CHAPTER 2

FIELD INVESTIGATIONS

2-1. General. Field investigations are necessary to provide data for containment area design. The channel must be surveyed to determine the volume of material to be dredged, and channel sediments must be sampled to obtain material for laboratory tests. Site investigations must be conducted to provide information for dike design and 'evaluation of potential foundation settlement, an important parameter in long-term storage capacity estimates. This chapter of the manual describes field investigations required to obtain the necessary samples for laboratory testing. The methods in common use for determining volumes of channel sediment to be dredged are well known and are not described in this manual. Basic considerations regarding sampling and volume determination are described in EM 1110-2-5025. The potential for the presence of contaminants should be evaluated when planning field investigations, and appropriate safety measures should be considered.

2-2. Channel Sediment Investigations.

a. Sample Type and Location.

(1) Samples of the channel sediments to be dredged are required for adequate characterization of the material and for use in laboratory testing. The level of effort required for channel sediment sampling is highly project-dependent. In the case of routine maintenance work, data from prior samplings and experience with similar material may be available, and the scope of field investigations may be reduced. For unusual maintenance projects or new work projects, more extensive field investigations will be required.

(2) For maintenance work, channel investigations may be based on grab samples of sediment. Since bottom sediments are in an essentially unconsolidated state, grab samples are satisfactory for sediment characterization purposes and are easy and inexpensive to obtain. Grab sampling may indicate relatively homogeneous sediment composition, segregated pockets of coarse- and fine-grained sediment, and/or mixtures. If segregated pockets are present, samples should be taken at a sufficient number of locations in the channel to adequately define spatial variations in the sediment character. In any case, results of grab sampling must allow estimation of the relative proportions of coarse- and fine-grained sediments present. Caution should be exercised in interpreting conditions indicated by grab samples since sediment surface samples do not indicate variation in sediment character with depth. For more detailed information, additional samples may be taken using conventional boring techniques.

(3) Water samples should be taken at several locations near the sediment-water interface in the area to be dredged. Subsequent salinity tests on these samples indicate whether the dredging will be done in a freshwater or saltwater environment. Potential changes in salinity because of tides or seasonal flooding should also be considered.

(4) Samples of sediment taken by conventional boring techniques are normally required only in the case of new work dredging. Based on information gained from initial grab sampling, locations for borings should be selected. Samples should be taken from within the major zones of spatial variation in sediment type or along the proposed channel center line at constant spacing to define stratification within the material to be dredged and to obtain representative samples. Borings should be advanced to the full depth of anticipated dredging if possible. This is normally done on a routine basis for new work projects to indicate the type of material to be dredged and the degree of dredging difficulty, since this information is required for the dredging contractor to use as a basis for bidding on the project. Test pits using a clamshell dredge can also prove useful for accessing dredgability and can be used to obtain larger sample quantities.

(5) Vibracore samplers have also proved successful in obtaining core samples of sediments. The Vibracore sampler is not a standardized piece of equipment, but it usually consists of a core-barrel and a vibratory driving mechanism mounted on a four-legged tower guide and platform. The entire assembly is lowered to the sediment surface below the water by a crane/cable hoist system. After the device has been accurately positioned on the bottom, compressed air is supplied to the vibratory unit through flexible hoses extending from the floating plant down to the Vibracore. Upon application of the compressed air, the oscillating hammer (vibrator) propels the core-barrel into the subbottom materials. The Vibracore can be equipped with a penetration recording device that will provide a record of the penetration depth and time. After the core-barrel has been extended to its full length, the sampler is retracted from the sediment and returned to the floating plant deck. The removable plastic core-barrel containing the sample is then removed from the sampling device, and the ends are capped for sample preservation. Typically 3-inch-diameter cores of up to 20 feet in length are obtained; some devices may be modified to take samples of 30- or 40-foot lengths. This device is generally used to sample sands. It has also been used to sample some fine-grained materials.

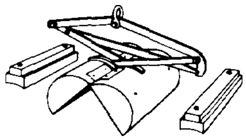
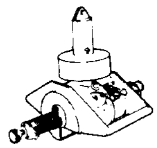
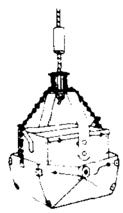
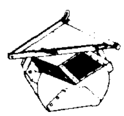
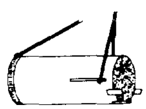
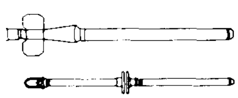
(6) Pertinent information regarding sediment samplers is summarized in Table 2-1. Grab samplers as described in Table 2-1 will allow retrieval of sufficient sediment to perform characterization tests and sedimentation and consolidation tests, if required.

b. Sample Quantity.

