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SAMPLING OF WATER AND WASTEWATER

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SAMPLING OF WATER AND WASTEWATER

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FOREWORD

Environmental sampling of water and wastewater is a prerequisite to monitoring and measurement in determining the quality of ambient waters and the character of waste discharges. The U.S. Environmental Protection Agency, through its various component laboratories, conducts research involving:

- Sampling and water quality monitoring
- Characterization of source flows
- Investigating the effect of polydisperse systems on sampling
- Recommendations addressing frequency of sampling, site selection and sample preservation prior to laboratory analysis
- Developing and implementing an Agency-wide quality assurance program to achieve uniformity and quality control in monitoring water and wastewater programs.

This report describes the state-of-the-art of commercially available and custom built automatic liquid samplers with recommended sampling procedures for the field.

The purpose and scope of this report is to provide personnel engaged in water quality surveys with practical and up-to-date information on the technology of water and wastewater sampling.

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PREFACE

This report represents a revision and update of an earlier USEPA Office of Technology Transfer Seminar Publication that was disseminated at the Industrial Wastewater Monitoring Seminar series in late 1974 and early 1975. It has been completely reorganized with mostly new material and additional subject matter covered. As a result, over 95 percent of the present report represents new or revised content as compared to its predecessor, which is hereby superseded.

An Agency-wide sampling and monitoring manual is currently being prepared by the Environmental Monitoring and Support Laboratory, OR&D, Cincinnati, Ohio. This new manual will contain portions of this report; the "Handbook for Sampling and Sample Preservation of Water and Wastewater" EPA-600/4-76-049, September 1976; and the "NPDES Compliance Sampling Manual" that was prepared by the USEPA Enforcement Division. This agency sampling and monitoring manual will be ready for distribution in 1978.

ABSTRACT

Water and wastewater sampling is discussed within the context of a water quality monitoring program. The general characteristics of the source flows are described, and the mechanics of polydisperse systems as they affect sample gathering are discussed. It is pointed out that the collection of a sample that is representative of the source in all respects is a frequently underrated task, especially insofar as suspended solids are concerned. The various types of samples are defined, compared, and their use indicated. Other practical considerations addressed include frequency of sampling, site selection, and sample quantity, preservation, and handling. Recommendations on when to use manual versus automatic sampling are given. Each of the elements of an automatic sampler is discussed from the viewpoint of design considerations in order to help the reader assess the ability of a particular unit to meet his needs. Commercially available samplers and some custom designed equipment are reviewed. Recommended field procedures for sampling are given, and a review of automatic sampler performance is provided. An appendix provides, in a common format, 102 descriptions covering over 250 models of commercially available automatic samplers and 16 descriptions of custom built devices.

This report was submitted in fulfillment of CA-6-99-3131A by Environmental Research Information Center (ERIC) under the sponsorship of the U.S. Environmental Protection Agency. This is a final report, and work was completed as of February 1977.

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INTRODUCTION

GENERAL

Water and wastewater sampling is not an end in itself but, rather, one of the basic elements common to any water quality monitoring program. These elements include:

1. Program Design
2. Flow Measurement
3. In Situ and Side Stream Determinations
4. Sampling
5. Laboratory Analysis
6. Quality Control
7. Data Management, Interpretation, and Reporting

From an overall perspective, water quality monitoring is the collective activity, embracing all of these elements, that allows determination of the suitability of a particular water source for a specific use. Keeping this in mind, it is more convenient to view a water monitoring program in terms of more specific purposes to be served, such as:

1. Planning (areawide, basin, subcatchment, etc.)
2. Permitting (issuance, validation, revision, etc.)
3. Compliance (including verification)
4. Enforcement (including case preparation)
5. Design (system, unit operation, etc.)
6. Operation (process control, material accountability, etc.)
7. Research

Within any one of these purposes there may be a number of monitoring objectives. As an example, monitoring objectives of interest to an areawide planner would include:

1. Establishing baseline conditions

2. Determination of assimilative capacities of streams

3. Following the effects of a particular project or activity

4. Pollutant source identification

5. Long-term trend assessment

6. Waste load allocation

7. Projecting future water characteristics

Although we could continue listing such objectives for this and other monitoring purposes, the foregoing is sufficient to illustrate the basic point to be made here; namely, that water and wastewater sampling, along with other activities, is an integral part of a larger effort whose purposes and objectives form the context within which the sampling must be conducted. Furthermore, these elements of monitoring are interrelated, and a systems approach is required in the design and execution of an efficacious monitoring program.

SCOPE

With the foregoing explanation, the remainder of this volume is limited to considerations of water and wastewater sampling. Thus, when sampling frequency is discussed it is in the context of a particular source at a particular site; not within the context of a particular monitoring program with certain specific objectives. Similarly, when sampling site selection is discussed, the concern is where to specifically locate within a general area chosen as a part of the overall monitoring program design, and so on. Thus, sampling aspects that are a part of an overall monitoring program design (e.g., number of sites, parameter selection, analytical methodology selection, data handling, etc.) are presumed to be already determined and, consequently, will not be dwelt on here to any appreciable extent.

