PART II

DETAILED EXPLANATION NOT GIVEN IN THE VIDEO

Chapter 1: Objectives and Significance of Environmental Sampling

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Chapter 2: Sampling of Water

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1. Objectives and Significance of Environmental Sampling

1.1 Clearly Understanding the Objectives and Significance

The objectives and significance must be clearly understood when environmental sampling is carried out. Field records and analysis data obtained using analytical instruments are required if we are to correctly evaluate the environmental situation, and such data must be representative of the environment. In order to obtain accurate environmental data, it is imperative that the analysis samples be representative. However, they are not particularly easy to collect, so can only be accumulated through appropriate planning and implementation of sampling.

In terms of types of aquatic sampling, we include river water, seawater, and factory effluent sampling. With regard to air sampling, we look at flue gases from factories and vehicles, as well as ambient air sampling. Sometimes riverbeds are also sampled.

As stated before, the most important issue when drawing up a plan for sampling is to clearly understand its significance and objectives. In other words, we must correctly determine how, why, and what to conduct the survey on. Furthermore, sampling work should be undertaken according to specified procedures. In this case, it is important to use samplers and sample containers that are suited to the task.

Regular surveys are required to provide successive sampling analysis data in order to identify environmental changes, so such sampling must be consistent in its methodology and location. A very high degree of accuracy is required when undertaking sampling to determine whether the law is being met. When sampling under accident conditions, data should be obtained to accurately establish the cause(s) and evaluate the state of the site in order to discuss appropriate countermeasures.

The above points are simplified in the chart on the following page. We trust it is useful for field observations, planning surveys, and carrying out sampling.

1.2 Notes on Fixed Point Environmental Observations

Surveys should be planned, prepared, and conducted with due consideration for the items shown in the following chart when conducting regular surveys at a specified point.

	Water Measurements	Air Measurements
Planning	River and sea water survey ├ Select the point (What is it representative of?) ├ Confirm survey date and site (map) Sampling method / survey items ├ Storage and pretreatment of samples └ Number of measurement times / analysis parameters Factory effluent survey ├ Document survey ── ├ Drainage outlet position / └ Effluent type ├ Confirmation of the survey date and point (map) └ Sampling method / analysis parameters	Ambient air survey ├ Select the point (What is it representative of?) ├ Understanding generating sources around the survey point ├ Confirm survey date and site (map) ├ Sampling method / survey items ├ Storage of samples └ Number of measurement times / analysis items Flue gas survey ├ Document survey ┬ Check the measuring hole / ├ Type and scale, etc., of emission source / └ Results of measurements by factory ├ Safety check of sampling site ├ Survey date / survey target / document survey └ Sampling method / analysis items
Preparation of Survey	1) Prepare equipment/materials, vessels, and field notes in accordance with the items to be surveyed. 2) Classify and prepare vessels per survey point. 3) Map and camera	1) Prepare equipment/materials, vessels, and field notes in accordance with the items to be examined. 2) Setup weighing of the filter paper, etc. 3) Tests must be carried out to ensure that the sampling equipment is working properly.
Survey Date	River and sea water survey ├ Record the weather of the day before and upstream ├ Check the water level ├ Record any peripheral situations such as construction work └ Check the tide table in affected areas Factory effluent survey └ Record the appearance of the effluent	Ambient air survey ├ Meteorological conditions (weather, temperature, wind direction and velocity) └ Record any peripheral situations around the survey site Flue gas survey ├ Operating status of the facility (fuel usage volume) ├ Flue gas temperature └ Volume of gas emitted
Execution	1) Care must be taken when washing equipment and vessels with solution. 2) Check the sample containers 3) Check storage of water samples and its preparation 4) Clearly describe the sampling position.5) Record the sampling time	1) Warm up the sampling equipment. 2) Washing the sampling bag with solution. 3) Clearly describe the sampling site. 4) Record the sampling time and volume.

1.3 Notes on Handling Accidents

Preparation on the assumption that an accident may occur is required as they tend to occur suddenly. In the event of an accident, check the current status in accordance with the table below, and plan, prepare, and conduct the required sampling to determine the cause(s) and draw up countermeasures.

	Many fish are floating in the river	Visible gas emission	Coughing or breathing difficulties
Information to be collected	Field information ├Floating position ├Size and numbers of fish ├Water level of the river ├Abnormalities in the river └Are fish floating continuously?	Field information ├Gas emission position ├Color of the gas ├Are birds flying on the downwind? ├Wind direction └Smell	Field information ├Site of breathing difficulties ├Appearance of people in the area ├Existence of chimneys ├Smell └Has emission of gas stopped?
Sampling to determine cause(s) and draw up countermeasures	Estimate of cause ├Water level and temperature ├Death in large numbers └Information on local factories Items taken for field checks ├Field note ├Poly bottles ├pH test paper ├Bag for fish ├Poly buckets └Camera Survey conducted by a number of groups ├Check floating fish ├Check water levels └Investigate local factories Caused by insufficient of dissolved oxygen ├Water thermometer ├Compact pH meter └Sample bottle for DO Caused by foreign matter such as poison ├Water thermometer ├Compact pH meter ├Sterilized bottles ├Glass bottles ├Amber colored glass bottles ├Preparation chemicals for the samples containing metals └Water sampler	Estimation of causes ├Gas emitting site ├Color and smell of gas └Information on local factories Items taken for field checks ├Field note ├Compact gas detector ├Sampling bag ├Compact pump ├Camera ├Transceiver └Gas mask	Estimation of causes ├Site of breathing difficulties ├Appearance of people in the area └Smell Items taken for field checks ├Field note ├Compact gas detector ├Sampling bag ├Compact pump ├Camera ├Transceiver └Gas mask

2. Sampling of Water

2.1 Survey Planning

2.1.1 Factors must be considered for survey

Three factors, namely, 'why', 'what', and 'how' must always be considered when conducting a water quality survey.