(1) The quantity of sediment samples to be collected should be determined by the designer, based on the requirements for the laboratory tests to be performed. A quantity of sediment sufficient to perform the necessary characterization tests and to provide some material for the composite sample for the column settling tests described in Chapter 3 should be collected from each established sampling point. If at all possible, the sampling efforts should be coordinated with other requirements for determining the presence of contaminants or for contaminant-related testing. In this case, appropriate procedures for sample collection, handling, and preservation should be followed. For grab samples, it is recommended that at least 5 gallons of sediment be collected at each sampling station. Five-gallon containers are generally recommended for collecting all grab samples; since most sampling

Table 2-1

Summary of Sediment Sampling Equipment

Sampler		Weight	Remarks
Peterson		39-93 lb	Samples 144-in.^{2} area to a depth of up to 12 in., depending on sediment texture
Shipek		150 lb	Samples 64-in.^{2} area to a depth of approximately 4 in.
Ekman		9 lb	Suitable only for very soft sediments
Ponar		45-60 lb	Samples 81-in.^{2} area to a depth of less than 12 in. Ineffective in hard clay
Drag bucket		Varies	Skims an irregular slice sediment surface. Available in assorted sizes and shapes
Phlegar tube		Variable 17-77 lb; fixed in excess of 90 lb	Shallow core samples may be obtained by self-weight penetration and/or pushing from boat. Depth of penetration dependent on weight and sediment texture
Conventional soil samplers			Conventional soil samplers may be employed using barge- or boat-mounted drilling equipment. Core samples attainable to full depth of dredging

will be performed from small motorboats, containers of this size are about the largest that can be handled efficiently. For core samples, a cornpositing scheme must be developed, depending on the number of cores taken, size of cores, and nature of the material.

(2) A smaller sample of sediment should be collected from each fine-grained grab sample and placed in a small (about g-ounce) watertight jar for water content and specific gravity tests. Care should be taken to collect small sediment samples that are representative of the sediment sample as a whole. Similar procedures for core samples are standard soil sampling practice.

(3) After the characterization tests have been performed on samples from each sampling point, samples can be combined to meet requirements for the settling tests described in Chapter 3. Approximately 15 gallons of channel sediment is required to perform the column settling tests.

c. Sample Preservation.

(1) The laboratory tests described in this manual do not require sophisticated sample preservation measures. There are two requirements:

(a) Collect the samples in airtight and watertight containers.

(b) Place the samples in a cold room (6° to 8° C) within 24 hours after sampling until the organic content can be determined. If the organic content is above 10 percent, the samples should remain in the cold room until testing is complete; otherwise, the samples need not be stored in the cold room. The in situ water content of the small samples must be maintained. These samples should not be allowed to drain, nor should additional water be added when they are placed into the containers.

(2) All sample containers should be clearly identified with labels, and the sample crew should keep a field log of the sampling activity. Laboratory testing should be accomplished on the samples as soon as practicable after sampling.

2-3. Containment Area Investigations.

a. Field investigations must be performed at the containment area to define foundation conditions and to obtain samples for laboratory testing if estimates of long-term storage capacity are required. The extent of required field investigations is dependent upon project size and upon foundation conditions at the site. It is particularly important to define foundation conditions (including depth, thickness, extent, and composition of foundation strata) ground-water conditions, and other factors that may influence construction and operation of the site. For new containment areas, the field investigations required for estimating long-term storage capacity should be planned and accomplished along with those required for the engineering design of the retaining dikes as described in Chapter 6.

b. For existing containment areas, the foundation conditions may have been defined by previous subsurface investigations made in connection with dike construction. However, previous investigations may not have included sampling of compressible soils for consolidation tests; in most cases, suitable samples of any previously placed dredged material would not be available. Field investigations must therefore be tailored to provide those items of information not already available.

c. Undisturbed samples of the compressible foundation soils can be obtained using conventional soil sampling techniques and equipment. If dredged material has previously been placed within the containment area, undisturbed samples must be obtained from borings taken within the containment area but not through existing dikes. The major problem in sampling existing containment areas is that the surface crust will not normally support conventional drilling equipment, and personnel sampling in these areas must use caution. Below the surface crust, fine-grained dredged material is usually soft, and equipment will sink rapidly if it breaks through the firmer surface. Lightweight drilling equipment, supported by mats, will normally be required if crust thickness is not well developed. In some cases, sampling may be accomplished manually if sufficient dried surface crust has formed to support crew and equipment. More detailed information regarding equipment use in containment areas may be found in Appendix I.

d. Water table conditions within the containment area must be determined in order to estimate loadings caused by placement of dredged material. This information must be obtained by means of piezometers, which may also be used for measurement of ground-water conditions during the service life of the area. Other desired instrumentation such as settlement plates may also be installed within the containment area for monitoring various parameters.

e. Additional information regarding conventional sampling techniques and equipment and development of field exploration programs is given in EM 1110-2-1907 and in Chapter 6 of this manual. Procedures for installation of piezometers and other related instrumentation are given in EM 1110-2-1908.