In order to keep this volume within reasonable bounds, emphasis is placed on techniques and equipment for proper sampling of wastewater, especially complex, highly variable flows. This is where the greatest problems are encountered, and where the use of a proper methodology is most critical if meaningful results are to be obtained. Proper sampling for these flows will certainly be adequate for more pristine waters. Similarly, primary emphasis is on flows in natural and man-made channels, as opposed to quiescent surface impoundments, tidal bodies, pressurized industrial process flows. or groundwater.

The objective of any sampling effort is to remove, from a defined universe, a small portion that is in some way representative of the whole. Ideally, a representative water or wastewater sample will accurately reflect the physical and chemical characteristics of the bulk source in every respect as they were during the sampling period. In water quality, such representativeness is seldom if ever wholly achieved and, fortunately, seldom required. As used herein, a representative sample is one that, when examined for a particular parameter, will yield a value from which that bulk source characteristic can be determined. The proper sampling methodology, i.e., that which will produce a representative sample, is dependent upon the type of bulk source to be sampled, e.g., surface water in natural channels (rivers, streams, lakes), municipal wastewater, ground water, urban runoff, industrial wastewater, treatment lagoon, and so on. Nonetheless, there are some more or less universal sampling considerations, and it is they that will be addressed in this volume.

GENERAL FLOW CHARACTERISTICS

Flow in Natural Channels

Concentrations of natural constituents, such as alkalinity, hardness, and minerals, generally vary inversely with stream flows in uncontrolled streams. Most of the water in a stream at low flows has spent much time underground in intimate contact with the minerals of the soil and has dissolved maximum concentrations of these minerals. At least some of the water at high flows has run off directly over the surface of the ground, and some of it has been underground a relatively short time, with less opportunity to dissolve minerals. There may, however, be a first flush effect associated with storm generated discharges, especially in areas heavily impacted by man's activities, e.g., urban runoff. Total loads, or quantities, of natural constituents carried by a stream, on the other hand, increase as flow increases. The increasing water carried by the stream more than balances the decreasing concentration to yield a greater load in terms of a unit of total quantity, such as pounds per day. Concentrations of wastes also vary inversely with stream flow when completely mixed with the stream immediately below the point of discharge. Negligible adverse effects of wastes may occur at high flows, whereas the stream may be polluted seriously at low flows.

The inverse relationship of stable waste constituents to stream flow continues downstream until additional dilution by tributary inflow occurs. Other factors come into play with unstable constituents. Time-of-water travel increases as flow decreases to accomplish natural purification in shorter distances. Higher densities of bacteria, for example, occur just below the point of discharge at lower flows, but they die off in shorter distances because of the longer time of travel.

Likewise, BOD's are higher near the point of discharge but stabilize in less distances at low discharges. DO concentrations drop to lower minimums but recover in shorter distances. Other factors, in addition to time-of-travel, contribute to the DO recovery. The stream surface, through which oxygen enters the water from the atmosphere, usually decreases only slightly as stream stage and flow decrease. Approximately the same quantity of oxygen enters decreasing quantities of water in a given stream reach as flow decreases, other things being equal. Therefore, the concentrations of DO in the smaller quantities of water increase as the flow decreases. The decrease in depth with decreasing flow generally increases the reaeration coefficient. The reverse of this variation may occur, however, in deep pools with relative low velocities at minimum flows. These factors, together with stabilization of BOD in shorter distances, combine to accomplish recovery of DO in shorter distances at lower stream flows, although more severe depletions generally occur in the affected reach at low flows.

The natural flow of uncontrolled streams usually varies over a wide range. Stream flows follow precipitation patterns except in the colder areas of the country, where precipitation falls as snow in winter and much of the surface water is frozen. There can be wide differences in stream flow throughout the year and in the annual flow cycle from year to year. Flow in most areas tends to be high in winter, especially in January and February, and to taper off subsequently to minimum quantities in September and October and, on occasion, into November. October is the minimum flow month as a general rule. High flows usually occur in colder areas when relatively warm spring rains melt the winter accumulation of ice and snow. The natural cycle may be altered to a considerable extent in streams controlled by impoundments, however. In any case, stream flows must be considered in selecting periods for stream study because of the considerable variations in water quality that accompany changes in flow.

