"Capacity Building and Strengthening Institutional Arrangement"

Workshop: Analysis and sampling of water

Environmental Sampling (Soil)

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PLAN OF THE SOIL SAMPLING PROGRAMME

The soil sampling programme must be accurately designed, before being performed.

The key element of a sampling programme should be:

- the objectives of the soil sampling;
- the sampling process to utilize for the attainment of the objectives of the soil sampling (strategies, sampling techniques, preservation and storage);
- preliminary research;
- timing of investigation.

DEFINITIONS

- *sample*: a portion of material selected from a larger quantity of material;
- *sampling:* process of obtaining a sample;
- *sampling sites*: a well delimeted area, where sampling operations take place;
- *representative sample:* sample resulting from a sampling plan that can be expected to reflect adequately the properties of interest in the parent polpulation.

PURPOSE OF SAMPLING

The object of sampling is to ensure that a sample or a group of samples accurately reflects the concentration of the contaminant(s) of concern at a given time and location and, therefore, accurately characterizes site conditions.

Production of a representative sample

SAMPLING OBJECTIVES

1. Sampling for the determination of general soil quality;
2. Sampling for preparation of soil maps;
3. Sampling to support legal or regulatory action;
4. Sampling for hazard and risk assessement.

The sampling objectives aid in determining the appropriate sampling strategies as well as the number of samples.

1. Sampling for determination of general soil quality

Such sampling is typically carried out at (irregular) time intervals to determine the quality of the soil for a particular purposee.g. for agriculture. As such it tends to concentrate on factors such as nutrient status, pH, organic matter content, trace element concentrations and physical fcators. Such sampling is usually carried out within the main rooting zone and also at greater depths.

2. Sampling for preparation of soil maps

Soil maps may be used in soil description, land appraisal (taxation), and for soil monitoring sites to establish the basic information on the genesis and distribution of naturally occuring or man-made soils, their chemical, mineralogical, biological composition, and their physical properties at selected locations. Special strategies are required to preserve samples in their original physical and chemical condition. Sampling is nearly always a one-off procedure.

3. Sampling to support legal or regulatory action

Sampling may be required to establish baseline conditions prior to an activity which might affect the composition or quality of soil, or it may be required following an antropogenic effect such as the input of an undesiderable material which may be from a point or a diffuse source.

Sampling strategies need to be developed on a site-specific basis.

4. Sampling for hazard and risk assessement

When land is contaminated with chemicals and other substances that are potentially harmuful to human health and safety or to the environment, it may be necessary to carry out an investigation as a part of a hazard and/or risk assessement, i.e. to determine the nature and the extent of contamination, to identify hazards associated with the contamination, to identify potential targets and routes of exposure, and to evaluate the risks relating to current and fure use of the site and neighbouring land.

Sampling strategies should be developed on a site-specific basis

PRELIMINARY RESEARCH

Collection of historical data and any useful information about (for exsample raw material used, product, waste, crop production etc) the sampling target (one hectar arable land, industrial or contaminated site,1000 m^2 seminatural area) as well as state, local file so to have:

- precise location areas of interest;

- information on sampling target condition (texture, soil condition, moisture, pedological info etc), what sampling tecnique?;

- identification of parameters of concern.

TIMING OF INVESTIGATION

In case of monitoring of characteristics or substance likely affected by seasonal factors or human activities (weather, soil conditioning/fertilization, use of plant-protective agents), these factors should be taken into account in the design of the sampling programme.

