick to the hands, can just be pushed out between fingers when squeezed firmly
CR3	1.0-1.4	Half ripe	Moderately soft, sticks to then hands and can be squeezed between fingers when squeezed firmly
CR4	1.4-2.0	Practically unripe	Soft, sticks fast to the hands and can easily be squeezed between fingers
CR5	>2.0	Unripe	Liquid mud cannot be kneaded; runs between fingers without squeezing

3.10. **Porosity, abundance** (simplified from FAO, 2006) *[POR_ABU]*

Voids are related to the arrangement of the primary soil constituents and aggregates. They are the results of rooting, burrowing of animals and other soil forming processes such as cracking, translocation, leaching. The term void includes all air and water-filled spaces in the soil; the term pore is often used in a more restrictive way and does not include fissures or planes.

The porosity is an indication of the total volume of voids discernible with a x10 hand lens assessed by area and recorded as the percentage of the surface occupied by pores.

PA1	Very low	<2 %
PA2	Low	2-5 %
PA3	Medium	5–15 %
PA4	High	15–40 %
PA5	Very high	> 40 %

3.11. **Cementation and compaction** (modified from FAO, 2006)

The occurrence of cementation or compaction, as pans or otherwise, is described according to their nature, continuity, structure, agent and degree. Cemented material does not slake after one hour of immersion in water.

3.11.1. Nature (type) *[CEM_TYP]*

The cementing agent or compaction activity composes of:

TT1	Gypsum
TT2	Silica
TT3	Carbonates
TT4	Iron oxides
TT5	Iron-manganese oxides
TT6	Iron-organic matter
TT7	Organic matter
TT8	Others
TT9	Not known

3.11.2. Continuity *[CEM_CTN]*

TC1	Broken	The layer is less than 50 % cemented/compacted and appears irregular
TC2	Discontinuous	The layer is 50 - 90 % cemented/compacted and appears regular
TC3	Continuous	The layer is more than 90 % cemented/compacted, and has few cracks only
TC4	Wavy	Wave-rippled

Notice the same codes apply for the form of rock structures.

3.11.3. Structure *[CEM_STRUCT]*

The structure (or fabric) of the cemented/compacted layer may be described as:

TS0	None	Massive without recognizable orientation
TS1	Platy	The cemented/compacted parts are plate-like with more or less horizontal orientation
TS2	Vesicular	The layer has large, equidimensional voids which may be filled with uncemented material
TS3	Pisolithic	The layer is composed of cemented, spherical nodules
TS4	Nodular	The layer is composed of cemented nodules or concretions of irregular shape

3.11.4. Degree *[CEM_DEG]*

TD0	Non-cemented and non-compacted	No compaction/compaction is observed (slakes in water)
TD1	Compacted	Compacted soil material is harder or more brittle than non-compacted soil material. Non-cemented.
TD2	Weakly cemented	Cemented mass is brittle and hard, but can be broken in the hands
TD3	Moderately cemented	Cemented mass cannot be broken in the hands but is discontinuous (less than 90 % of soil mass)
TD4	Cemented	Cemented mass cannot be broken in the hands and is continuous (more than 90 % of soil mass)

3.12. **Nodules** (FAO, 2006)

Mineral nodules cover a large variety of secondary concentrations. There are gradual transitions with mottles. Nodules are described according to their kind, type, abundance, size, shape, hardness and colour, as well as their presence within the horizon:

3.12.1. Kind *[NOD_KIND]*

NK1	Crystal	
NK2	Concretion	A discrete body with a concentric internal structure, generally cemented
NK3	Soft segregation	Differs from the surrounding soil mass in colour and composition but is not easily separated as a discrete body

NK4	Nodule	Discrete body without an internal organization
NK5	Residual rock fragment	Discrete body still showing rock structure

3.12.2. Type *[NOD_TYP]*

Nodules are described according to their composition or impregnating substance. Examples:

NT1	Gypsum
NT2	Silica
NT3	Carbonates
NT4	Carbonates-silica
NT5	Salt
NT6	Clay
NT7	Clay-oxides
NT8	Manganese oxides
NT9	Iron-manganese oxides
NT10	Iron oxides
NT11	Sulphur
NT12	Not known

3.12.3. Abundance (by volume) *[NOD_ABU]*

NA0	None	0 %
NA1	Very few	0 - 2 %
NA2	Few	2 - 5 %
NA3	Common	5 - 15 %
NA4	Many	15 - 40 %
NA5	Abundant	40 - 80 %
NA6	Dominant	> 80 %

3.12.4. Size *[NOD_SIZE]*

NZ1	Very fine	< 2 mm
NZ2	Fine	2 - 6 mm
NZ3	Medium	6 - 20 mm
NZ4	Coarse	> 20 mm

3.12.5. Shape *[NOD_SHP]*

NS1	Rounded (spherical)
NS2	Elongated
NS3	Flat
NS4	Irregular
NS5	Angular

3.12.6. Hardness *[NOD_HARD]*

NH1	Hard	Cannot be broken between the fingers
NH2	Soft	Can be broken between forefinger and thumb nail
NH3		Both hard and soft

3.12.7. Colour *[NOD_COL]*

General colour names are usually sufficient to describe nodules, in the same way as mottles:

NC1	White
NC2	Yellow
NC3	Yellowish red
NC4	Reddish yellow
NC5	Red

NC6 Yellowish brown
NC7 Reddish brown
NC8 Brown
NC9 Green
NC10 Blue
NC11 Bluish-black
NC12 Grey
NC13 Black

3.13. **Roots** (modified from FAO, 2006)

Presence/absence of roots is the most essential information to take notice of. If there is a sudden change in the quantity and/or size of the roots it is very important to explain why. Possible root limiting factors are: compaction (check the bulk density), cementations, discontinuous pore system etc. A qualitative description of the size and the abundance of roots is important. Sometimes it may be useful to record additional information, such as an abrupt change in root orientation.
Remember the abundance of roots should only be compared within the same size class.