Flow in Manmade Conduits

In manmade conduits, the effects of flow variation are probably greatest in storm sewers. Although storm sewers are basically designed to carry storm runoff, during periods of no rainfall they often carry a small but significant flow (dry weather flow). This may be flow from ground water, or "base flow," which gains access to the sewer from unpaved stream courses. Such base flow may appear as runoff from parks or from suburban areas where there are open drains leading to the storm sewer. Unfortunately, much of the dry weather flow in storm sewers is composed of domestic sewage or industrial wastes or both, arising from unauthorized discharges to them. In some cases, the runoff from septic tanks is carried to them. Connections for the discharge of swimming pools, foundation drains, sump pumps, cooling water, and pretreated industrial process water to storm sewers are permitted in many municipalities and contribute to flow during periods of no rainfall. In some areas, sewers classed as storm sewers are, in fact, sanitary or industrial waste sewers due to the unauthorized or inappropriate connections made to them. This may become so aggravated that a continuous flow of sanitary or industrial wastes, or both, flows into the receiving stream.

The "dry-weather" portion of storm sewer flow may vary significantly with time. Probably the most steady flow, and constant character of pollutants therein, occurs in storm sewers when all flow is base flow derived from ground water. Because of the slow movement of water through the ground, changes in flow and concentration of pollutants occur only during relatively long time periods. Where unauthorized connections of domestic sewage and industrial waste lines to storm sewers are found, rapid fluctuations with time may occur. The domestic sewage constituent varies with time of day, with season of year, and probably over long-term periods. Industrial wastes vary with specific processes and industries. Very rapid changes may occur with plant shift changes and with process dynamics. Conditions on weekends and holidays may be very different from those on regular work days.

Variation With Time

Storm runoff is the excess rainfall which runs off the ground surface after losses resulting from infiltration to ground water, evaporation, transpiration by vegetation, and ponding occur. A small portion of the rainfall is held in depression storage, resulting from small irregularities in the land surface. The quantity, or rate of flow, of storm runoff varies with intensity, duration, and areal distribution of rainfall; character of the soil and plant life; season of the year; size, shape and slope of the drainage basin; and other factors. Ground seepage loss varies during the storm, becoming less as the ground absorbs the water. The period of time since the previous, or antecedent, rainfall significantly affects the storm runoff. In general, storm runoff is intermittent in accordance with the rainfall pattern for the area. It is also highly variable from storm to storm and during a particular storm.

The pollutant concentration in most man-made conduits and especially in storm and combined sewers is highly variable, both with respect to the time and with the position in the sewer cross-section. This is true during periods of no rainfall as well as during storm runoff periods, but usually to a lesser extent. Observation and experience have demonstrated that the heaviest concentration of suspended solids during periods of storm runoff usually occurs during the early part of the storm. At this time, the stage is rising and accumulated dry-weather solid residue is being flushed from the sewers and washed and eroded from the tributary land areas. As runoff recedes, the sewer and land area surfaces exposed to flow are reduced, the flow velocities which serve to flush and erode are decreased, and the more easily dislodged solids have been acted upon. Thus, suspended material is reduced in concentration. This pattern of variation may not be followed during a period of storm runoff which immediately follows a previous storm runoff period because the land surface and sewer lines are relatively clean.

Pollutants derived from nonpoint sources, such as those from stockpile drainage, vary at the sampling location with time of travel from the source to the point of observation. Maximum concentration may occur after the peak of storm runoff. It is conceivable that there would be no contribution from some sources during a specific storm because of areal variation of rainfall in the basin.

Variation With Position in Cross-Section

The variations in flow composition with position in the flow cross-section are attributable to a number of factors including degree of turbulence, variations in velocity profiles, the tendency for flows transporting materials of different density (or having different temperatures) to remain separate from each other for quite some distance following their convergence, the fact that substances in solution may well behave independently of suspended particles, and so on.

Suspended solids heavier than water have their lowest concentrations near the surface, and the concentration increases with depth. Near the bottom of the sewer may occur a "bed load" composed almost entirely of heavier solids. This may "slide" along the bottom or, with insufficient flow velocity, may rest on the bottom. As the velocity and turbulence increase, the "bed load" may be picked up and suspended in the liquid flow. At the beginning of storm runoff, as water picks up solids which have accumulated in the sewer upstream during periods of no rainfall, the flow may be composed largely of sewage solids, or "bed load," which appears to be pushed ahead by the water.

Suspended materials lighter than water, such as oils and greases, float on the surface, as do leaves, limbs, boards, bottles, and cloth and paper materials. Other small, light particles are moved randomly within the flow by turbulence. These may be well distributed in the cross-section without significant effect of variable velocity within the section.

Larger, heavier suspended and floating solids tend to move to the outside of a horizontal curve as a result of centrifugal inertia force. Particles with a specific gravity much less than 1.00 may tend to move toward the inside of the curve. Because the effect of curvature on flow often continues downstream a considerable distance, it is probable that a normal distribution of suspended matter is not found on a curve, or downstream for a distance of 20 or more diameters.