SAMPLING PROCESS

Sampling pattern

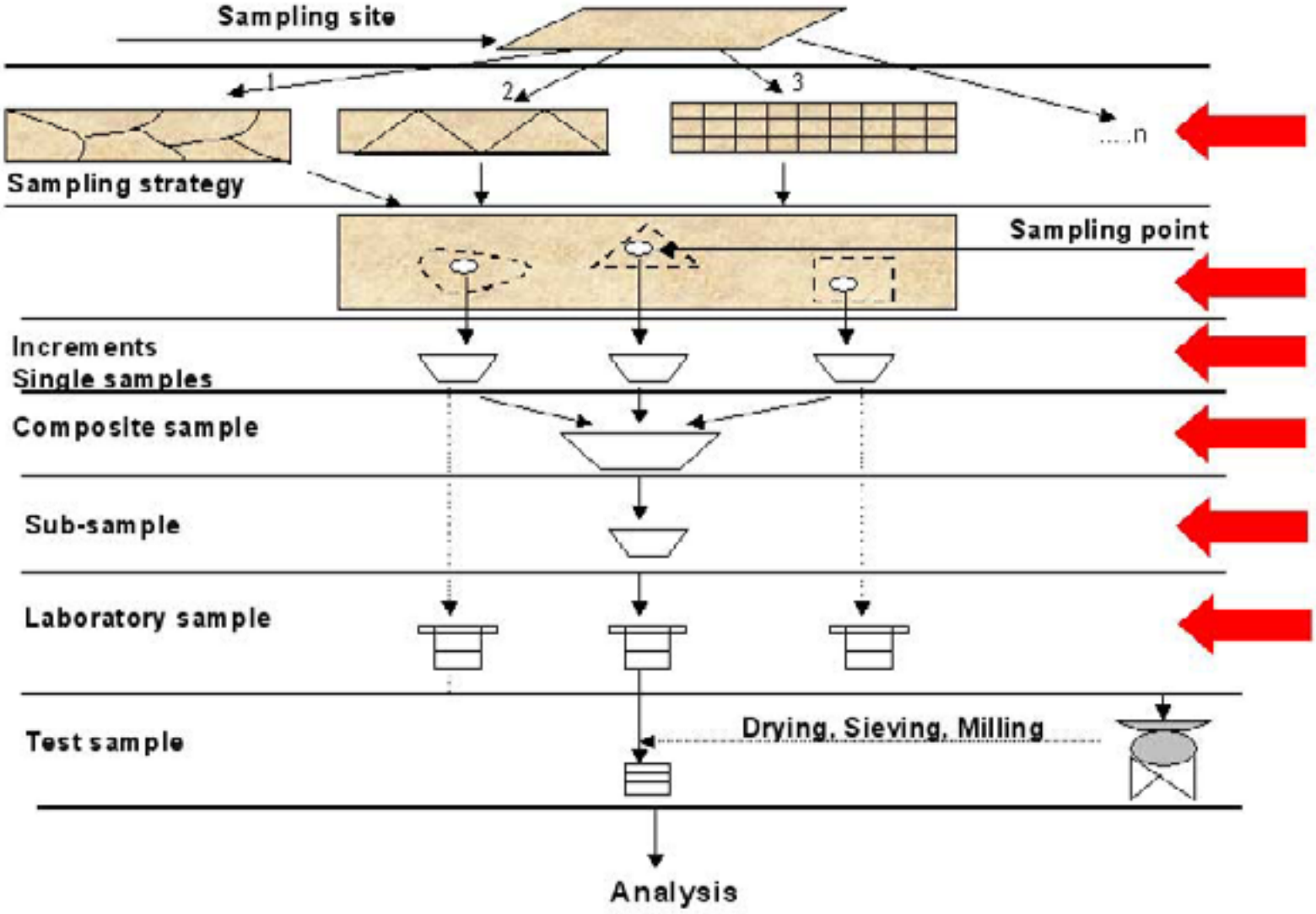
Type of sample

Sampling equipment

Sample preparation

Storage and preservation of sample

SAMPLING PROCESS



Sampling patterns

- *Judgemental sampling (*sampling in which location are chosen according to the judgement of an expert)
- *Random* (it is suitable for the areas where the site is suspected to be homogenous with respect to the parameters to monitored)
- *Stratified random* (subdivides site into smaller areas based on historical information or prior analytical results, each area is more homogeneous than the site as whole)

Sampling patterns (2)