*3.13.1. **Abundance** (number of roots/dm^2) **per size class*** ***[ROO1_ABU; ROO2_ABU; ROO3_ABU; ROO4_ABU]***

Code	**Size class:** / **Abundance:**	**Very fine** **ROO1_ABU** <0.5 mm	**Fine** **ROO2_ABU** 0.5-2 mm	**Medium** **ROO3_ABU** 2-5 mm	**Coarse** **ROO4_ABU** >5 mm
OA0	None	0	0	0	0
OA1	Very few	1 - 20	1 - 20	1 - 2	1 - 2
OA2	Few	20 - 50	20 - 50	2 - 5	2 - 5
OA3	Common	50 - 200	50 - 200	5 - 20	5 - 20
OA4	Many	>200	>200	>20	>20

Example: common very fine, few fine, very few medium and no coarse roots, will be reported as:
Common very fine: ROO1_ABU: OA3;
Few fine ROO2_ABU: OA2;
Very few medium ROO3_ABU: OA1;
None Coarse ROO4_ABU: OA0

3.13.2. Effective rooting depth ***[ROO_D]***

The effective rooting depth may be defined as the depth of the soil at which root growth is strongly inhibited. Rooting depth being plant specific, it is recommended that representative species are used to indicate the effective rooting depth of the soil. The effective rooting depth is governed by such factors as the presence of cemented, toxic or compacted layers, hard rock, or indurated gravel layers. A high permanent water table may also control the rooting depth, but may change after drainage. The effective hydrological depth may be much greater. Apart from obvious situations such as the presence of hard rock, it is realized that the estimation of effective rooting depth is subject to individual interpretation.
Example: The code for rooting depth is OD, so if the rooting depth is 113 cm, it is written as OD113.

3.14. **Other biological features** (FAO, 2006)

Krotovinas (an animal burrow, which has been filled with material from another horizon), insect nests, worm casts, burrows or other disturbances of larger animals such as mole, rabbit, badger, fox etc., are described in terms of abundance and kind. In addition, specific locations, patterns, size, composition or any other characteristic may be recorded.

3.14.1. Kind *[BIO-KIND]*

Examples of biological features:

BK1 Burrows (unspecified)
BK2 Open large burrows
BK3 Infilled large burrows
BK4 Earthworm channels
BK5 Ant channels and nests
BK6 Other insect activity
BK7 Pedotubules[1]
(voids filled with soil material by faunal and floral activity, see also footnote)
BK8 Charcoal

3.14.2. Abundance *[BIO-ABU]*

Abundance of biological activity is recorded as a percentage of the exposed surface:

BA1	Few	<5%
BA2	Common	5-15%
BA3	Many	15-40%
BA4	Abundant	>40%

3.15. **Carbonates** (modified from FAO, 2006)

The presence of calcium carbonate ($CaCO_3$) is established by adding some drops of 10% HCl to the soil. Following information should be collected per horizon:

- Is the matrix calcareous or non-calcareous (the exact quantity on carbonates will be tested in the laboratory). If traces are found in at least one horizon of the profile, the presence/absence should be recorded for all horizons.
- Is the carbonate at least partly secondary (pedogenic).

3.15.1. Presence *[CAR_PR]*

Following categories apply:

KK0 No presence of carbonates
KK1 Matrix is non-calcareous, but secondary carbonate is present
KK2 Matrix is calcareous, no evidences of secondary carbonate
KK3 Matrix is calcareous, and secondary carbonate is present

3.15.2. Type of secondary carbonates *[CAR_TYP]*

The type of secondary carbonate should be described. Following categories has been defined, more can be defined where applicable:

KT1 Capping
KT2 Coatings
KT3 Nodules
KT4 Pendants
KT5 Pseudomycelia
KT6 Others (define)

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[1] The term pedotubules is proposed for a group of pedological features which have a tubular external form and which are distinguished from cutans by their complex internal composition and fabric. Pedotubules are classified according to their internal fabric and composition, details of external form, distinctness, and by a comparison of their fabric and composition with that of the horizons of the soil profile. Their general morphology suggests their origin as voids caused by faunal and floral (root) activity which have been filled, or partially filled, with soil material. Since little is known of the details of the effects of faunal activity on soil materials, such interpretations are tentative (Brewer and Sleeman, 1963)

3.16. **Readily soluble salts** (modified from FAO, 2006) **[SALT_PR]**

Readily soluble salts are more soluble than gypsum; the most common salts are chlorides.
The salt content of the soil can be estimated from the electrical conductivity (EC in dS/m = mS/cm) measured in a saturated soil paste or a more diluted suspension of soil/water. If salts are observed during fieldwork, the electric conductivity of a saturated paste should be analysed for all horizons in the soil.

Is salt present?

Y	Evidences of soluble salts
N	No evidences of soluble salts
X	Not known

3.17. **Odour**

Any particular smell is described according to type and intensity of the smell. It is important to test the smell on freshly sampled soil material. NOTICE, in case of strong soil pollution do not perform this test!

3.17.1. Type of odour *[ODOUR_TYP]*

OT0	None	No smell detected
OT1	Petrochemical	Smell of oil, gasoline, diesel etc.
OT2	Sulphurous	Presence of hydrogen sulphide. This is evidences by a smell of rotten eggs
OT3	Other	Other smell, please describe

3.17.2. Degree (intensity) of the odour *[ODOUR_DEG]*

OD1	Faint
OD2	Distinct
OD3	Intense

3.18. **Man-made materials** (simplified from FAO, 2006) **[MMM]**

The areas dominated or significantly changed by human activity are rapidly extending. Of particular importance are the man-made materials found in soils; their age, amount, state and composition determine their durability and environmental impact. Any human impact on the soil should be recorded. Examples are:

- Evidences of past agriculture
- Presence of artefacts (e.g. ceramics)
- Remains of past structures (e.g. postholes)
- Other features of possible human origin (e.g. charcoal)

3.19. **Human-transported material** (simplified from FAO, 2006) **[HTM]**

This is any material brought onto the site. This may be for agricultural purposes (e.g. large-scale terracing, mine spoil…), for human settlement, or simply to dispose of material (e.g. dredgings). It is a soil parent material in the same way as alluvium.

3.20. **Soil horizon designation** (Langohr, 1994; Schoeneberger et al., 2002; Soil Survey Staff, 2003; Englisch et al., 2005; FAO, 2006)

The term horizon indicates a soil layer presumed to bear the imprint of soil forming processes, as opposed to layers that are laid down by sedimentation, volcanic activity or other geological events.

Horizons are identified by symbols that consist of one or two capital letters for the master horizon and lower case letter suffixes for subordinate distinctions, with or without a figure suffix. More detailed definitions of the different horizon symbols and rules that applies are found in appendix D.

3.20.1. Master horizons and layers [HOR_MAS]

The capital letters H, O, A, E, B, C, R and I represent the master horizons or layers. Genetic horizons are not equivalent to diagnostic horizons, although they may be identical in soil profiles. Diagnostic horizons are quantitatively defined features used in classification.

H Dominated by organic material. All H horizons are saturated with water for prolonged periods or were once saturated but are now drained

O Dominated by organic material that is not saturated with water for prolonged periods.

A subdivision of the O layer is made according to the following definitions:

OL (Litter, Förna): this organic horizon is characterised by an accumulation of mainly leaves/needles, twigs and woody materials. Most of the original biomass structures are easily discernible. Organic fine substance amounts to less than 10 % by volume.