Incoming sewage from an upstream lateral with different density and temperature may not mix well, and often flows for long distances without combining with the main body of the sewer. The appearance may be of two streams flowing side-by-side, each with different quality characteristics. A sample taken from either stream is not representative of the entire stream character.

MECHANICS OF POLYDISPERSE SYSTEMS

The mechanics of polydisperse systems such as wastewater flows are among the most complex and least thoroughly understood of all aspects of science. This is not surprising, when one considers that it covers dynamic processes ranging from such sedimentology subjects as the movement of soil to the thixotropic world of colloid chemistry. With complete descriptions having to account for such topics as electrokinetics, descriptive and structural rheology, sorption, flocculation, diffusion, and Brownian motion as well as hydraulic system influences, it is little wonder that empirical progress has outpaced analytical descriptive efforts. Even under well-controlled laboratory conditions, the study of suspended solid laden flows remains very difficult. The point of all of this is not to suggest that any attempt to seriously study the subject is doomed to failure but, rather, to point out that one should not approach it as though it were a ±1-percent cosmos.

Since suspended solids are one of the most troublesome wastewater constituents to sample representatively, they form a good place to begin this discussion. It is desirable to have standard terms that carry definite notions of particle size. Although size terms based upon a major physical dimension (e.g., sand, silt, clay) are very useful for certain fields such as soil mechanics and geology, they do not present as much information about the behavior of the particle in water as others might. First, suspended solids particles are not spheres but are actually of innumerable shapes and degrees of angularity; second, not all particles are of the same specific gravity, especially those more directly associated with the activities of man. In regard to the first point, sieves with square openings of uniform dimensions express a size value that becomes more and more misleading as to true particle volume as the shape of the particle deviates from a sphere. This volume, together with specific gravity as mentioned in the second point, determines the mass of the particle and, hence, is one predictor of its behavior in a hydrodynamic force field. As has been noted by numerous workers, the use of hydraulic size (W), which is the average rate of fall that a particle would finally attain if falling alone in quiescent distilled water of infinite extent at 24°C, as a descriptor for a particle involves its volume, shape, and density. It is presently considered to be the most significant measurement of particle size. However, there are no analytical relationships to allow its computation; recourse must be made to experiment.

An excellent discussion of the fundamentals of particle size analysis is given by the Federal Inter-Agency Sedimentation Project (FIASP; 1957). Table 1, which is taken from data presented therein, illustrates the effect of shape factor (a measure of particle angularity) on hydraulic size for sand particles with specific gravity of 2.65 in water at 20°C. It can be noted that while a sphere (SF=1) with a diameter of 0.2 mm will fall only about one-third faster than a similar sized particle with a shape factor of 0.3, a sphere with a diameter of 4.0 mm falls over 2-1/2 times faster than a particle with SF=0.3. Thus, shape factor considerations become less important as particle size decreases. For curves showing temperature effects, correction tables, etc., the reader is referred to FIASP (1957).

TABLE 1. EFFECT OF SHAPE FACTOR ON HYDRAULIC SIZE (in cm/sec)*

Nominal diameter (mm)	Shape factor				
	0.3	0.5	0.7	0.9	Spheres
0.20	1.78	1.94	2.11	2.26	2.43
0.50	4.90	5.63	6.31	7.02	7.68
1.00	8.49	10.10	12.10	14.00	15.60
2.00	12.50	15.50	19.30	23.90	28.60
4.00	17.80	22.40	28.00	35.60	46.90

* Data from FIASP (1957)

For Reynolds numbers less than unity and nearly spherical particles, Stokes' Law can be used to relate hydraulic size to particle density and diameter. The region of validity of Stokes' Law is depicted graphically in Figure 1 (taken from Shelley and Kirkpatrick; 1975b), with water at 15.6°C (60°F) as the fluid. Note that for the denser particles, only those of rather small size will obey Stokes' Law.

The use of hydraulic size as a descriptor for sediment particles is useful down into the clay range. For smaller particles, shape factor is no longer as important, and fall velocities become so slow that they no longer serve as such a useful descriptor, being better stated in centimeters per century. For sediment particles larger than very small pebbles, fall velocities become very large (and difficult to measure) and, consequently, are not as useful a descriptor as for the smaller particles.