1) 'Why': Survey objective

   Surveys must be planned in accordance with the objective, as the sampling frequency / number of times, survey sites, and measurement items differ depending on why the water quality is to be examined.

2) 'What': Survey target

   Concentration of water components and coexistent substances differ according to whether the target is a river, lake/pond, underground or marine, as well as various water types for utilization or drainage, etc. There are also individual characteristics in those fluctuation and distribution patterns of water quality. The characteristics of the targeted water should be sufficiently understood and an appropriate sampling plan drawn up with due consideration for the survey objective and method (in particular, the items to be measured and analysis method). Furthermore, the condition of the targeted water area must be considered as well as general differences and characteristics.

3) 'How': Survey method

   Related to the above 2), a quantitative method must be selected in accordance with the targeted water, and a plan must be drawn up to implement the required pretreatment. The quantitative method may be selected with consideration for operational speed and simplicity in accordance with the precision required, which will itself depend on the survey objective. Continuous measurement and automatic analysis may also be considered depending on the sampling requirements.

The following factors are considered necessary to draw up a water quality survey plan.

(a) Selection of a survey site
(b) Survey section
(c) Survey period
(d) Survey frequency
(e) Sampling method
(f) Storage and pretreatment of samples
(g) Water analysis procedure (Measurement items and analysis method)
(h) Collection of data concerned

Actual restrictions must also be considered, so how to narrow the gap between ideal and realistic plans is important when drawing up an appropriate survey plan. The following are issues that need to be considered.

(i) Status of the survey site
(ii) Water sampling method
(iii) Transportation means, transport facilities
(iv) Volume of water samples and number of vessels
(v) Investigators, and their experience and technical levels
(vi) Survey expenses

When a water quality survey is first conducted in an area, the condition must be known sufficiently by carrying out a pre-survey.

For example, as regards (i), there are many unclear issues when looking at the map, such as how to get to the survey site, its peripheral status, piping/drainage cannel at the predetermined site, etc., so field checks must be carried out.

Regarding (ii), there are several issues to be addressed, such as whether or not water can be collected directly, what kind of water samplers can be used, and whether there is any usable water craft related to flow velocity and water level must be confirmed as well.

When surveys on water are conducted for industrial water, industrial wastewater, tap water and sewage for management purposes, it is important to understand the characteristics of the targeted water, existence of the treatment facility, and status of water in the area.

In particular, (a) Selection of the survey site, (b) Survey section, (c) Survey period, and (d) Survey frequency, are explained in following section.

2.1.2 Selection of the survey site

Selection methods of sites for water quality survey on rivers, lakes/ponds, and in the sea, and survey of water management for utilization/drainage, and pollution status are listed in Table 2.1 'Selection of Survey Sites'.

Table 2.1 'Selection of survey sites'

Waters	General water quality survey	Survey into water quality for utilization / drainage and pollution
Rivers	1) Sites along the main rivers and its tributaries upstream of their confluence, and other sites downstream where the waters are sufficiently mixed. 2) A site close to the mouth of a river 3) When there are dams and lakes, select sites up- and downstream of them. 4) If there is the possibility that abnormal water is flowing, select sites up- and downstream of the suspected cause	1) Water utilization site 2) A site in the drainage system, and sites before and after the mixing of effluent.
Lakes/ Ponds	1) Center of the lake 2) Site where water exits into a river 3) A site in the entry river, and another after the water is well mixed	1) Water utilization site 2) A site in the drainage system, and a site after the mixing of effluent.
Sea	Select sites with due consideration for the shape of the water area and the river water flow status.	Select sites with due consideration for the shape of the water area, ocean currents, tides, water utilization status, and the positions of primary sources of pollution.

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2.1.3 Survey sections

(1) Rivers

Make a decision with due consideration for the uniformity of the water quality at the sampling site and the survey objective.

1) Representative water quality

It is considered that sampling in the maximum-depth-stream (the area of the river with the maximum cross-sectional flow rate) is generally best to determine the representative water quality. However, it takes much time and effort to find the maximum-depth-stream through detailed measurements of the flow velocity distribution, and such accuracy is not strictly required. Thus, it is normal to determine the quickest flow area by sight and sampling the water surface. Although there is a method involving sampling at a depth 20% from the surface (examination method for public waters specified by the Environment Agency of Japan), it is actually rather difficult to sample water at a depth 20% from the surface in such narrow areas, so using a bucket or suchlike to sample the surface is sufficient.

2) Heterogeneous water quality

When water quality differs depending on its depth and position in the cross-sectional direction of the river, take water samples at various positions in accordance with the objective, and carry out analysis on individual or mixed samples accordingly.

For example, water quality may be heterogeneous in positions where effluent is not well mixed or if there is a branch stream of different water quality. It is not necessary to conduct an survey of typical water quality as mentioned in 1) at such a site, but if there is no other suitable survey site, a survey on mixing and diffusion must be conducted, although sampling the water and analysis are troublesome. When it is thought likely that water quality is heterogeneous, it is better to determine the sampling site after measuring the temperature, pH, electrical conductivity, and amount of dissolved oxygen to check uniformity.

(2) Lakes/Ponds

Water sampling sites must be decided with consideration for differences in water quality due to depth. Thermoclines are found in temperate zone lakes during summer and winter which prevent the mixing of upper and lower water layers and often result in some unique characteristics in the vertical distribution of the water quality. In this case, water below the thermocline must be sampled as well as surface water.

When operating in subtropical zones with both dry and rainy seasons, it is necessary to conduct water sampling during both seasons to understand the workings of the vertical distribution. A unique characteristic in water quality is sometimes seen with bottom layer water due to deposit and decomposition of suspended solids, and elution from bottom sediment. In particular, sampling of bottom layer water and water near bottom sediment is also important when conducting surveys with consideration for organic impurities, eutrophication, and the behavior of heavy metals. The important sites are summarized as follows.