OF (Fragmented and/or altered): this organic horizon is characterised by an accumulation of partly decomposed (i.e. fragmented, bleached, spotted) organic matter derived mainly from leaves/needles, twigs and woody materials. The proportion of organic fine substance is 10 % to 70 % by volume.

OH (humus, humification): characterised by an accumulation of decomposed organic matter. The original structures and materials are not discernible. Organic fine substance amounts to more than 70 % by volume.

A Mineral horizon formed at the surface or below an O horizon, in which all or much of the original structure of the parent material has been obliterated.

E Mineral horizon in which the main feature is loss of clay, iron, aluminium, or some combination of these.

B Horizon formed below an A, E, H or O horizon, and in which the dominant features are the obliteration of all or much of the original structure of the parent material

C Horizon, excluding hard bedrock, that is little affected by pedogenetic processes (lacks properties of H, O, A, E, or B horizon.

3.20.2. Transitional horizons

There are two kinds of transitional horizons: those with properties of two horizons superimposed and those with the two properties separate.

Superimposed: Examples: AB, EB, BE, BC…
Two properties separate: Examples: A/B, B/C, C/R, B/I…

3.20.3. Subordinate characteristics within master horizons and layers [HOR_SOR]

Designations of subordinate distinctions and features within the master horizons and layers are based on characteristics observable in the field. Lower case letters are used as suffixes to designate specific kinds of master horizons and layers, and other features. The list of symbols and terms is shown in Table 5 and explanations are given below:

Table 5: Subordinate characteristics within master horizons

b	Buried horizon	**l**	Capillary fringe mottling (gleying)
c	Concretions or nodules.	**n**	Pedogenetic accumulation of exchangeable sodium
d	Dense horizon (physically root-restrictive; not used in combination with m).	**p**	Ploughing or other artificial disturbance
g	Mottles due to stagnic conditions	**r**	Strong reduction
h	Accumulation of organic matter	**t**	Illuvial accumulation of clay

i	Slickensides	**u**	Urban and other man-made materials
j	Jarosite accumulation	**w**	Development of colour or structure in B (only used with B)
k	Accumulation of pedogenetic carbonates	**z**	Pedogenetic accumulation of salts more soluble than gypsum

3.20.4. Vertical subdivisions *[HOR_VER]*

A horizon or layer designated by a single combination of letter symbols can be subdivided using arabic numerals following the letters. Within a C, for example, successive layers could be C1, C2, C3, etc.; or if the lower part is gleyed and the upper part is not, the designations could be C1-C2-Cg1-Cg2 or C-Cg1-Cg2-R.

These conventions apply whatever the purpose of subdivision. A horizon identified by a single set of letter symbols may be subdivided on the basis of morphology, such as structure, colour, or texture. These subdivisions are numbered consecutively. The numbering restarts with 1 at whatever level in the profile. Thus Bt1-Bt2-Btk1-Btk2 is used, not Bt1-Bt2-Btk3-Btk4.

The numbering of vertical subdivisions within a horizon is not interrupted at a discontinuity (indicated by a numerical prefix) if the same letter combination is used in both materials: Bs1-Bs2-2Bs3-2Bs4 is used, not Bs1-Bs2-2Bs1-2Bs2. A and E horizons can be subdivided similarly, for example Ap1, A1, A2, Ap2, A3; and E1, E2, Eg1, Eg2.

3.20.5. Discontinuities *[HOR_DISC]*

In mineral soils, arabic numerals are used as prefixes to indicate discontinuities. Wherever needed, they are used preceding A, E, B, C and R. They are not used with I, although this symbol clearly indicate a discontinuity. These prefixes are distinct from arabic numerals used as suffixes to denote vertical subdivisions.

A discontinuity is a significant change in particle size distribution or mineralogy that indicates a difference in the material from which the horizons formed or a significant difference in age, or both - unless that difference in age is indicated by the suffix b. Symbols to identify discontinuities are used only when they will contribute substantially to the reader’s understanding of relationships among horizons. The stratification common in soils formed in alluvium is not designated as discontinuities - unless particle size distribution differs markedly from layer to layer - even though genetic horizons have formed in the contrasting layers.

Where a soil has formed entirely in one kind of material, no prefix is used (the whole profile is material 1). Similarly, the uppermost material in a profile having two or more contrasting materials is understood to be material 1, but the number is omitted. Numbering starts with the second layer of contrasting material, which is designated 2. Underlying contrasting layers are numbered consecutively. Even though a layer below material 2 is similar to material 1, it is designated 3 in the sequence. The numbers indicate a change in the material, not the type of material. Where two or more consecutive horizons formed in one kind of material, the same prefix number applies to all of the horizon designations in that material, e.g. Ap-E-Bt1-2Bt2-2Bt3-2BC. The number suffixes designating subdivisions of the Bt horizon continue in consecutive order across the discontinuity.

If an R layer is below a soil that formed in residuum and the material of the R layer is judged to be like that from which the material of the soil weathered, the arabic number prefix is not used. If the R layer would not produce material like that in the solum, the number prefix is used, as in A-Bt-C-2R or A-Bt-2R. If part of the solum formed in residuum, R is given the appropriate prefix: Ap-Bt1-2Bt2-2Bt3-2C1-2C2-2R.

In organic soils, discontinuities between different kinds of layers are not identified. In most cases the differences are shown by the letter suffix designations, if the different layers are organic, or by the master symbol if the different layers are mineral.

3.21. Sampling

The samples taken is noticed, with following data (see also appendix C: Recommendations for quality soil sampling and strategy):

- Sample number
- Horizon number
- Sampling depth
- Type of sample (composite sample, weighted average sample…)

4. Additional information, not recorded in the field

4.1. Elevation [ELEV]

The elevation or altitude (m) of the site relative to sea level should be obtained as accurately as possible, preferably from detailed topographic maps.

4.2. Climatic data [TEMP; RAIN]

Collect from the meteorological station most representative to the experimental site following data:

- the mean temperatures (in °C) for each month of the year
- the mean precipitation (in mm) for each month of the year.
- The time frame that the data are based on (e.g. 30 years mean values)
- The name, altitude and location (latitude-/ longitude coordinates) of the climatic station with respect to the soil profile

Example: Annual mean temperature: 9.4°C
Annual mean precipitation 838 mm
Data based on the period 1931-1960. Meteorological staion Uccle, located at 95 m altitude, at the Royal Meteorological Institute in Brussel.