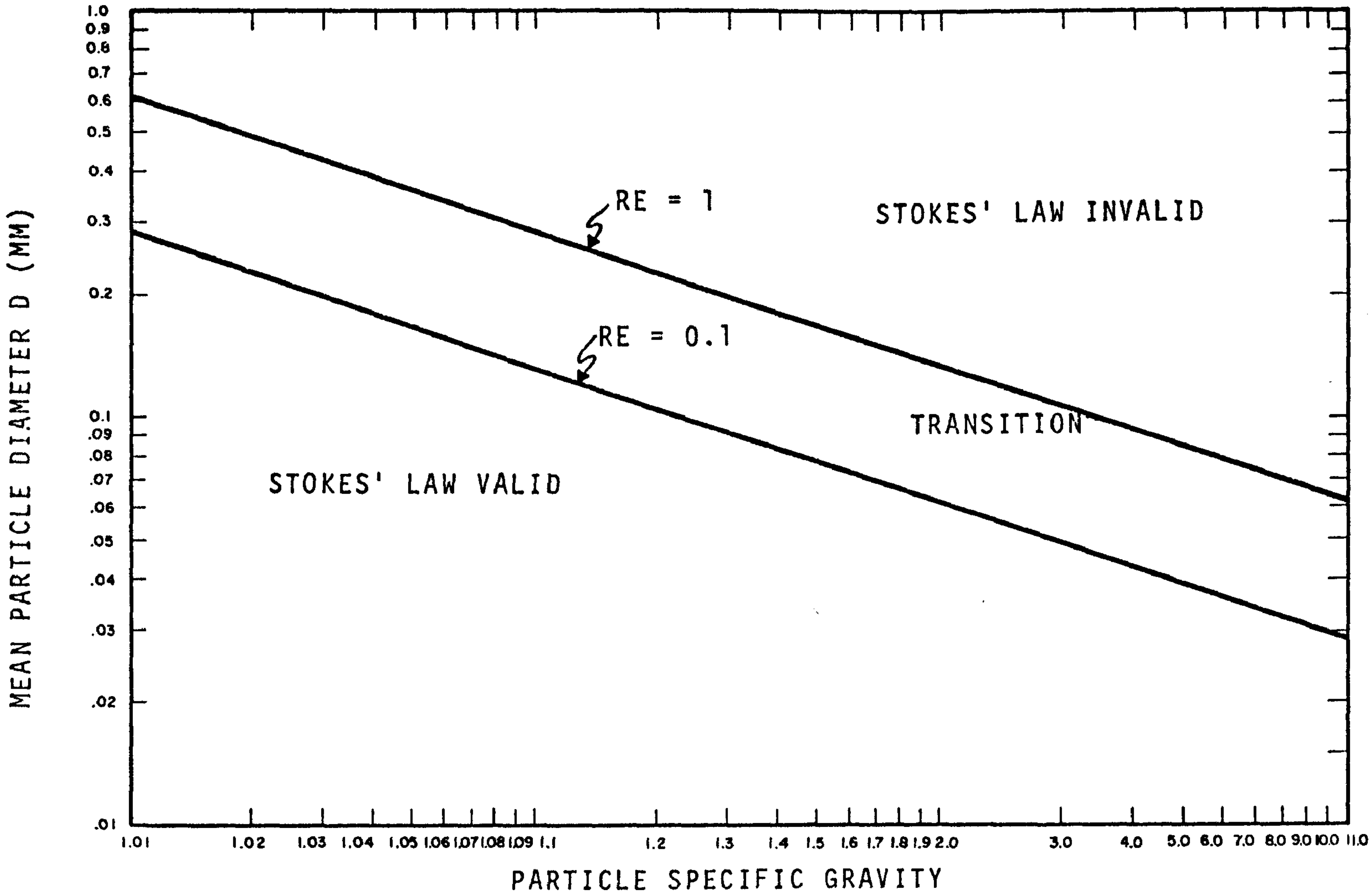


Figure 1. Region of validity of Stokes' Law.*

* Taken from Shelley and Kirkpatrick (1975b)

Table 2 (taken from Shelley; 1976b) has been prepared to give a better appreciation of the orders of magnitude and characteristics of suspended solids. Eight decades of particle sizes are covered, and nominal dimensions are given in millimeters, microns, and angstroms, as some readers may have a better appreciation for size in one set of units rather than another. The changes in particle weight (or mass or volume) with size are indicated relative to a 1-mm particle. Changes in hydraulic size with mean particle diameter are indicated relative to a quartz sphere (s.g. = 2.65) 1 mm in diameter. Within the range of validity of Stokes' Law, they vary with the square of the diameter. The displacement due to Brownian motion relative to a 1-mm-diameter particle is also indicated. Major divisions of particle size classification are indicated, as is the physical nature or phase of the mixture. Several other characteristics of particle-water mixtures are also given, including the visual appearance, methods of particle observation, separation techniques, and the form of the solids after evaporation.

The distribution of suspended solids or sediment in a transport stream is expressed in terms of concentration in one of two ways. Spatial concentration is defined (FIASP; 1963) as "the quantity of sediment relative to the quantity of fluid in a fluid-sediment mixture." Thus, it could be expressed as the dry weight of solids per unit volume of water-solids mixture (e.g., mg per liter). Turbidity, density, and other fluid properties of the water-solids mixture are related to the spatial concentration. On the other hand, the discharge-weighted concentration is defined as the quantity of suspended solids relative to the discharge of the fluid-solids mixture. Thus, it could be expressed as the dry weight of solids in a unit volume of discharge, or the ratio of the dry weight of solids discharge to the weight of the water-solids discharge. The discharge-weighted concentration may be multiplied by the overall stream discharge to obtain suspended solids discharge (e.g., kg per hour).