2-4. Site Selection for Avoidance of Ground-Water Impacts.

a. As water percolates through in-place dredged material, leachate may be produced. This leachate water may be the result of precipitation or entrained water resulting from the dredging operation. Available data for the characterization of leachate produced from dredged material are very limited. Potential adverse water quality impacts will most likely be caused by the increases of chloride, potassium, sodium, calcium, total organic carbon, alkalinity, iron, and manganese. These factors should be considered even for dredged material that is considered uncontaminated. This is especially true if a saltwater dredged material may be placed over a freshwater aquifer.

b. Site location is an important, if not the most important, consideration in minimizing any adverse impact to underlying ground water. Selection of a technically sound site may reduce or eliminate the need for any restrictions or controls. Site characteristics affecting ground-water impacts are presented in Table 2-2. Site characteristics that are particularly important in the evaluation of ground-water impacts at potential upland disposal sites are discussed in the following paragraphs:

Table 2-2

Site Characteristics Affecting Ground-water Impacts

Site volume	Depth to bedrock
Site area	Depth to aquicludes
Site configuration	Direction and rate of ground-water flow
Dredging method	Existing land use
Climate (precipitation, temperature wind, evaporation)	Depth of ground water
Soil texture and permeability	Ecological areas
Soil moisture	Drinking water wells
Topography	Receiving streams (lakes, rivers, etc.)
Drainage	Level of existing contamination
Vegetation	Nearest receptors

(1) Location. While the significant characteristics of a given site are usually unique, useful hypotheses about pathways of migration and estimates of parameters needed to calculate migration rate can often be developed from available regional data and keyed to location, topography, surface drainage patterns, flood potential, subsurface stratigraphy, ground-water flow patterns, and climate.

(2) Topography. Topographic variables are important in evaluating surface drainage and run-on and runoff potential of the site. This information would be helpful in determining the amount of water that may be available to percolate through the in-place dredged material.

(3) Stratigraphy. The nature of subsurface soils, determined by examination of soil core borings to bedrock, is an important input to evaluation of pathways of migration in both the unsaturated and saturated zones.

(4) Ground-water levels (equipotential surfaces). Seasonal maps of water table contours and piezometric surfaces, developed by analysis of ground-water monitoring well data, are important in predicting ground-water flow directions and hydraulic gradients, as these can vary greatly at upland or nearshore sites.

(5) Ground-water flow. Information on permeability and porosity of subsurface strata, combined with data on hydraulic gradients, is important in predicting ground-water flow velocities and direction.

(6) Meteorology and climate. Precipitation, including annual, seasonal, or monthly rain and snowfall, is an important parameter in determining a water balance for the site and in evaluating leachate potential. Evapotranspiration is also important in developing a water balance for the site. It is often estimated from temperature and the nature of vegetative growth at the site.

(7) Soil properties. An important variable in evaluating mobility of many metal contaminants is pH. Cation exchange capacity (CEC) is an important determinant of the mobility of metallic species in soils; if the CEC is sufficiently high to adequately immobilize the heavy metals present in the soil, no adverse ground-water impacts may result. Redox potential (Eh) is important in determining the stability of various metallic and organic species in the subsurface environment of the site. Organic carbon content is a major variable affecting adsorption, and hence mobility, of organic species in the subsurface environment. Soil type (e.g., clay, till, sand, fractured bedrock) is a major variable affecting rates and routes of ground-water migration.

(8) Potential ground-water receptors and sensitive ecological environments. Ground-water and surface water usage, especially downgradient of the site, is important in evaluating adverse impacts. Size of population and nature of ecological resources downgradient of the site are also important variables in determining adverse impacts.

c. Examples where site location alone can be used to reduce or eliminate adverse impacts to ground water include:

(1) Selection of sites that have natural clay underlying formations that can minimize potential ground-water contamination concerns.

(2) Selection of sites to avoid aquifer recharge areas that can minimize potential ground-water contamination concerns. Another consideration associated with site location is that some fine-textured dredged material tends to form its own liner as particles settle with percolation drainage water; however, it may require considerable time for self-sealing to develop. For this reason, if an artificial liner is considered useful, a temporary liner subject to gradual deterioration with time may be adequate in many cases.