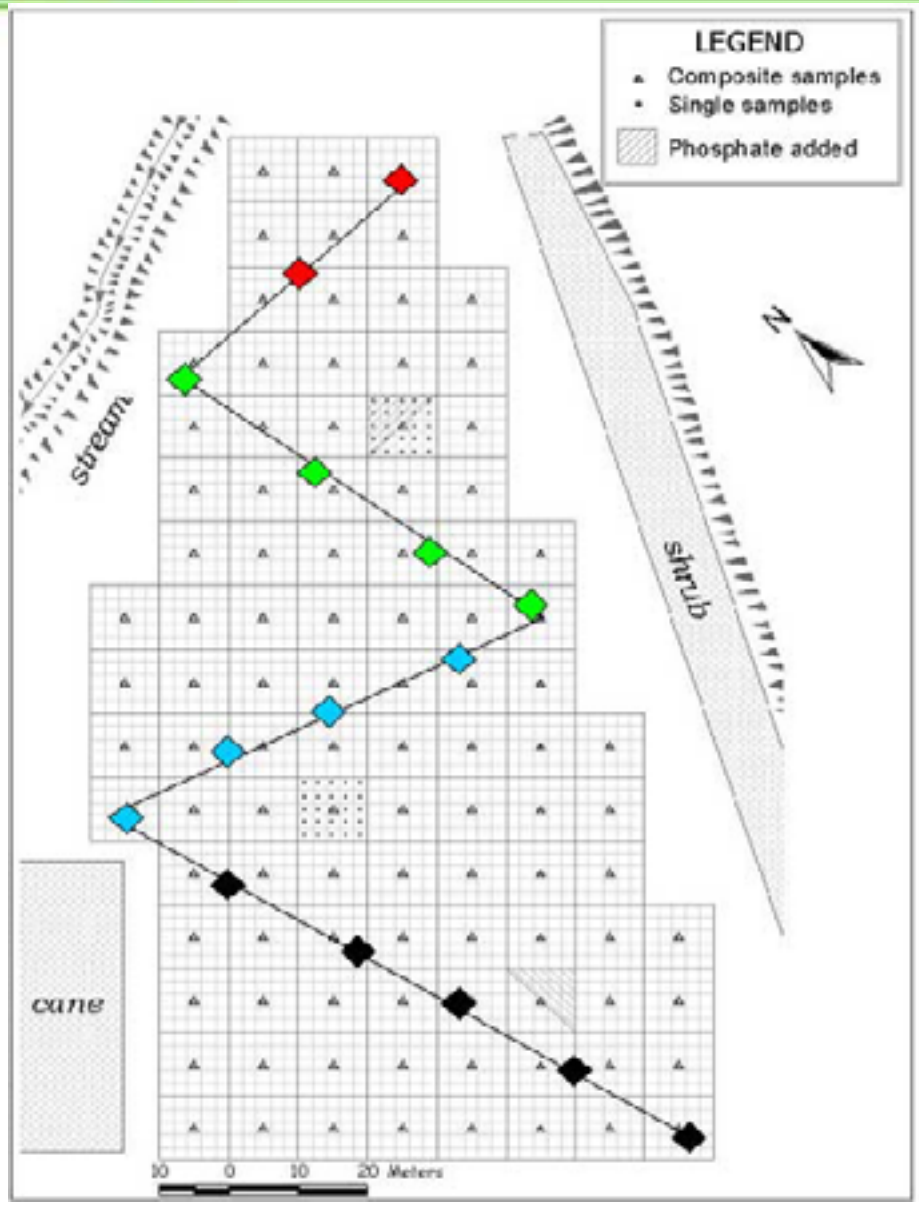
- *Systematic grid* (subdivides area of concern into a block or triangular grid with sampling performed at the nodes or inside the grid . It is often used to delineate the extent of contamination and to define contaminant concentration gradient).

- *Systematic random* (as systematic grid but sampling is performed at random location within the cells of the grid. It is useful and flexible to design for estimating the average pollutant).

- *Search sampling* utilizies either a systematic grid or systematic random sampling approach to search for areas where contaminants exceed applicable clean-up (hot spots).

Sampling patterns (3)