1) Single-site water sampling: Sample the surface water.
2) Double-site water sampling: Sample the surface and bottom layer waters.
3) Vertical distribution of water quality: Measure the vertical distribution of water temperature, pH, electrical conductivity, and dissolved oxygen, and sample water in at least three sites in accordance with the stratification.
4) Survey in accordance with water utilization purpose: Sample the water in accordance with where it is taken from when conducting water quality surveys related to water utilization, such as water for agricultural and industrial use or as a water supply.

(3) Sea

Seawater sampling sites are shown in Table 2.2 as an example of the sampling methods for seawater quality mainly along the coastline.

Table 2.2 Seawater sampling sites

Sea depth	Sampling depth
<5m	0.5m below the surface
5~10m	0.5 and 2 m below the surface
>10m	0.5, 2, and 10m below the surface

0.5, 2, and 10m below the sea's surface are sometimes referred to as the top, middle, and bottom layers regardless of the depth of the water, so care must be taken when displaying the results. Also, water should be sampled at relevant depths in accordance with each objective for various research-related surveys.

2.1.4 Survey period

(1) Rivers

1) Select a day with stable water quality after a spell of relatively good weather to determine the general condition of the water quality.
2) Periodically collect regular water samples when carrying out consecutive surveys throughout the year.
3) Choose an survey period in accordance with the water utilization status when carrying out a water quality survey for water utilization.

(2) Lakes/Ponds

1) Conduct surveys in each season to determine the general condition of the water quality.
2) Stagnation period must be considered important when examining eutrophication.

3) When the effects on water temperature and turbidity in manmade lakes with dam are considered important, surveys are also conducted on related rivers including the season when they are swollen.

2.1.5 Survey frequency

Fluctuation patterns of water quality in the targeted water area are explained as examples.

1) Daily fluctuation pattern example

   Periodic daily fluctuations may be seen in rivers into which urban sewage and factory effluent flow. In this case, frequent water sampling is required to determine the representative water quality and outflow load.

2) Monthly fluctuation pattern example

   Frequent sampling is required for suspended solids (SS), which fluctuates in relation to the flow rate, rain status, and various basin factors, as the fluctuation pattern may not be clearly understood through monthly measurements alone.

3) Examples of fluctuating water quality due to rising water

   When water quality must be considered in relation to the outflow mechanism for various chemical components, a number of water samples must be taken at short intervals in the initial stages of rain fall, particularly when any such rise is due to rainwater.

2.2 Types of Sample Containers

Normally, polyethylene or colorless glass bottles with ground stoppers are used as sample containers. Samples should not become contaminated and the components targeted for testing should not be allowed to escape from the sample in the containers, so it must be made of a quality material and it should be possible to close it securely. They should only be used after being sufficiently rinsed to avoid any impediment to testing. Rubber and cork stoppers must not be used to avoid the risk of contaminating the sample.

Each material has the following advantages and disadvantages.

2.2.1 Poly bottles (polyethylene, polypropylene, etc.)

Colorless bottles must be used. Their shock resistance, lightness, and superior chemical resistance make them popular. They come in varying degrees of toughness, from hard to comparatively soft, and generally such materials are considered not to virtually elute. However, catalytic molybdenum, chrome, and chitin used during their production become slightly eluted in some products, so care must be taken with the usage objectives. Colored ones are unsuitable.

Care must be taken when using poly bottles to store samples for long term as they are opaque, have weak heat resistance, and are not airtight, so microorganisms and algae are easily propagated.

Typical mineral water bottles (polyethylene terephthalate (PET) bottles) can also be used, but great care must be taken with their use as they are thin and easily damaged if scarred. Other bottles that were used for juice, coffee, or tea are not suitable as it is difficult to clean them of adhered components thoroughly enough.

Polyethylene bottles have a tendency to adsorb phosphorus compounds, organic matter, and heavy metals, etc. from samples. The adsorption of heavy metals can be prevented during storage by adding nitric and hydrochloric acids.

Rinsing bottles

Prior to their usage, rinse them first with tap water and then with distilled or ion exchange water. When testing for trace amounts of metals, rinse them with warmed nitric acid (1+10) or warmed hydrochloric acid (1+5), then with tap water again, and finally rinse them out with distilled or ion exchange water.

When used bottles are re-used, rinse them with warmed nitric acid (1+10), warmed hydrochloric acid (1+5), or medical rinsing liquid such as a surface-active agent, rinse them again with tap water, and finally rinse them out with distilled or ion exchange water. When some matter is adhered, use a brush with cleanser or something suitable to give it a pre-wash before taking the above action. (Soaps are not suitable as they are liable to remain inside the bottle.) Cleansers that include components being targeted in the test should not be used.

2.2.2 Glass bottles

These are widely used as sample containers, and have a number of advantages such as little deterioration of samples and ease of observation. However, they are inconvenient when transporting a large amount of samples, as they are easy to break.

There are two types of glass, namely hard and soft. Hard glass bottles blown with mold is generally used for sample containers. Either wide- or narrow-mouthed bottles can be used, but bottles whose inner shoulder curves are easy to clean are most suitable. Alkaline elements, such as sodium, potassium, silica, and boron are easily eluted from new bottles. Arsenic, zinc, antimony, and lead may be eluted from some products. In particular, boron is eluted from hard glass bottles, so soft glass products must be used for boron-related tests. Examples of the chemical composition of such glass are shown in Table 2.3.