4.3. Description status [DESC_STA]

The status of the description refers to the quality of the soil description and accompanying analytical data. The status is allocated after completion of the analyses.
The following distinctions are made:

DS1 Reference profile description: All essential elements or details are complete. The accuracy and reliability of the description, sampling and analysis permit the full characterization of all soil horizons to a depth of 125 cm, or more if required for classification, or down to a C or R horizon or layer, which may be shallower.

DS2 Routine profile description. No essential elements are missing from the description, sampling or analysis. The number of samples collected is sufficient to characterize all major soil horizons, but may not allow precise definition of all sub-horizons, especially in the deeper soil. The profile depth is 80 cm or more, or down to a C or R horizon or layer, which may be shallower. Additional augering and sampling may be required for lower level classification.

DS3 Incomplete description: Certain relevant elements are missing from the description, insufficient samples were taken, or the reliability of the analytical data does not permit a complete characterization of the soil. However, the description may still be useful for specific purposes and provides a satisfactory indication of the nature of the soil at high levels of soil classification.

DS4 Soil auger description: Soil augering does not permit comprehensive soil description, but are suitable for soil observation and identification in soil mapping. Soil samples may be collected from augerings.

DS5 Other descriptions: Essential elements are missing from the description, preventing a satisfactory soil characterization and classification.

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APPENDIX A: Codes for parent materials

- The parent material code must be selected from the list provided below. This list has evolved from a number of approximations using experiences from several pilot projects. The current version has been prepared as the reference list in the Manual for the Georeferenced Soil Database for Europe at 1 :250.000, version 1.1. It includes four levels: Major Class, Group, Type and Subtype.
- Depending on the level of detail available to describe the dominant and secondary parent materials of the STU, i.e. Major Class or Group or Type or Sub-type, the user will choose any one of the codes provided in the table.

Whenever possible, it is recommended to identify as precisely as possible the exact type of parent material, using the full 4 digit code. For example, calcareous sandstone (1211) is preferred over sandstone (1210) or over psammite (1200). The latter should be used either if the type of sandstone has not been precisely defined on the soil maps, or when more than one type of sandstone is present in the STU.

The parent material (Reference Soil Geographical Data Base):

Major Class level		Group level		Type level		Sub-type level	
0000	no information						
5000	unconsolidated deposits (alluvium, weathering residuum and slope deposits)	5100	marine and estuarine sands	5110	pre-quaternary sand	5111	tertiary sand
				5120	quaternary sand	5121	Holocene coastal sand with shells
						5122	delta sand
		5200	marine and estuarine clays and silts	5210	pre-quaternary clay and silt	5211	tertiary clay
						5212	tertiary silt
				5220	quaternary clay and silt	5221	Holocene clay
						5222	Holocene silt
		5300	fluvial sands and gravels	5310	river terrace sand or gravel	5311	river terrace sand
						5312	river terrace gravel
				5320	floodplain sand or gravel	5321	floodplain sand
						5322	floodplain gravel
		5400	fluvial clays, silts and loams	5410	river clay and silt	5411	terrace clay and silt
						5412	floodplain clay and silt
				5420	river loam	5421	terrace loam
				5430	overbank deposit	5431	floodplain clay and silt
						5432	floodplain loam
		5500	lake deposits	5510	lake sand and delta sand		
				5520	lake marl, bog lime		
				5530	lake silt		
		5600	residual and redeposited loams from silicate rocks	5610	residual loam	5611	stony loam
						5612	clayey loam
				5620	redeposited loam	5621	running-ground
		5700	residual and redeposited clays from calcareous rocks	5710	residual clay	5711	clay with flints
						5712	ferruginous residual clay
						5713	calcareous clay
						5714	non-calcareous clay
						5715	marly clay
				5720	redeposited clay	5721	stony clay
		5800	slope deposits	5810	slope-wash alluvium		
				5820	colluvial deposit		
				5830	talus scree	5831	stratified slope deposits
7000	aeolian deposits	7100	loess	7110	loamy loess		
				7120	sandy loess		
		7200	aeolian sands	7210	dune sand		
				7220	cover sand		
8000	organic materials	8100	peat (mires)	8110	rainwater fed moor peat (raised	8111	folic peat
						8112	fibric peat

					bog)	8113	terric peat
				8120	groundwater fed bog peat		
		8200	slime and ooze deposits	8210	gyttja, sapropel		
9000	anthropogenic deposits	9100	redeposited natural materials	9110	sand and gravel fill		
				9120	loamy fill		
		9200	dump deposits	9210	rubble/rubbish		
				9220	industrial ashes and slag		
				9230	industrial sludge		
				9240	industrial waste		
		9300	anthropogenic organic materials				

APPENDIX B: Detailed definitions, rules and conventions on master and subordinate horizon symbols

Master horizons and layers [HOR_MAS]

H horizon: Dominated by organic material, formed from accumulations of fresh or partially decomposed organic material at the soil surface (which may be under water). All H horizons are saturated with water for prolonged periods or were once saturated but are now drained. A H horizon may be on top of mineral soils or at any depth beneath the surface if it is buried.

O horizon: Dominated by organic material, consisting of fresh, partially or completely decomposed litter (such as leaves, needles, twigs, moss, and lichens) that has accumulated on the surface; it may be on top of either mineral or organic soil. It is not saturated with water for prolonged periods. The mineral fraction of such material is only a small part of the volume of the material and generally is much less than half of the mass.
An O layer may be at the surface of a mineral soil or at any depth beneath the surface if it is buried. A horizon formed by illuviation of organic material into mineral subsoil is not an O horizon.
A subdivision of the O layer is made according to the following definitions:

- **OL** (Litter, Förna): this organic horizon is characterised by an accumulation of mainly leaves/needles, twigs and woody materials. Most of the original biomass structures are easily discernible. Leaves and/or needles may be discoloured and slightly fragmented. Organic fine substance (in which the original organs are not recognisable with naked eye) amounts to less than 10 % by volume.

- **OF** (fragmented and/or altered): this organic horizon is characterised by an accumulation of partly decomposed (i.e. fragmented, bleached, spotted) organic matter derived mainly from leaves/needles, twigs and woody materials. The proportion of organic fine substance is 10 % to 70 % by volume. Depending on humus form, decomposition is mainly accomplished by soil fauna (mull, moder) or cellulose-decomposing fungi. Slow decomposition is characterised by a partly decomposed matted layer, permeated by hyphae.