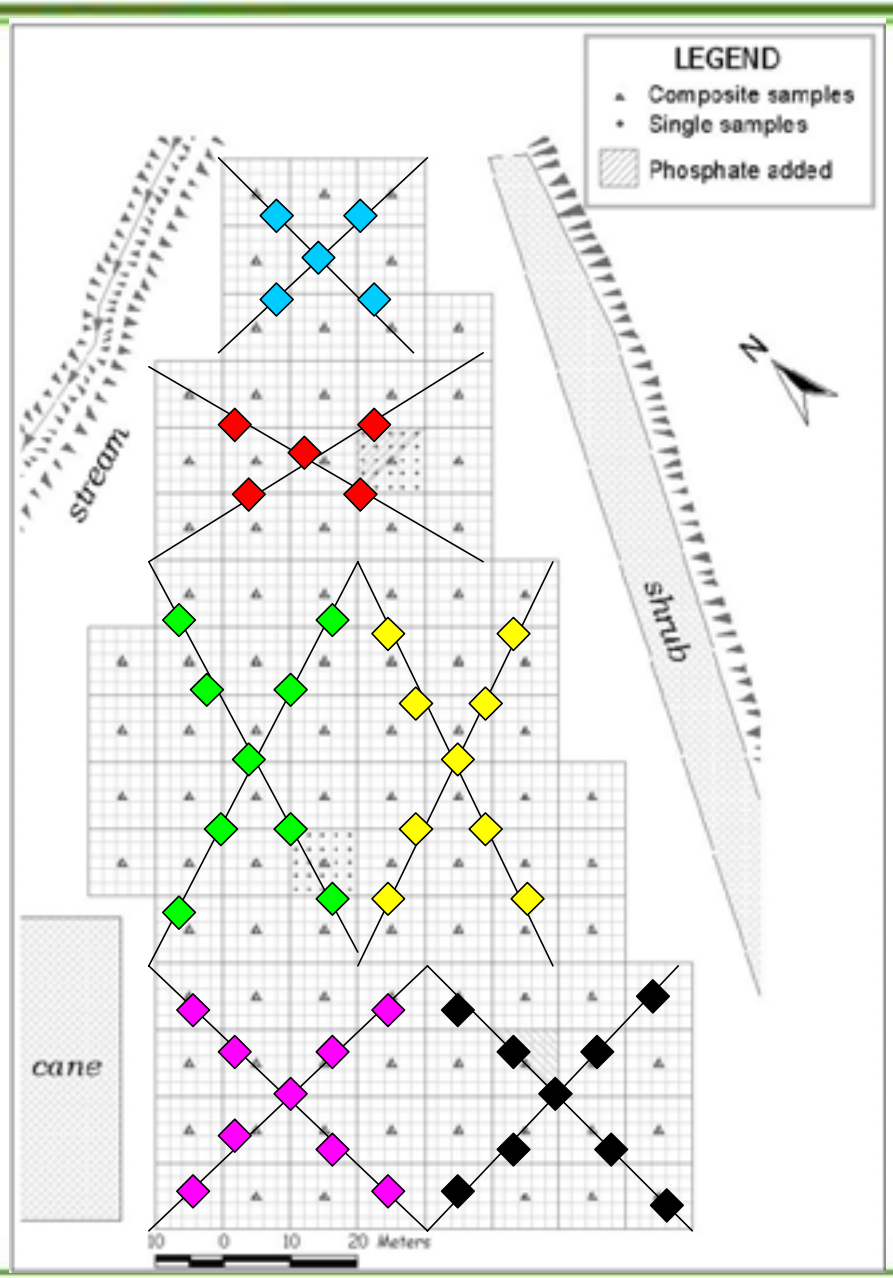
➢ *Transect sampling* involves establishing one or more transect lines across the surface of a site. Samples are collected at regular intervals along the transect lines at the surface and/or at one or more given depths. It is often used to delineate the extent of contamination and define contaminant concentration gradient. For example, a transect sampling approach migth be used to characterize a linear feature such a drainage ditch, along its full length. Sample aliquots are collected at regular intervals along the transect line and are then composited.