Table 2.3 Example of the chemical composition of glass (%)

	Soft glass	Hard glass
SiO_2	71.3	80.5
Al_2O_3	1~3	2.0
Na_2O	13.4	4.4
K_2O	1	0.2
MgO	0.3	0.1
CaO	12.5	0.3
B_2O_3	~	11.8
As_2O_3	0.01	0.3
Fe_2O_3	0.01	0.04

Prior to use, they should be sufficiently rinsed in the same way as poly bottles. When glass bottles are reused, foreign matter attached to the inside of the glass must be removed and, depending on the type of foreign matter attached, it should be cleaned with a mixed solution of nitric acid and hydrogen peroxide (3 parts nitric acid (6N): 1 part hydrogen peroxide solution (30w/v%)) before rinsing.

Amber-colored bottles that cut out light should be used for samples when measuring components that are liable to photochemical or photolysis reactions such as agricultural chemicals, organic chemical components, and nitrite ions. Alternatively, bottles should be wrapped with shade paper or put in a shade bag and placed in a refrigerated box for transport to a laboratory, after which measurements should be carried out as soon as possible.

2.2.3 Others

Beer bottles, Japanese sake bottles, and bottles wound with rattan are made of soft glass whose components elute easily, and it is anticipated that such bottles are very contaminated making them difficult to clean sufficiently. Thus, it would be better not to use such containers.

It is sensible to take extra sample bottles in case you collect more water samples than planned for water quality survey. Additional polyethylene bags as well as such bottles are convenient for unexpected water samples.

2.3 Various Types of Water Sampler and Usage

The most suitable water sampler should be used in terms of the survey objective and field status. Typical water samplers are described as follows.

2.3.1 Sampling using sampling vessels (surface water sampling)

Rinse the sampling vessel with water on site 3~4 times. Care must be taken to avoid contaminating water to be sampled during rinsing.

Submerge the sampling vessel gently, fill it with the water sample and close it tightly. If the collected water sample may be frozen, leave some space for expansion equivalent to about 10% of the sampling vessel.

2.3.2 Surface water sampling using buckets or samplers with shafts (scoops)

Such instruments made of polyethylene are often used. A rope can be attached to the bucket if required. Scoops with adjustable shafts are convenient. Items made of synthetic resins such as polypropylene can also be used. Samplers made of stainless steel can be used provided they are not to be used for tests on trace amounts of heavy metals. An example of a water sampler with shaft is shown in Figure 2.1.

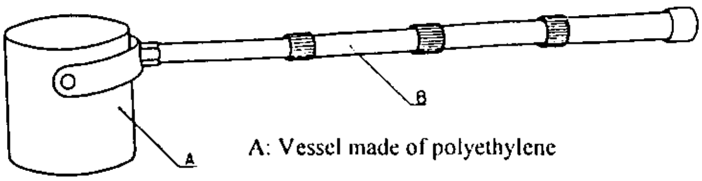


Figure 2.1 Example of long handle water sampler

Procedure:

Rinse the sampler with water on site. Next, scoop up some water at the sampling site, quickly rinse the sample container with it, then fill them with the water and close it tight. When sampling water with substantial amounts of suspended solids, pour it quickly into the sample container while mixing it sufficiently to ensure uniformity.

2.3.3 Water collection using Heyroth water sampler

Water can be sampled at various depths from water storage tanks, waterways, rivers, lakes, wells, and the sea using this water sampler. It is generally used to sample water up to depths of 10m.

However, the water samples replace air within the sampling vessel, so this method is not suitable for sampling a thin stratification as the water is agitated during sampling. Also, the sample comes into contact with the air, so it is not suitable for certain test samples such as for dissolved oxygen or reductive substances.

The sampling vessel is attached to the frame with a weight, and the vessel's stopper is removed at the required depth to obtain the water. 500 ~ 1000ml capacity vessels are generally used. An example of a Heyroth water sampler is shown in Figure 2.2.

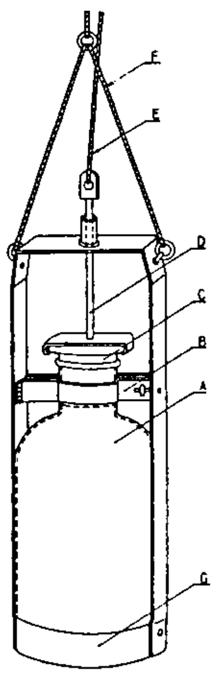


Figure 2.2 An example of a Heyroth water sampler

Procedure:

Make sure there are no malfunctions with the Heyroth water sampler, suspension rope, and chain to open the stopper, etc.; attach a sampling vessel that has already been rinsed with water into place, and secure it to the metal frame.

Gently sink the water sampler to the appropriate depth using the suspension rope, and confirm the depth of the water. Pull the chain or rope to open the stopper and leave it to fill with water. Release the chain or rope to close the stopper, raise the water sampler, remove the sampling vessel, and close it tightly.

Refer to the manual for detailed handling of the sampler. Mark the suspension rope at each depth before sampling. Care must be taken that the rope and so forth do not pollute the water at the sampling area. It is better to secure the suspension rope so as to prevent losing the water sampler in the water.

Simple water sampler

Simple water sampling bottles with weights on the sampling vessels are shown in Figures 2.3. Water is sampled by pulling the water sampling string and removing the rubber stopper or the soft vinyl chloride tube. Care must be taken not to disconnect the sampling vessel when removing the stopper as it comes out easily if not securely fixed to the vessel with a suspension rope with weight.

An appropriately sized cleaned stone that is placed and suspended in a synthetic resin net can be used as a 'weight'.