- **OH** (humus, humification): characterised by an accumulation of decomposed organic matter. The original structures and materials are not discernible. Organic fine substance amounts to more than 70 % by volume. OH differs from the OF horizon by showing a more advanced humification due to the action of soil organisms

A horizon: A mineral horizon formed at the surface or below an O horizon, in which all or much of the original structure of the parent material has been obliterated and characterized by one or more of the following:

- An accumulation of humified organic matter intimately mixed with the mineral fraction and not displaying properties characteristic of E or B horizons (see below);
- Properties resulting from cultivation, pasturing, or similar kinds of disturbance;
- A morphology that is different from the underlying B or C horizon, resulting from processes related to its surface position.

If a surface horizon has properties of both A and E horizons but the dominant feature is an accumulation of humified organic matter, it is designated an A horizon. Where the climate is warm and arid, the undisturbed surface horizon may be less dark than the underlying horizon and contains only small amounts of organic matter. It has a morphology distinct from the C layer, though the mineral fraction may be unaltered or only slightly altered by weathering; such a horizon is designated

A because it is at the surface. Examples of surface horizons which may have a different structure or morphology due to surface processes are Vertisols, soils in pans or playas with little vegetation, and soils in deserts.
Recent alluvial, colluvial or aeolian deposits that retain fine stratification are not considered to be an A horizon unless cultivated.

E horizon: A mineral horizon in which the main feature is loss of clay, iron, aluminium, or some combination of these, leaving a concentration of coarse particles, and in which all or much of the original structure of the parent material has been obliterated.
An E horizon is usually, but not necessarily, lighter in colour than an underlying B horizon. In some soils, the colour is that of the sand and silt particles but, in many soils, coatings of iron oxides or other compounds mask the colour of the primary particles. An E horizon is most commonly differentiated from an underlying B horizon in the same soil profile by colour of higher value or lower chroma, or both; by coarser texture; or by a combination of these properties. An E horizon is commonly near the surface, below an O or A horizon and above a B horizon, but the symbol E may be used without regard to position in the profile for any horizon that meets the requirements and that has resulted from soil processes.

B horizon: A horizon formed below an A, E, H or O horizon, and in which the dominant features are the obliteration of all or much of the original structure of the parent material, together with one or a combination of the following:

- Illuvial concentration of clay, iron, aluminium, humus, carbonates, gypsum, silica or some combination of these;
- Evidence of removal of carbonates;
- Residual concentration of iron and aluminium oxides;
- Coatings of humus and/or oxides that make the horizon conspicuously lower in value, higher in chroma, or redder in hue than overlying and underlying horizons;
- Alteration that forms silicate clay or liberates oxides or both, and that forms a granu¬lar, blocky, or prismatic structure if volume changes accompany changes in moisture content;
- Brittle consistence.

All kinds of B horizons are, or were originally, subsurface horizons. Included as B horizons are layers of illuvial concentration of carbonates, gypsum, or silica (these horizons may or may not be cemented) and brittle horizons that have other evidence of alteration, such as prismatic structure or illuvial accumulation of clay.
Examples of layers that are not B horizons are layers in which clay films either coat rock fragments or are on finely stratified unconsolidated sediments, whether the films were formed in place or by illuviation; layers into which carbonates have been illuviated but that are not contiguous with an overlying pedogenetic horizon; and layers with gley colours but no other pedogenetic changes.

C horizon: A horizon, excluding hard bedrock, that is little affected by pedogenetic processes (lacks properties of H, O, A, E, or B horizon). The material of C layers may be either like or unlike that from which the soil is presumed to have formed. A C layer may have been modified even if there is no evidence of pedogenesis. Plant roots can penetrate C layers, which provide an important growing medium.
Included as C layers are sediments, saprolite, and unlithified geological materials that, commonly, slake within 24 hours when air-dry chunks are placed in water and, when moist, can be dug with a spade.. Some soils form in material that is already highly weathered; such material that does not meet the requirements of A, E or B horizons is designated C. Changes not considered pedogenetic are those not related to overlying horizons. Layers having accumulations of silica, carbonates, or gypsum, even if indurated, may be included in C layers, unless the layer is obviously affected by pedogenetic processes; then it is a B horizon.

Transitional horizons

There are two kinds of transitional horizons: those with properties of two horizons superimposed and those with the two properties separate.

For horizons dominated by properties of one master horizon but having subordinate properties of another, two capital letter symbols are used, such as AB, EB, BE and BC. The master horizon symbol that is given first designates the dominant properties: an AB horizon, for example, has characteristics of both an overlying A horizon and an underlying B horizon, but is more like the A than like the B.
In some cases, a horizon can be designated as transitional even if one of the master horizons to which it is apparently transitional is not present. A BE horizon may be recognized in a truncated soil if its properties are similar to those of a BE horizon in a soil in which the overlying E horizon has not been removed. An AB or a BA horizon may be recognized where bedrock underlies the transitional horizon. A BC horizon may be recognized even if no underlying C horizon is present; it is transitional to assumed parent material. A CR horizon can be used for weathered bedrock which can be dug with a spade though roots cannot penetrate except along fracture planes.
Horizons or layers in which distinct parts have recognizable properties of two kinds of master horizons are indicated as above, but the two capital letters are separated by a stroke (/), as E/B, B/E, B/C or C/R. Commonly, most of the individual parts of one component are surrounded by the other material.

Subordinate characteristics within master horizons and layers [HOR_SOR]

Designations of subordinate distinctions and features within the master horizons and layers are based on characteristics observable in the field. Lower case letters are used as suffixes to designate specific kinds of master horizons and layers, and other features. The list of symbols and terms is explained more in detail below:

b	Buried horizon: Used in mineral soils to indicate identifiable buried horizons with characteristics that were formed before burial. Horizons may or may not have developed in the overlying materials which may be either like, or unlike, the assumed parent material of the buried soil. The symbol is not used in organic soils or to separate an organic layer from a mineral layer, in cryoturbated soils, or with C layers.
c	Concretions or nodules: In mineral soil it indicates a significant accumulation of concretions or of nodules. The nature and consistence of the nodules is specified by other suffixes and in the horizon description.
d	Dense layer: Used in mineral soils to indicate a layer of relatively unaltered, mostly earthy material that is not cemented but that has such bulk density or internal organization that roots cannot enter except in cracks; the symbol is not used in combination with the symbols m (cementation) and x (fragipan).
g	Stagnic conditions: Designates horizons in which a distinct pattern of mottling occurs that reflects alternating conditions of oxidation and reduction of sesquioxides, caused by seasonal surface waterlogging. If aggregates are present, the interiors of the aggregates show oxidizing colours and the surface parts reducing colours.
h	Accumulation of organic matter: Designates the accumulation of organic matter in a mineral horizon. The accumulation may occur in a surface horizon or in subsurface horizons (through illuviation).
i	Slickensides: In mineral soils, denotes the occurrence of slickensides, i.e. oblique shear faces caused by the shrink-swell action of clay; wedge-shaped polished peds and seasonal surface cracks are commonly present.
j	Jarosite: Indicates the presence of jarosite (straw-yellow) mottles, coatings or hypodermic coatings.
k	Accumulation of pedogenetic carbonates: Indicates an accumulation of alkaline earth carbonates, commonly calcium carbonate.
l	Capillary fringe mottling: Indicates mottling caused by ascending groundwater. If aggregates are present, the interiors of the aggregates show reducing colours and the surface parts oxidizing colours.
n	Pedogenetic accumulation of exchangeable sodium.
o	Residual accumulation of iron/aluminium oxides: Indicates residual accumulation of sesquioxides, as opposed to the symbol s, which indicates illuvial accumulation of oxides or organic and oxide mixture.