TABLE 2. PARTICLE ORDERS OF MAGNITUDE AND CHARACTERISTICS*

Milimeters	10	1	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}
Microns	10,000	1,000	100	10	1	0.1	0.01	0.001	0.0001
Angstroms	10^{8}	10^{7}	10^{6}	10^{5}	10^{4}	10^{3}	10^{2}	10	1
Relative Weight of a Particle	10^{3}	1	10^{-3}	10^{-6}	10^{-9}	10^{-12}	10^{-15}	10^{-18}	10^{-21}
Relative Fall Velocity	4.8	1	$5.6x10^{-2}$	$5.6x10^{-4}$	$5.6x10^{-6}$	$5.6x10^{-8}$	$5.6x10^{-10}$	$5.6x10^{-12}$	-
Relative Brownian Displacement	-	1	10^{1}	10^{2}	10^{3}	10^{4}	10^{5}	10^{6}	-

Classification

sand | silt | clay | ultra clay | solution

Phase	bed load	coarse suspension	coll. susp.	colloidal solution	molecular soln.
Appearance	on bottom	very cloudy	turbid	virtually clear	clear
Observed w/	naked eye	naked eye	microscope	electron or ultra-microscope	-
Separated w/	screen	filter paper	clay filter	ultrafilter	-
Form after evaporation	granular	loose powder	powder or gel	gel	crystal

* Taken from Shelley (1976b).

Notes:

- The fall velocity of a 1-mm diameter quartz sphere is 16.0 cm/s. Similar particles much below 10^{-4} mm in diameter essentially do not settle, their fall velocities being better stated in centimeters per century.
- The time for average Brownian displacement of a 2-mm diameter sphere by 1 cm is around 7300 yr. Brownian motion starts as a practical consideration for diameters smaller than 10^{-2} mm.
- The resolution limit of an ordinary microscope is around 2000A, compared to 10A for electron or ultramicroscopes.
- The size of particles passing the finest practical sieves (300 mesh) is around 0.05 mm. The limit of an ultrafilter is approximately 10^{-6} mm.

SECTION 2

PRACTICAL SAMPLING CONSIDERATIONS

SAMPLE TYPES

The selection of the type of sample to be collected depends on a number of factors, such as the rates of change of flow and the character of the water or wastewater, the accuracy required, and the availability of funds for conducting the sampling program. There is presently a tendency on the part of some workers to make only two distinctions in sample types -- grab and composite. This is unfortunate, since a composite sample may be made up in a number of ways, and results may or may not be comparable, depending upon variations in flow and constituents. It is a better practice to distinguish among the various methods of compositing by referring to them as sample types. All samples collected, either manually or with automatic equipment, are included in the following types, which terminology has been recommended for standard usage by Shelley and Kirkpatrick (1975a).

Discrete Samples (Individual and Sequential)

An individual discrete sample (sometimes called a grab sample) is one that is collected at a selected point in time and retained separately for analysis. A sequential discrete sample is a series of such samples, usually taken at constant time intervals (e.g., one each hour over a 24-hour period), but sometimes at constant discharge increments (e.g., one for each 100,000 gallons of flow) when paced by a flow totalizer.

Simple Composite Sample

A simple composite sample (sometimes called a time composite sample) is one that is made up of a series of aliquots (smaller samples) of constant volume (Vc) collected at regular time intervals (Tc) and combined in a single container. Such a sample could be denoted by TcVc, meaning time interval between successive aliquots constant and volume of each aliquot constant.

Flow Proportional Composite Sample

A flow proportional composite sample is one collected in relation to the flow volume during the period of compositing, thus, indicating the "average" condition during the period. One of the two ways of accomplishing this is to collect aliquots of equal volume (Vc), but at variable time intervals (Tv), that are inversely proportional to the volume of the flow. That is, the time interval between aliquots is reduced as the volume of flow increases. Alternatively, flow proportioning can be achieved by increasing the volume of each aliquot in proportion to the flow (Vv), but keeping the time interval between aliquots constant (Tc).

Sequential Composite Sample

A sequential composite sample is composed of a series of short-period composites, each of which is held in an individual container. For example, each of several samples collected during a 1-hour period may be composited for the hour. The 24-hour sequential composite is made up from the individual 1-hour composites.

Continuous Composite Sample

A continuous composite sample is one collected by extracting a small, continuously flowing stream from the bulk source and directing it into the sample container. The sample flow rate may be constant (Qc), in which case the sample is analogous to the simple composite, or it may be varied in proportion to the bulk source flow rate (Qv), in which case the sample is analogous to the flow proportional composite.