Sampling Pattern

Random

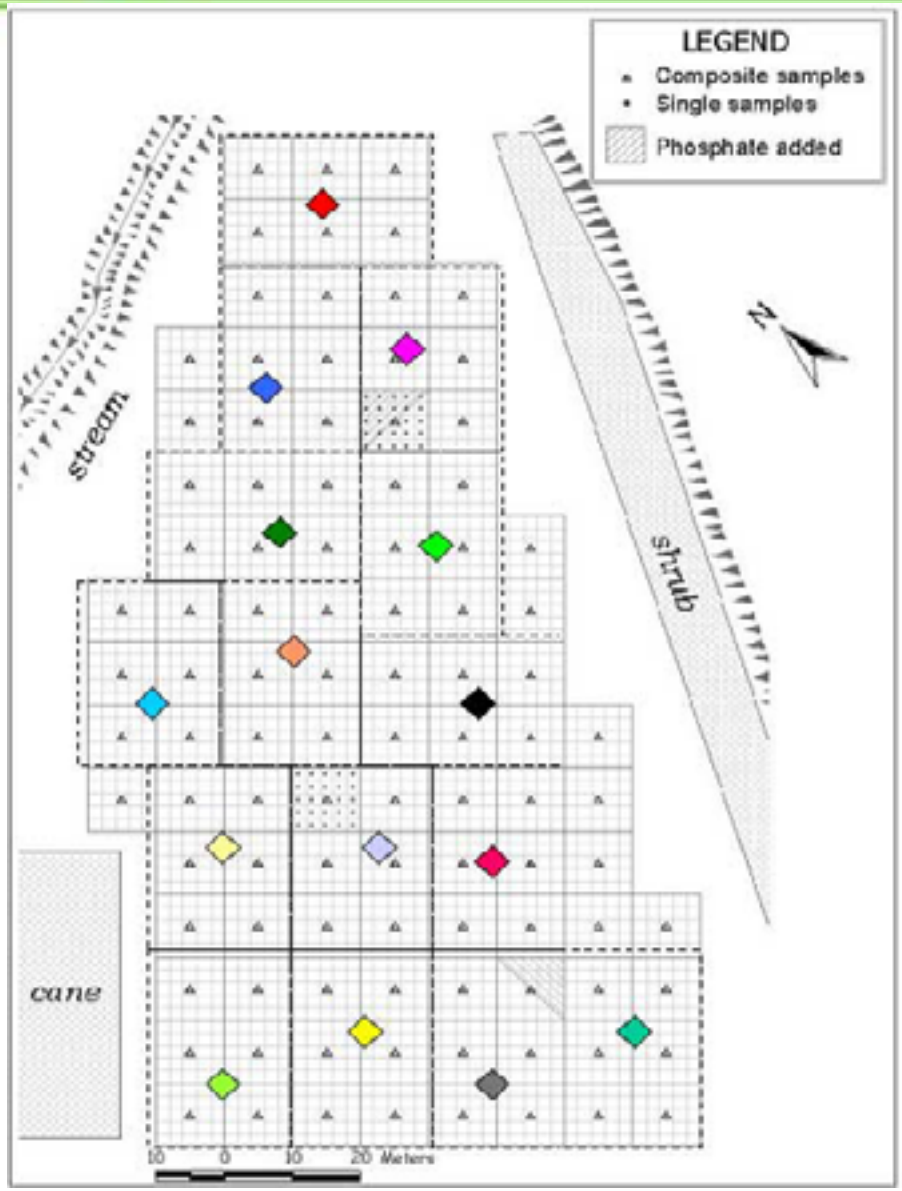
W Shape



Sampling Pattern

Random

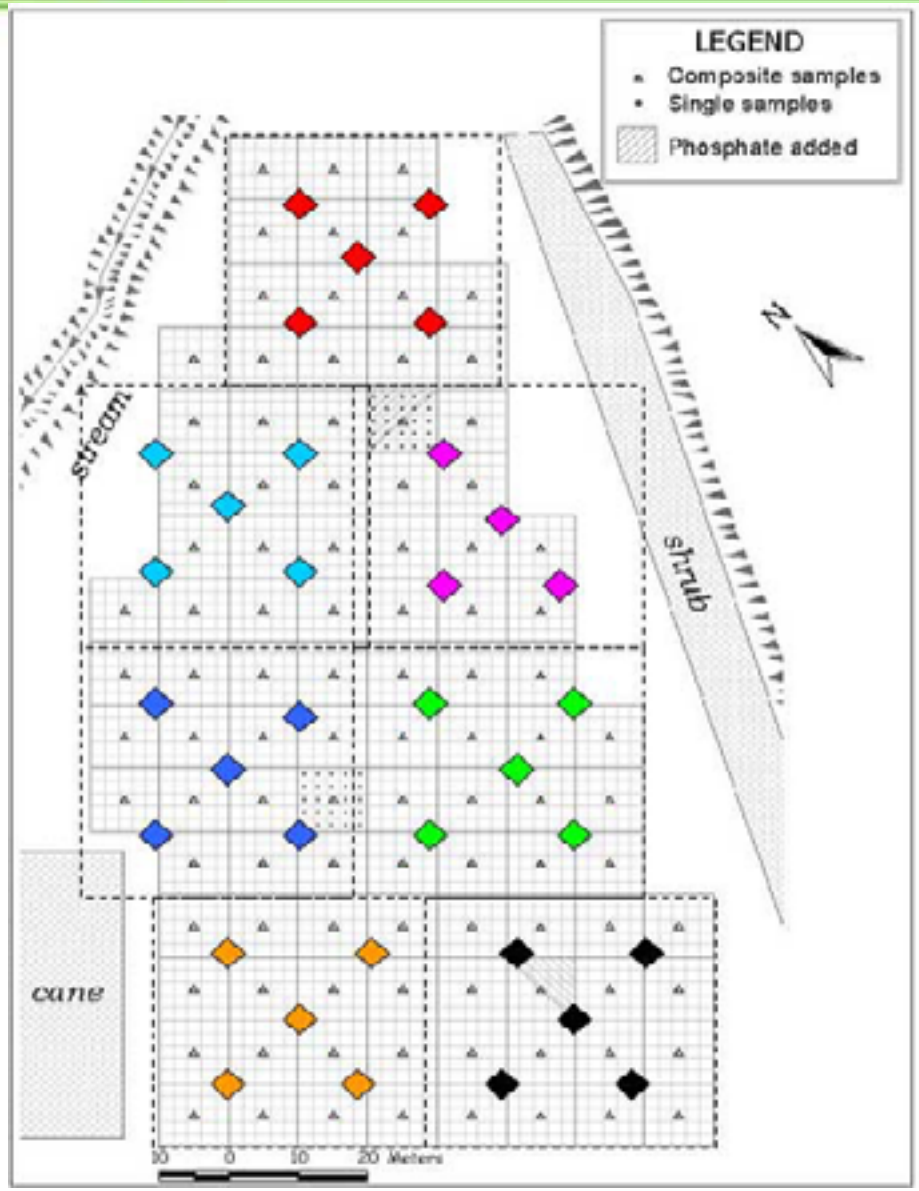
X Shape



Sampling Pattern

Systematic Random

Sub-area 30x20 meters



Sampling Pattern

Sistematic
Grids 40x40 meters

Type of samples

• *Disturbed sample:* sample obtained without any attempt to preserve the soil structure.

• *Undisturbed sample*: sample obtained using a method designated to preserve the soil structure (soil particles and voids don't change from their original distribution in the ground).

➢Single sample: sample collected from a single point (Disturbed or Undisturbed sample).

➢ Composite sample: two or more increments or sub-sample mixed together in appropriate proportions, either discretely or continuously(Disturbed sample).

Type of samples (2)

Composite sample are usually required in cases where the avarage concentration of substance in adefined horizon/layer is to be determined.

Single samples are required in cases when the distribution of a substance over a defined area or with depth is required

In most guidelines on sampling for agricultural or similar investigation, it is recommended that composite samles be collected by pooling a number of increments (according to ISO 10381-4 at least 25 icrements should be obtained) The number of composite sample depends on the exstension of the samplingtarget

When preparing composite samples, regard should be paid to analytical requirements (never composite samples if volatile compound are to be determined).

Sampling equipment

The selection of a sampling device and sampling procedures require the consideration of many factor including the number of sample to be collected, available funds, the depth of sampling, the soil characteristics, site limitation and the type of determinand to determine.