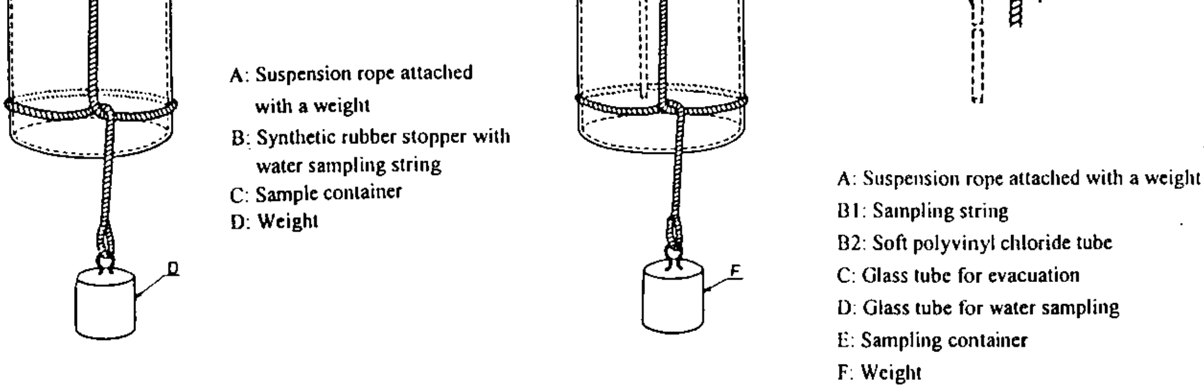


Figure 2.3 Examples of water sampling bottles using sample containers

2.3.4 Vandorn water sampler

Samples water at different depths in water storage tanks, waterways, rivers, lakes, wells, and sea. Synthetic rubber lids are attached to the top and bottom of the synthetic resin cylinder. There are two types, one of which is opaque and made of polyethylene and the other which is clear and made of acrylic resin or polycarbonate. The cylinder capacity varies from 1 to 20 liters.

An example of a Vandorn water sampler is shown in Figure 2.4.

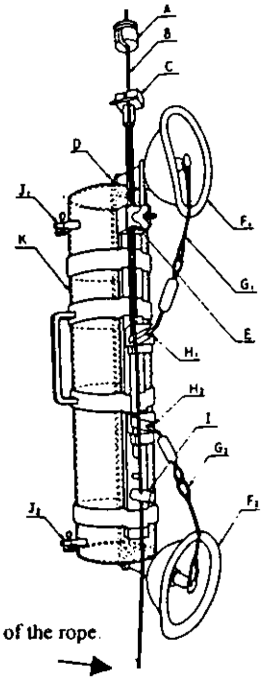


Figure 2.4 An example of a Vandorn water sampler

<u>Procedure</u>:

Check that there are no malfunctions with the messenger receiver, lids at either end, wires for the rubber lids, and suspension rope, etc of the Vandorn water sampler. If the spring on the messenger receiver has been weakened, the cylinder lid may close during sampling, so make sure it is strong enough.

Rinse the water sampling cylinder, top and bottom lids, and bucket to be used, etc., with water on site before sampling.

Attach the top and bottom lids with the wire metal fittings.

Gently sink the Vandorn water sampler to the appropriate depth using the suspension rope, and confirm the depth of water.

Move the Vandorn water sampler up and down two or three times to ensure the water within the cylinder is sufficiently exchanged, drop the messenger, close the lids at top and bottom of the cylinder, and sample the water. In this case, the sampler is moved up and down at the appropriate depth of water, so it is unsuitable for sampling thin stratification of water.

Pull up the Vandorn water sampler, open the (soft) vinyl tube with the pinch cock to allow in the water sample to pour some of the water sample in the cylinder out into the bucket to rinse it, before transferring the rest of the water sample to the bucket.

Rinse the sampling vessel with the water sample once or twice while mixing it, and then fill it with the water sample.

When measuring dissolved oxygen within the collected sample, attach the soft vinyl chloride tube to the nozzle of the water sampler, insert it so that the end of the vinyl tube reaches the bottom of the sample bottle for measuring dissolved oxygen (dissolved oxygen bottle), and pour in the water sample. Allow it to overflow by approximately 50% of the sample bottle volume, and make quick measurements through appropriate pretreatment for dissolved oxygen or by using a DO meter.

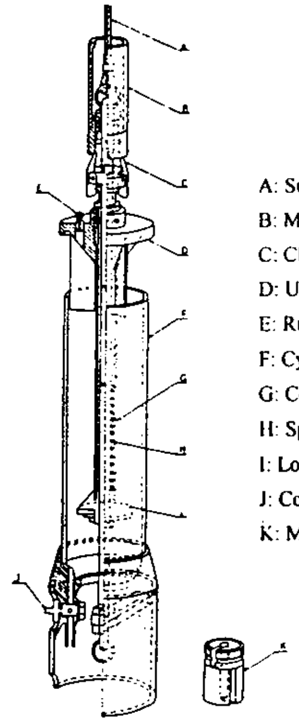
If the sample has many suspended solid, it should be handled carefully as sediment may settle on the bottom of the cylinder.

Refer to the manual for details on handling the sampler.

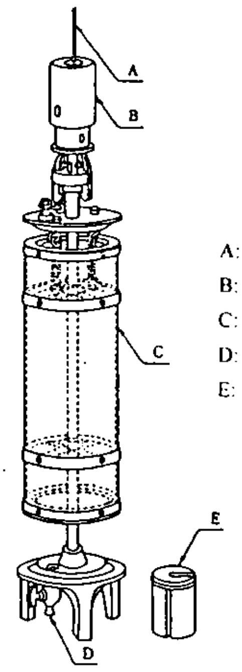
2.3.5 Insulated water sampler

Insulating material is used around the water sampler to keep the temperature of the collected water as near as possible to that when it was collected, and its field operability is superior. There are two types, one of which seals the sample by dropping the messenger and lowering the lids and cylinder after the water sampler is sunk to the appropriate depth by the messenger, while the other operates by closing the upper and lower lids tightly.

Figures 2.5 show examples of insulated water samplers.