p	Ploughing or other artificial disturbance: Indicates mixing of the surface layer by ploughing or other tillage practices. A disturbed organic horizon is designated Op or Hp. A disturbed mineral horizon, even though clearly originally an E, B or C, is designated Ap.
r	Strong reduction: Indicates presence of iron in reduced state. If r is used with B, pedogenetic change in addition to reduction is implied; if no other change has taken place, the horizon is designated Cr.
t	Accumulation of clay: Used with B or C to indicate an accumulation of clay that either has formed in the horizon or has been moved into it by illuviation, or both. At least some part should show evidence of clay accumulation in the form of coatings on ped surfaces or in pores, as lamellae, or as bridges between mineral grains.
u	Urban and other man-made materials: Used to indicate the dominant presence of man-made materials.
w	Development of colour or structure in B: Indicates development of colour or structure, or both, in B horizons lacking other diagnostic characteristics. It is not used to indicate a transitional horizon.
z	Pedogenetic accumulation of salts more soluble than gypsum.

Conventions for using letter suffixes

Many master horizons and layers that are symbolized by a single capital letter will have one or more lowercase letter suffixes. More than three suffixes is cumbersome. The following rules apply:

- Letter suffixes should immediately follow the capital letter;
- A B horizon that has significant accumulation of clay and also shows evidence of develop¬ment of colour or structure, or both, is designated Bt (t has precedence over w, s and h);
- Suffixes are listed alphabetically.

APPENDIX C: Field recording forms

Chap-ter	Reporting category title	Reporting category code	Field observations:
1.1	Site name	[PLOT]	
1.2	Observation no.	[P-NO]	
1.3	Date and time	[DATE]	
		[TIME]	
1.4	Author(s)	[AUT]	
1.5	Site location	[LOCA]	
1.6	Profile coordinates	[LAT]	
		[LONG]	
2.1.1	Present weather	[WETH-PR]	
2.2.1	Meso landform	LND-FRM	
2.2.2	Slope position	[TERR]	
2.2.3	Slope form	[SLP-FRM]	
2.2.4	Slope gradient	[SLP-GRD]	
2.2.5	Slope length	[SLOPE-LGT]	
2.2.6	Slope orientation	[SLOPE-ORI]	
2.3.1	General surface topo.	[MUD-MOR]	
	Depth depressions	[DEP-D]	
	Diameter depressions	[DEP-SIZE]	
	Ripples general morp.	[RIP-MOR]	
	Ripples abundance	[RIP-ABU]	
	Ripples height	[RIP-ELEV]	
	Ripples wideness	[RIP-WID]	
	Ripples length	[RIP-LGT]	
2.3.2	Special surface morp.	[MUD-SMOR]	
	Rill mark size	[RILL-SIZE]	
	Rill mark length	[RILL-LGT]	
	Rill mark distance	[RILL-DIS]	
	Micro cliff height	[MCLIF-ELEV]	
	Micro cliff position	[MCLIF-LOCA]	

Chap-ter	Reporting category title	Reporting category code	Field observations:
2.4.1	Cliff height	[CLIF-ELEV]	
2.4.2	Cliff slope	[CLIF-SLP]	
2.4.3	Cliff form	[CLIF-FRM]	
2.4.4	Cliff vegetation	[CLIF-VEG]	
2.4.5	Thickness root layer	[THK-ROO]	
2.4.6	Cliff coarse fragments	[CLIF-STO]	
2.5	Land use	[USE]	
	Hunting allowed	[WILDLIFE]	
	Domestic grazing	[GRAZING]	
2.6	Human influence	[HUM-INF]	
2.7	Parent material	[PAR-MAT]	
2.8	Drainage class	[DRA-CLAS]	
2.9	External drainage	[EXT-DRA]	
2.10.1	Flooding frequency	[FLO-FRQ]	
2.11.1	Surface cover	[STO-COV]	
2.11.2	Size classes	[STO-SIZE]	
2.12.1	Type erosion	[ERO]	
2.12.2	Area affected	[ERO-AREA]	
2.12.3	Degree	[ERO-DEG]	
2.12.4	Activity	[ERO-ACT]	
2.13.1	Surface crack, size	[CRK-SIZE]	
2.13.2	Distance of cracks	[CRK-DIS]	
2.14.1	Salt, cover	[SALT-COV]	
2.14.2	Thickness	[SALT-THK]	

Additional information related to the site description:

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Chap-ter	Reporting category title	Reporting category code	Plot no. [PLOT]: Field observations (mineral horizons): H1	H2	H3	Profile no. [P-NO]: H4	H5	H6	H7
3.1.2	**Horizon** -depth	[D-HOR-L]							
3.1.3	-distinctness	[HOR-DIST]							
3.1.4	-topography	[HOR-TOPO]							
3.3	**Soil colour** -moist	[M-COL]							
	-dry	[D-COL]							
	-wet	[W-COL]							
3.4.1	**Mottling** -colour	[MOT-COL]							
3.4.2	-abundance	[MOT-ABU]							
3.4.3	-size	[MOT-SIZE]							
3.4.4	-contrast	[MOT-CNT]							
3.4.5	-boundary	[MOT-BDR]							
3.5.1	**Reducing** conditions	[RED]							
3.5.2	Reductimorphic colours	[COL-REDU]							
	Oximorphic colours	[COL-OXIM]							
3.6	Texture class	[TEX-CLAS]							
3.7.1	**Gravel** -abundance	[GRAVEL-ABU]							
3.7.2	-size	[GRAVEL-SIZE]							
3.7.3	-shape	[GRAVEL-SHP]							
3.7.4	-weathering	[GRAVEL-WTH]							
3.7.5	-nature (type)	[GRAVEL-TYP]							
3.8.1	**Structure** -type	[STRUCT1-TYP]							
3.8.2	Size	[STRUCT1-SIZE]							
3.8.3	Grade	[STRUCT1-GRD]							