The available sampling devices are:

- *Augers* (hand and powered) mainly for sampling of homogeneous soil. In sandy soil can collect sample at most 5m.
- *digger* to form trial tips,
- *simple manual excavation* (corer, shovel, spatula, pick and fork) down to about 1m,
- *machine excavation* to between 3m to 4,5m depth (wheel driven back-hoe excavator) or up to 6m depth (track driven machine)
- *equipment for Boreholes* several types, max depth of sampling 40 m.

Applicability of ground excavation, drilling and sampling tecniques

Designation	Method	Method of sample extraction	Normal Area/Diameter	Soil Profile Detail	Suitability for Ground Type		Suitable for Water Table	Type of sampling possible	Depth of sampling	Comments
					Unsuitable for soil type	Suitable for soil type				
Manual methods										
Hand auger	Rotary	With auger	50-100mm	50 mm	Non cohesive gravel, stones, rubble, lumps of material	Clay, silt cohesive sand and similar ground	No	Disturbed	0-2 m	Sampling to 5 m possible in cohesive sandy ground
Hand excavation	Digging	With sampling tool	1m x 1m	10mm	Solid concrete or similar obstruction	All types	No	Disturbed and Undisturbed	0-1,5	In unstable ground the sides may need support
Power Driven Sampling Holes										
Power auger	Rotary	With auger	50mm	50mm	Non Cohesive gravel, large stones, lumps of material	Clay, silt, cohesive sand and similar ground	No	Disturbed	0.05-2 m	Sampling to 5m possible cohesive sandy ground
Pulse boring dynamic probe	Ramming	With sample tool on machine	50mm	25mm	Gravels, large stones, lumps of material	Clay, silt,cohesive sand and similar ground	Yes	Disturbed and Undisturbed	0.5-10m	

Precautions during sampling….