Discussion

A summary of sample types is given in Table 3. For initial characterization of wastewater flows, sequential discrete sampling is generally desired. It is mandatory for accurate stormwater characterization, since it allows characterization of the wastewater over a time history and provides information about its variations with time. If the samples are sufficiently large, manual compositing can also be performed, based on flow records or some other suitable weighting scheme, and a preferred composite type determined. However, some form of automatic compositing will usually be desired for continued wastewater discharge characterization, since manual compositing is fraught with practical difficulties and opportunities for errors as sample handling increases.

A brief look at the different types of composite samples is in order. Any scheme for collecting a composite sample is, in effect, a method for mechanically integrating to obtain average flow characteristics. The simple composite is the crudest attempt at such averaging and theoretically will be representative of the waste flow during the period only if the flow properties are relatively constant.

For variable flows, some type of proportioning must be used. This is equivalent to saying that the simple composite is a very poor scheme for numerical integration, and a higher order method is desirable. There are two fundamental approaches to obtaining better numerical integration, given a fixed number of steps. One is to increase the order of the integration scheme to be used, as in going from the trapezoidal rule to Simpson's rule. The other is to vary the step size in such a way as to lengthen the steps when slopes are changing very slowly and shorten them when slopes change rapidly. Typical of the first approach are the constant time interval, variable volume (TcVv) proportional

TABLE 3. SUMMARY OF SAMPLE TYPE

Sample Type	Designation	Principle	Comments	Disadvantages
Discrete (Individual)	D	Sample quantity is taken over a short period of time, generally less than 5 minutes.	Most commonly used. Provides a "snapshot."	Tells nothing about time variations or average conditions.
Discrete (Sequential)	Ds	Series of individual discrete samples taken at constant increments of either time or discharge.	Used by some automatic samplers; impracticable to collect manually. Provides a history of variation with time.	Most useful if rapid fluctuations are encountered or detailed characterization is required. Many analyses must be run with attendant higher cost.
Simple Composite	TcVc	Constant aliquot volume; constant time interval between aliquots.	Most widely used type of composite at the present time.	Only useful if variations are relatively small, say ±15% or so.
Flow Proportional Composite	TvVc	Constant aliquot volume; time interval inversely proportional to flow.	Most common type of flow proportional composite.	Requires a flowmeter; also a record if composited manually.
Flow Proportional Composite	TcVv	Constant time interval; aliquot volume proportional to instantaneous flow rate.	Used in some automatic samplers and widely used manually.	Requires a flowmeter; also a rate record if composited manually.
Flow Proportional Composite	TcVv	Constant time interval; aliquot volume proportional to flow since last aliquot was taken.	Used by few automatic samplers; easily done manually.	Requires a flowmeter; also a record if composited manually.
Sequential Composite	S	Series of short-term composites (often simple) but held separately for analysis.	Used by some automatic samplers; not practicable for manual compositing. Requires fewer samples than sequential discrete.	Most useful if rapid fluctuations are encountered and some time history is desired. Higher analytical cost.
Continuous Composite	Qc	Constant sample extraction rate.	Only useful for pristine flows, e.g., drinking water; not widely used.	May require inordinately large sample volume; may not be representative if variations are large.
Continuous Composite	Qv	Sample extraction rate is proportional to flow rate.	Seldom used.	Requires a flowmeter and complicated sampling equipment.

composites. There are two straightforward ways of accomplishing this. One is to let the aliquot volume be proportional to the instantaneous flow rate, and the other is to make the aliquot volume proportional to the quantity of flow that has passed since extraction of the last aliquot. Typical of the second approach is the variable time interval, constant volume (TvVc) proportional composite. Here a fixed volume aliquot is taken each time an arbitrary quantity of flow has passed.

It is instructive to compare these four composite sample schemes. For the purposes of this example, four flow functions and five concentration functions are examined. The selections are completely arbitrary (except for simplicity in exact integration) and, in practice, site specific data should be used. For each flow/concentration combination, the exact average concentration of the flow was computed (as though the entire flow stream were diverted into a large tank for the duration of the event and then its concentration measured). The ratio of the composite sample concentration to the actual concentration so computed is presented in matrix form in Figure 2 (adapted from Shelley and Kirkpatrick; 1975b). The four rows in each cell represent the four types of composite samples discussed as indicated in the legend. The best overall composite for the cases examined is the TcVv, with the volume proportional to the instantaneous flow rate q. The TcVv where the volume is proportional to the flow since the last sample, and the TvVc gave very similar results with a slight edge to the former. However, the differences are not large for any case. This brief look at compositing merely scratches the surface. Flow records and a knowledge of the temporal fluctuation of pollutants, as can be obtained from discrete samples, are required in order to choose a "best" compositing scheme for a given installation.