Chap- ter	Reporting category title	Reporting category code	Field observations (mineral horizons): H1	H2	H3	H4	H5	H6	H7
3.8.1	**Structure** -type	[STRUCT2-TYP]							
3.8.2	Size	[STRUCT2-SIZE]							
3.8.3	Grade	[STRUCT2-GRD]							
3.8.4	Rock struc.: form	[STRUCT1-FRM]							
	Rock struc.: disturbance	[STRUCT1-DISB]							
3.9.1	**Concistence** -dry	[D-CONS]							
3.9.2	-moist	[M-CONS]							
3.9.3	-wet, stickiness	[W-CONS-S]							
	-wet, plasticity	[W-CONS-PL]							
3.10	**Porosity** -abundance	[POR-ABU]							
3.11.1	**Cementation** -type	[CEM-TYP]							
3.11.2	-continuity	[CEM-CTN]							
3.11.3	-structure	[CEM-STRUCT]							
3.11.4	-degree	[CEM-DEG]							
3.12.1	**Nodules** -kind	[NOD-KIND]							
3.12.2	-type	[NOD-TYP]							
3.12.3	-abundance	[NOD-ABU]							
3.12.4	Size	[NOD-SIZE]							
3.12.5	Shape	[NOD-SHP]							
3.12.6	Hardness	[NOD-HARD]							
3.12.7	Colour	[NOD-COL]							

Chap-ter	Reporting category title	Reporting category code	Field observations (mineral horizons):						
			H1	H2	H3	H4	H5	H6	H7
3.13.1	**Roots- Abundance**								
	-very fine	[ROO1-ABU]							
	-fine	[ROO2-ABU]							
	-medium	[ROO3-ABU]							
	-coarse	[ROO4-ABU]							
3.13.2	Effective rooting depth	[ROO-D]							
3.14.1	**Carbonates -**presence	[CAR-PR]							
3.14.2	-type	[CAR-TYP]							
3.15	**Salt**	[SALT-PR]							
3.16	**Man-made materials**	[MMM]							
3.17	**Transported material**	[HTM]							
3.18.1	**Master** symbols	[HOR-MAS]							
3.18.3	**Subordinate** symbol	[HOR-SOR]							
3.18.4	**Vertical subdivision**	[HOR-VER]							
3.18.5	**Discontinuities**	[HOR-DISC]							
	Soil sample taken:	[SAMPLE-LAB]							

Additional information related to the site description:

APPENDIX D: Database codes and forms

Summary description of the data contained in the soil profile database: partim site description.

No.	Name	Description	Type	Unit	Field Size
1	PLOT	Observation plot (e.g. 12)	Integer		4
2	P_NO	Profile number (e.g. 19)	Integer		4
3	DATE	Date of description (ddmmyy)	Integer		6
4	TIME	Time of description (hhmm)	Integer		5
5	AUT	Author(s) (use initials)	Text		8
6	LOCA	Location, user defined (e.g. municipality, village or forest name)	Text		20
7	LAT	Latitude profile coordinates (in degrees, minutes, seconds; e.g. +512331)	Real number		7
8	LONG	Longitude profile coordinates (in degrees, minutes, seconds)	Real number		7
9	WETH_PR	Present weather condition (e.g. PW1= sunny)	Character		3
10	LND_FRM	Meso scale land form	Character		5
11	TERR	Slope position (e.g. SP02= intermediate part)	Character		4
12	SLP_FRM	Slope form (e.g. SF1= straight, straight; SF4= convex, straight)	Character		4
13	SLP_GRD	Slope gradient (e.g. SG3= gently sloping, 2-5%)	Character		4
14	SLP_LGT	Slope length (e.g. 1175)	Real number	m	4
15	SLP_ORI	Slope orientation (e.g. E; NE)	Character		2
16	MUD_MOR	Tidal mud flat general surface morphology	Character		3
17	DEP_D	Depth of depressions (e.g. ID2= 5-10 cm)	Character		3
18	DEP_SIZE	Size of depressions	Character		3
19	RIP_MOR	Current ripple morphology	Character		3
20	RIP_ABU	Current ripple abundance	Character		3
21	RIP_ELEV	Current ripple height	Character		3
22	RIP_WID	Current ripple wideness	Character		3
23	RIP_LGT	Current ripple length	Character		3
24	MUD_SMOR	Tidal mud flat special surface morphology	Character		3
25	RILL_SIZE	Rill mark size	Character		3
26	RILL_LGT	Rill mark length	Character		3
27	RILL_DIS	Rill mark mutual distance	Character		3
28	MCLIF_ELEV	Micro cliff height	Character		3
29	MCLIF_LOCA	Micro cliff location on tidal mud flat	Character		3
30	CLIF_ELEV	Marsh cliff height	Character		3
31	CLIF_SLP	Marsh cliff gradient	Character		3
32	CLIF_FRM	Marsh cliff form	Character		3
33	MARSH_VEG	Marsh cliff vegetation	Character		3
34	THK_ROO	Thickness root layer	Character		3
35	CLIF_STO	Marsh cliff coarse fragments	Character		3
36	USE	Type of land use (e.g. LU11= natural forest and woodland with no felling)	Character		4
37	WILDLIFE	Is hunting allowed? (use: Y/N/X)	Character		1
38	GRAZING	Is grazing practised? (use: Y/N/X)	Character		1
39	HUM_INF	Human influence (e.g. HI03= mineral additions; HI05= ploughing), up to 3 answers are possible.	Character		12
40	PAR_MAT	Parent material (e.g. 2112= soft limestone)	Integer		4

41	DRA_CLAS	Drainage class (e.g. DC3= well drained)	Character		3
42	EXT_DRA	External drainage (e.g. EX5= rapid run-off)	Character		3
43	FLO_FRQ	Frequency of flooding (e.g. FF11= none)	Character		4
44	STO_COV	Coarse surface fragments, surface cover (e.g. RC3= common)	Character		3
45	STO_SIZE	Coarse surface fragments, size classes (e.g. RS5= boulders, 20-60 cm)	Character		3
46	ERO	Main categories of erosion and sedimentation (e.g. ES2= Sheet erosion)	Character		4
47	ERO_AREA	Area affected by surface erosion (e.g. EA0= 0%)	Character		3
48	ERO_DEG	Degree of surface erosion (e.g. ED7: severe erosion)	Character		3
49	ERO_ACT	Activity of surface erosion (e.g. EY4= active at present)	Character		3
50	CRK_SIZE	Width of surface cracks (e.g. SW5= Extremely wide)	Character		3
51	CRK_DIS	Distance between surface cracks (e.g. SD2= closely spaced)	Character		3
52	CRK_PTR	Surface crack pattern	Character		3
53	SALT_COV	Salt coverage (e.g. SV1= low, 2-15%)	Character		3
54	SALT_THK	Salt coverage thickness (SN2= medium, 2-5 mm)	Character		3