A: Suspension rope
B: Messenger receiver
C: Click for fixing upper and lower lids
D: Upper lid
E: Rubber stopper for thermometer
F: Cylinder of synthetic resin
G: Central shaft
H: Spring
I: Lower lid
J: Cock for taking sample
K: Messenger



A: Suspension rope
B: Messenger receiver
C: Transparent cylinder
D: Cock for taking the sample
E: Messenger

Figure 2.5 Example of an insulated water sampler

This water sampler is not as good at allowing the water in or out due to its structure, so move the sampler up and down a few times at the prescribed depth before sealing it to collect the water sample to facilitate exchange of water within the cylinder. As a result, water is mixed and sampled at a depth that ranges by 60cm or more, making it unsuitable to sample water in thinner stratifications.

The water temperature can be checked by inserting a mercury thermometer into the opening. A sampler has been produced to minimize any water sample temperature changes by insulating the cylinder with thick synthetic rubber, etc, and this is used when measuring the water temperature is also important, such as with well water.

Comply with the Vandorn water sampler described before for general operational details and how to clean the sampler.

2.3.6 Other methods

Using an underwater pump:

There are a variety of pumps ranging from large types for construction to small types for domestic use. Those with a water pumping capacity of between a dozen and several tens of liters and a pumping capability of approximately 2m-aq are suitable for use when water sampling. Domestic versions used for pumping bath water can also be used. Most domestic types operate on 6~12V DC, are light, simple, and easy to use as they can be powered by a car battery in the field. In this case, vinyl piping, etc., must be used as the water conduit, and it must be cleaned and checked prior to use as it easily becomes contaminated by organic matter and algae, etc., attached inside the pipe.

Other:

Furthermore, sampling can be done using siphon action by taking advantage of the difference in depth of the water surface and the bottom of the observation boat, and other methods involving collecting water by suction using small vacuum pumps for experimental use into sample bottles.

Sites to note when sampling flowing water

Adequate consideration is required in accordance with the field conditions when sampling flowing water such as in rivers or canals as the water sampler is easily displaced and it is difficult to sample water at the prescribed depth.

Certain techniques are required such as tying the boat to a bridge support or tree on the riverbank using a rope or dropping an anchor to prevent drifting due to winds or currents when sampling water from an observation boat.

Water must be sampled from a position where the propeller and steering of the boat are not effected by ropes or cables when using the water sampler or other observation machinery and materials. Around the prow of the boat is normally considered appropriate.

If the water sampler is subject to drift due to the current and can not be kept at the prescribed depth, tie the sampler to a straight pole, and sample the water by lowering it vertically to the prescribed depth from the boat. In this case, it is convenient to use a pole with measurement markings to show the depth. (A flat disk is attached to the bottom edge, the pole is marked every 10~20 cm and different colors are used for each section. A number of poles can be used as a set, and screwed together.)

An example is shown in Figure 2.8.

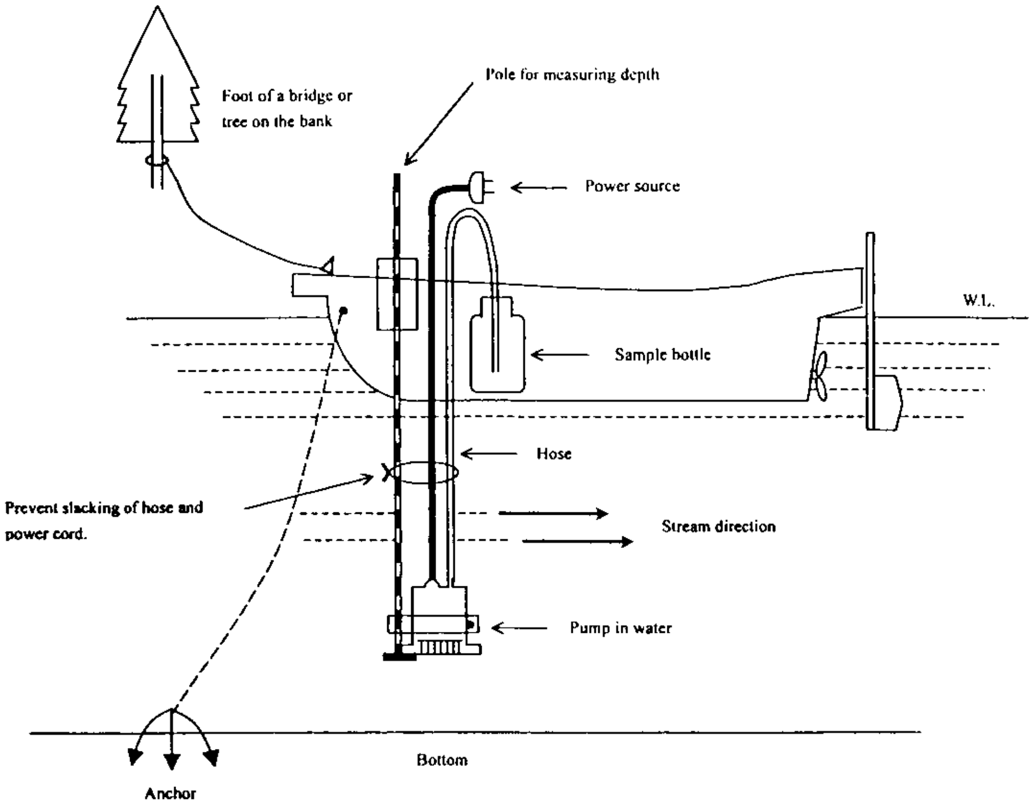


Figure 2.8 Example of sampling flowing water

2.4 Sample Water Storage Method

If the planned water quality items can be measured in the field, misjudgments caused by changes in the water quality due to the passage of time can be avoided. However, it is still normal to carry out measurements in a laboratory after conducting minimum measurements in the field and taking samples back as there are many restrictions, such as conditions at the measuring site, delivery of the measuring equipment, and survey schedule.

In this case, appropriate action should be taken to preserve the samples. Generally, they are refrigerated, have chemicals added, or have their pH adjusted, depending on the test procedure for each parameter, to control the hydrolysis and volatility of the chemical compounds and biological activity.