Avoid contamination of the sample (via contact with the sampling device or the container)

Keep clean the sampling equipment by water or paper between the collection of two samples (cross_contamination)

Preparation of sample

The preparation of the sample depends on:

- the quantity of material sampled;
- the analytes of interest;
- the analytical methods to be used or available.

It can be performed in the sampling site if needed, or successively in the laboratory upon the operations to do.

The sample may be to reduce, the primary sample (the mass soil collected from the ground) is then cone-quartered, split. This operation often is done on sampling site.

Instead in laboratory for obtaining the test sample (sample from which the test portions are removed for testing or analysis) the laboratory sample could be dried, sieved or milled and so on.

Definitions (2)

Test sample: " "sample, preparedfrom yhe laboratory sample, from which the test portions are removed for testing or for analysis"

Test portion: "Quantity of material, of proper size for measurement of the concentration or other property of interest, removed from the tested sample"

Preservation and storage of sample

Sample of soils and related materials are liable to change to different extent as a result of physical, chemical or biological reactions which take place between the time of sampling and the analysis (exspecially for volatile coumpounds).

The causes of samples modifications can be:

- changes due to the activities of living organism in the soil;
- oxidation by atmospheric oxigen;
- changes in the chemical nature of certain substance due to changes of temperature, pressure and hydroscopicity;
- irreversible adsortion o the surface of cointainers of metal or organic compounds;
- polymerization or depolymerization.

Preservation and storage of sample(2)

The addition of chemical preservatives or stabilizing agents is not a common practice for soil sampling. This is because a single soil sample is usually used for a large number of different determinations, and moreover has to undergo preparation (drying, milling..) during which unwanted and unquantificable reactions of the preservatives may occur.

But if the preservative is necessary it must not introduce unacceptable contamination.

Other preservation method are freezing or refrigeration (4°C) and storage in darkness.

In every case, the method of storage must be compatible with the analytical tecniques which will be used.

Sample containers

Factors to consider in general in the choice of the cointainers:

- no adsorption onto the walls of the cointainers,
- no reaction between constituents of the sample and the cointainer,
- resistance to temperature exstreme,
- water and gas tigthness,
- size, shape or mass, potential for cleaning and re-use.

Examples: polyethylene buckets, wide mouth glass-container.

Labelling and the sampling report

Once a sample is obtained it should be clearly and unmistakably marked, labelling them.

It is essential that any labels and iscriptions are stable considering the surrounding environmental conditions.

A detailed sampling report should specify any useful related to the sample to be collected for example:

- title ;
- site data;
- sampling procedure;
- sampling location;
- sample description;
- name of the sampler (operator)
- trasportation and storage.

SAMPLING OF VOC

Table : Some Volatile Organic Coumpound

Contaminant
Trichloroethene
Tetrachloroethene
1,2-transDichloroethene
Choroform
1,1-Dichloroethene
Methylene Chloride
1,1,1-Trichloroethane
1,1- Dichloroethane
1,2- Dichloroethane
Acetone
Toluene
Benzene
Vinil Chloride

VOC are the class of compound most commonly encountered at hazardous waste sites. VOC exhibit estreme mobilities, particularly in the vapour phase.

•For their sampling, devices that obtain undisturbed soil sample are recommended.

•The transfer of soil from device to container must be rapid utilizing subcoring device (plunger/ barrel device)

•The sample could be put into a cointainer that is directly connected to the analytical device in the laboratory (avalaibility in the laboratory!!)

•Methanol imersion procedure (large mass sample, composite sample)

•The preservation tecnique is storage at 0-4°C in the dark and the addition of preservative (aluminum or magnesium silicate desiccant 0,2 mg every 5g of soil)

Bibliography

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