Summary description of the data contained in the soil profile database: partim soil horizon description:

No.	Name	Description	Type	Unit	Field size
55	HOR_NO	Horizon number (e.g. H11)	Character		3
57	D_HOR_L	Lower boundary of the horizon in cm. Organic surface horizons are indicated with negative depth values. The zero depth is per definition at the contact between the organic and the mineral soil.	Real number	cm	3
58	HOR_DIST	Distinctness of the horizon (e.g. BD2: clear))	Character		3
59	HOR_TOPO	Topography of the horizon (e.g. BT4: broken)	Character		3
60	M_COL	Moist colour (e.g. 7.5YR 5.5/6 becomes 7.5YR 5.5-6.0)	Character		13
61	D_COL	Dry colour (e.g. 1.5Y 4/2.5 becomes 1.5Y 4.0-2.5)	Character		13
62	W_COL	Wet colour (e.g. 5BG 6/1 becomes 5BG 6.0-1.0)	Character		13
63	MOT_ABU	Abundance of mottles (e.g. MA1: very few)	Character		3
64	MOT_COL	Colour of mottles (e.g. 10YR 6.0-6.0)	Character		13
65	MOT_SIZE	Size of mottles (e.g. MS2: fine)	Character		3
66	MOT_CNT	Contrast of mottles (e.g. MC3: prominent)	Character		3
67	MOT_BDR	Boundary of mottles (e.g. MB1: sharp)	Character		3
68	RED	Reducing conditions present (use: Y/N/X)	Character		1
69	COL_REDU	Reductomorphic mottles present (use: Y/N/X)	Character		1
70	COL_OXIM	Oximorphic mottles present (use: Y/N/X)	Character		1
71	TEX_CLAS	Texture class (e.g. S= sand; SiL= Silty loam; SiCL= Silty Clay Loam)	Character		4

72	GRAVEL_ABU	Abundance of rock fragments (e.g. RA3: many)	Character		3
73	GRAVEL_SIZE	Size of rock fragments (most important fraction)	Character		3
74	GRAVEL_SHP	Dominant shape of rock fragments (e.g. RF4: rounded)	Character		3
75	GRAVEL_WTH	State of weathering of rock fragments (e.g. RW1: weathered)	Character		3
76	GRAVEL_TYP1	Nature of rock fragments, most common mineral (e.g. 3110: granite)	Integer		4
77	GRAVEL_TYP2	Nature of rock fragments, second most common mineral	Integer		4
78	GRAVEL_TYP3	Nature of rock fragments, third most common mineral	Integer		4
79	STRUCT1_TYP	Primary soil structure, type (e.g. PT11: platy)	Character		4
80	STRUCT1_SIZE	Primary soil structure, size (e.g. PZ3: 2-5mm for platy)	Character		3
81	STRUCT1_GRD	Primary soil structure, grade (e.g. PG1: weak)	Character		3
82	STRUCT2_TYP	Secondary soil structure, type	Character		4
83	STRUCT2_SIZE	Secondary soil structure, size	Character		3
84	STRUCT2_GRD	Secondary soil structure, grade	Character		3
85	STRUCT1_FRM	(Rock) structure, form	Character		3
86	STRUCT1_DISP	(Rock) structure, type of disturbance	Character		3
87	D_CONS	Consistency when dry (e.g. CD2: slightly hard)	Character		3
88	M_CONS	Consistency when moist (e.g. CM2: friable)	Character		3
89	W_CONS_S	Consistency when wet, stickiness (e.g. CS0: non sticky)	Character		3
90	W_CONS_PL	Consistency when wet, plasticity (e.g. CP1: slightly plastic)	Character		3
91	POR_ABU	Total porosity, abundance (e.g. PA3: medium)	Character		3
92	CEM_TYP	Cementation, nature/type (e.g. TT3: carbonates)	Character		3
93	CEM_CTN	Cementation, continuity (e.g. TC2: discontinuous)	Character		3
94	CEM_STRUCT	Cementation, structure (e.g. TS4: nodular)	Character		3
95	CEM_DEG	Cementation, degree (e.g. TD4: cemented)	Character		3
96	NOD_KIND	Nodules, kind (NK1: crystal)	Character		3
97	NOD_TYP	Nodules, nature/type (e.g. NT6: clay)	Character		4
98	NOD_ABU	Nodules, abundance (e.g. NA0: none)	Character		3
99	NOD_SIZE	Nodules, size (e.g. NZ1: very fine)	Character		3
100	NOD_SHP	Nodules, shape (e.g. NS1: rounded)	Character		3
101	NOD_HARD	Nodules, hardness (e.g. NH1: hard)	Character		3
102	NOD_COL	Nodules, colour (e.g. NC2: yellow)	Character		4
103	ROO1_ABU	Very fine roots, abundance (e.g. OA1: very few)	Character		3
104	ROO2_ABU	Fine roots, abundance	Character		3
105	ROO3_ABU	Medium roots, abundance	Character		3
106	ROO4_ABU	Coarse roots, abundance	Character		3
107	ROO_D	Effective rooting depth	Real number	cm	5
108	CAR_PR	Carbonates: matrix calcareous (e.g. KK0: no presence of carbonates)	Character		3
109	CAR_TYP	Carbonates, type of secondary carbonates (e.g.	Character		3

		KT1: capping)			
110	SALT_PR	Readily soluble salts, presence (use: Y/N/X)	Character		1
111	MMM	Man made materials. User defined, please provide translation of used codes (e.g. AR= presence of artefacts)	Character		4
112	HTM	Human transported material. User defined please provide translation of used codes (e.g. MS= mine spoil)	Character		4
113	HOR_MAS	Soil horizon designation, master symbol (e.g. A, E, B, C, EB, E/B)	Character		3
114	HOR_SOR	Soil horizon designation, subordinate symbols (e.g. Bhs)	Character		4
115	HOR_VER	Horizon, vertical subdivision	Integer		1
	HOR_DISC	Horizon, discontinuity	Integer		1

Summary description of the data contained in the soil profile database: partim additional information not recorded in the field:

No.	**Name**	**Description**			**Field size**
116	ELEV	Elevation above mean sea level. If the exact figure is not known then apply ELEV_CODE for the appropriate altitude class.	Real number	m	4
117	TEMP	Mean annual temperature in °C, always indicated with one digit after the comma (e.g. 10.9°C)	Real number	°C	4
118	RAIN	Mean annual precipitation	Real number	mm	4