The sample water volume required differs according to the analytic method and concentration of the targeted components, so the required volume for each survey item should be considered and determined beforehand.

As a general rule, collected samples must be saved in accordance with the method that has been officially specified per parameter. Sites to note for preserving sample water per parameter are listed with reference to the JIS and standard methods in Table 2.4. For other parameters, sample should generally be stored in a cool, dark place between zero and ten degrees centigrade.

The general standard of required water sample volumes is shown.

Table 2.4 Sites to note for preservation of sample water

Test items	Water sampling bottle	Required water sample volume (ml)	Preparation and safekeeping method
Smell	G	500	Fill a glass bottle with a ground stopper, store it in a cool, dark place at 4°C, and conduct measurements as soon as possible.
Color	G	200	Measurements should be conducted immediately as it is easily changed due to physical and biochemical reactions.
Turbidity	P, G		Store it in a cool, dark place at 4°C and carry out measurements within 24 hours. Vigorously shake it before measurements.
Alkalinity and acidity	P, G (B)	200	Fill the bottle, tightly close the lid, store it at 4°C and carry out measurements within 24 hours. Do not stir the sample or leave it in contact with the air to avoid any reactions such as with carbonic acid.
Suspended solids (SS), total dissolved solids (TDS) and total evaporation residue (TR)	P, G (B)	500	Quickly filter, separate and measure. TDS and TR increase if stored in a soft glass bottle. When iron or manganese is included, close the lid tightly to avoid any exposure to the air, and store it in a dark place at 10°C or lower (but without freezing).
BOD	P, G	1000	Store it in a cool, dark place at between 0°C and 10°C. Testing should be carried out as soon as possible.
COD	P, G	100	Store it in a cool, dark place at between 0°C and 10°C. Measurements should be carried out as soon as possible.
TOC, TOD	G (amber colored), P	100	Store it in a cool, dark place at 10°C or lower.
Hexane extracts (oil content) Non-volatile mineral oils / Animal and vegetable oils	G (S, Wide-mouthed bottle)	5L ~ 10L	Fill a wide-mouthed bottle with a ground stopper, which has been sufficiently rinsed with N-hexane, with the water sample leaving sufficient space at the top. Use the whole amount for measurement and do not transfer or separate it. If it must be stored or transported, add methyl orange indicator, then add hydrochloric acid (1+1) until the sample water turns red, and close it tightly.
Carbon tetrachloride extracts	G (S, wide-mouthed bottle)	1000	Treat in the same manner as hexane extracts
Phenols	G	500	Add phosphoric acid until the pH = 4. Add copper (II) sulfate pentahydrate (1g) per liter of sample, shake it and store it in a cool, dark place at between 0°C and 10°C.

G: Glass bottles, P: Poly bottles

(A): washed with acid, (B): borosilicate glass, (S): washed with organic solvent

For the parameters sensitive to photochemical reactions, samples should be kept in amber-colored glass bottles or covered with black boxes.

Test items	Water sampling bottle	Required water sample volume (ml)	Preparation and safekeeping method
Nitrogen (1) Nitrite ions	P, G	100	Store it in a cool, dark place at between 0°C and 10°C. Measurements should be carried out as soon as possible. If it is stored for around three days, add 1ml chloroform per liter of sample and store it in a cool, dark place at between 0°C and 10°C. Immediate measurements should be carried out when ion chromatography is used without being stored.
(2) Nitrate ions	P, G	100	Measure immediately. If this is not possible, add hydrochloric or sulfuric acid to the sample until the pH = 2~3, and store it in a cool, dark place at between 0°C and 10°C. Immediate measurements should be carried out when ion chromatography is used without being stored.
(3) Ammonium ion	P, G	500	Measure immediately as it is easily changed. If this is not possible, store it in the same way as nitrate ions.
(1) Phosphorus Phosphorus Compounds	G (A)	100	When fractional determination is carried out per phosphorus type, filter the sample water immediately after collecting it in accordance with the targeted. Add approximately 5ml of chloroform per liter of the sample while it is neutral, and store it in a cool, dark place at between 0°C and 10°C. Under such conditions, it can be saved for 1~2 days.
(2) Total phosphorus (T-P)	G (A)	100	These can preserved by adding sulfuric or nitric acid until the pH = around 2.
(3) Dissolved phosphorus	G (A)	100	Filter the sample water using 0.45μm or No. 5C filter paper immediately after collection, add approximately 5ml of chloroform per liter of the sample and store it in a cool, dark place at between 0°C and 10°C. Under such conditions, it can be saved for 1~2 days.
(4) Phosphate ion	G (A)	100	As above
Dissolved oxygen	G (BOD bottle)	100~300	Measure immediately after the water is sampled, or carry out on-site preparation of the sample for preservation, store it in a cool, dark place at between 0°C and 10°C after closing it tightly, and measure it as soon as possible.
Residual chlorine	G	100	Measure immediately after the water is sampled. It can not be stored.
Cyanogen compounds	P, G	500	Add sodium hydroxide solution (20W/V%) until the pH = about 12 and store it. If oxidized substances such as residual chlorine exist, add L-ascorbic acid for reduction, and change the pH to about 12.
Sulfur compounds	P, G	200	These are classified per type, such as sulfide ions, sulfurous acid ions, and sulfate ions, etc. The processing and storage methods differ according to the analysis method that will be adopted.

2.5 Sample Transportation

Carry the sample water that has been collected in sample bottles. Great care must be taken concerning the following sites when sampling water.

(1) Use appropriate sample bottles in accordance with the objective of quantitative survey. The bottles should be sufficiently rinsed out before use to avoid any contamination from the bottles themselves.
(2) Rinse the sample bottle with a small amount of the sample water two or three times, gently them fill up with the water, and close them tightly.
(3) If the sample water contains a lot of suspended solids, quickly pour the water into the sample bottle to ensure uniformity. Care must be taken to avoid any large pieces of matter, such as leaves or other bits off trees.
(4) Pretreatment for sample preservation – as mentioned in Section 2.4 – must be carried out when storing samples in accordance with the parameter.
(5) Place the label clearly describing the sample site, date and time on the sample bottle.

The sample water is normally carried to the lab by a water-sampling vehicle. Sites to note concerning the loading and transportation of the water samples by vehicle are described as follows.

(1) When a number of analysis parameters are sampled simultaneously, classify the sample containers per analysis item as mentioned in Section 2.2 and load them.
(2) It is convenient to use boxes with partitions for each parameters to prevent sample bottles falling over during transportation.
(3) Use protective wrapping (synthetic resin net) to prevent damage due to contact with other vessels, and soft padding to cushion fragile vessels (such as glass ones) from shock.
(4) For parameters that need to be kept cool against to temperature rises within the vehicle, (i.e. BOD, COD, bacteria, VOC, etc.), samples should be stored/transported in an ice box (cool box) with ice or coolants

Store the water samples that have been collected in a fridge or cold room. Although analysis must be carried out as soon as possible as a general rule, storage of certain parameters is possible by carrying out the appropriate procedure.

2.6 Field Note Description

When conducting sampling, also measure the air and water temperatures and note the outward appearance of the sampled water. In particular, components that easily decompose or react should be measured in the field or should be suitably prepared for storage. The instruments and reagents required for measurements when water is sampled are shown in Table 2.5.

Table 2.5 Measurements when sampling water

Items	Instruments and reagents
Outward appearance	Transparent glass bottle or beaker
Air and water temperatures	Mercury thermometer, thermistor
pH	pH colorimeter or pH meter
Transparency	Transparency meter Secchi plate
Turbidity	Turbidity meter
Electrical conductivity	Electrical conductivity meter
Dissolved oxygen	Dissolved oxygen bottle, reagent for the sample preservation, instruments or DO meter
Fe^{2+}	Reagents and instruments for absorption photometry Spectrophotometer (portable)
Sulfide ion	Reagents and instruments for sample preservation
Flow rate	Flow velocity meter and instrument to measure side cross-sections

Items to be measured in the field, instruments and reagents must be added in accordance with the objective of the survey. Some items may not be required depending on the target, such as rivers, lakes, underground water and seawater, so items to be measured in the field should be selected in accordance with the survey objective, and appropriate reagents and instruments selected. An example of a water-sampling diary is show in Table 2-6. Sites to describe for the table are shown below.

(1) Water sampling personnel: Water sampling is generally conducted in groups of two or more, so the names of all people concerned should be detailed.

(2) Survey name: Describe the name of the survey.

(3) River or factory name: Describe the items required in accordance with whether the target is a river, lake, underground water or sea, or the name of the source, such as factory.

(4) Water sampling site: Clearly describe the name of the bridge for rivers, center or shore (i.e. dam site) for lakes, name of the well owner for underground water, name of the local coastline for seawater, and what kind of wastewater treatment is conducted for the effluent is discharged in the case of a factory. If it is a regular monitoring site or sites that have already been plotted on a map, the site reference number can be used for simplicity.

(5) Water sampling time: Describe in hours and minutes.

(6) Weather: Describe the weather on the day of sampling and one day before as clear, fair, cloudy or rainy, etc.

(7) Outward appearance: Describe the degree of turbidity by eyesight when water is sampled. For example, if it is obviously turbid, use three categories such as ‘Very’, ‘Somewhat’ and ‘Slightly’, while if there are no apparent impurities, describe ‘None’. It is preferable to describe the color of the water as well. ‘Forel and Ule’s color scale’ is used as the international standard for the quality of the water’s color. Water quality standard solutions can be observed in a total of 21 colors, comprising Forel (11 types) and Ule (10 types).

(8) Air / water temperature: Use normal mercury thermometers to measure air temperatures in the shade. Also measure water temperature by immersing a mercury thermometer in the water sample until it

shows a constant value. Digital water thermometers that come with handy built-in pH meters can also be used.

(9) Dissolved oxygen, electric conductivity, and pH: They must be measured and recorded if a convenient portable meter is available. It is also important to cross check the dissolved oxygen meter with a measured value of the sample using DO bottle.

(10) River width and depth: Depths should be detailed in the case of rivers. If it is the first time the survey has been conducted at this site, estimate the width by counting the number of paces from one side to the other. The river depth is an important measurement item, so measure the depth with a weighted rope and record it. Also describe the depth at which each water sample is taken for vertical distribution surveys in lakes and the sea.

(11) Flow velocity: Make a judgment on a five-point scale based on your visual observations. Floats can be used for instant measurements of the flow rate, so it should be measured when required.

The following sites should generally be considered when selecting the location to measure flow velocity.

a) Stream should flow through single channel.

b) Water should flow several times further than the river width (normally four times) in a straight line both up- and downstream, and there should not be a big difference in the cross section or inclination of the riverbed.

c) Poor condition riverbeds such as those with irregularly placed rocks and stones should not be selected.

d) Water streams should not be too fast or slow.

e) There should not be any whirlpools, backward flow, or stagnation.

12) Remarks: Describe any smells and changes in the environment (plants, waterfowl, etc.).

Table 2.6 Field note for water sampling

		Sampling personnel	Survey name	
			Sampling date	Day: Month: Year:

River name / Factory name								
Sampling site								
Sampling time								
Weather	on one day before							
	on the day							
Outward appearance								
Air temperature ℃ ／ Water temperature ℃		／	／	／	／	／	／	／
pH								
Dissolved oxygen (mg/l)								
Electric conductivity (μυ/cm)								
River width (m)								
River depth (m)								
Flow velocity								
Remarks								