Continuous samples are also composite in nature but do not fit in the foregoing discussion since the discrete step integration analogy is not applicable. Had we included the Qv continuous sample in the foregoing example, its ratio would have been unity for all combinations in Figure 2. Other considerations severely limit the instances where a continuous sample is the composite of choice. For wastewater sampling, it is generally agreed that the minimum line inside diameter is 0.64 cm (1/4 in.) and that the sample flow velocity should be at least 0.61 m/s (2 fps). A simple calculation shows that the minimum volume of a 24-hour continuous sample would be 1668 liters (441 gal.), hardly a practicable size. For this reason, continuous samples are useful only for very pristine flows (e.g., drinking water), where the very low flow rates necessary to keep sample volumes reasonable may still allow a representative sample to be obtained.

FREQUENCY OF SAMPLING

As was indicated earlier, the frequency of sampling is dependent upon the type of sample being collected and the time-varying characteristics of the wastewater flow. Little *a priori* information can be provided.

CONC k / q FLOW	$1-t$	$1-\frac{t}{2}$	$\cos\frac{\pi t}{2}$	e^{-t}	$\sin\pi t$
c	0.90 0.90 0.90 0.90	0.97 0.97 0.97 0.97	0.92 0.92 0.92 0.92	0.95 0.95 0.95 0.95	0.99 0.99 0.99 0.99
t	1.35 0.90 0.86 0.87	1.09 0.97 0.96 0.96	1.26 0.90 0.87 0.89	1.14 0.97 0.95 0.95	0.99 0.90 0.89 0.97
$1-t$	0.68 0.95 0.92 0.92	0.87 0.98 0.97 0.97	0.72 0.98 0.95 0.93	0.82 0.96 0.95 0.95	0.99 1.12 1.09 0.97
$\sin\pi t$	0.90 1.01 0.90 0.90	0.97 1.00 0.97 0.97	0.88 1.00 0.92 0.92	0.97 1.00 0.95 0.95	0.80 1.01 0.98 0.97

The rows within each flow/concentration cell refer to the following sample types:

Row 1. TcVc - Simple composite
Row 2. TcVv - Volume proportional to instantaneous flow rate (q)
Row 3. TcVv - Volume proportional to flow (Q) since last sample
Row 4. TvVc - Time varied to give constant ΔQ

Figure 2. Ratio of composite sample concentration to actual concentration.*

* Adapted from Shelley and Kirkpatrick (1975b).

The best approach is to characterize the flow in question by sequential discrete sampling and then select a suitable compositing scheme that yields representative results. The optimum sampling frequency is one that is short enough to allow adequate representation but long enough so as not to overburden the laboratory with excess analysis work. In no case should any evaluations be attempted or decisions reached with fewer than three independent values, even by experienced and qualified professionals. The likelihood of a process upset that will drastically alter the wastewater characteristics is also a factor in selecting sampling frequency. Shorter sampling frequencies are indicated when less stable unit process operations are involved. Batch versus continuing process operations will also impact upon the desirable sampling frequencies.

Because of the variability in the character of many wastewater flows noted earlier and because of the many physical difficulties in collecting samples to characterize them, precise characterization is not practicable, nor is it possible. In recognition of this fact, one must guard against embarking on an excessively detailed sampling effort and thus increasing costs, both for sampling and for analyzing the samples, beyond costs that can be considered sufficient for conducting a program that is adequate for the intended purpose.

A careful study of costs should be made prior to commencing a program of sampling, balancing cost against the number of samples and analyses required for adequate characterization of the wastewater. As the program progresses, current study of the results being obtained may make it reasonable to reduce or increase the number of samples collected.

SAMPLING SITE SELECTION

Given, from the design of the monitoring program, an identified catchment, stream reach, or other general location where measurements are desired, there are some general criteria that can aid in selecting the best specific sampling site. They include:

1. Maximum accessibility and safety. Manholes on busy streets should be avoided if possible; shallow depths with manhole steps in good condition are desirable. Sites with a history of surcharging or submergence by surface water, or both, should be avoided if possible.

2. Be sure that the site provides the information desired. Familiarity with the sewer system is necessary. Knowledge of the existence of inflow or outflow between the measurement point and point of data use is essential.

3. Make certain the site is far enough downstream from tributary inflow to ensure mixing of the tributary with the main stream.

4. Locate in a straight length of channel, at least 20 widths below bends.

5. Locate at a point of maximum turbulence, as found in sections of greater roughness and of probable higher velocities. Locate just downstream from a drop or hydraulic jump, if possible.

6. In all cases, consider the cost of installation, balancing cost against effectiveness in providing the data needed.

The success or failure of selected equipment or methods, with respect to accuracy and completeness of data collected as well as reasonableness of cost, depends very much on the care and effort exercised in selecting the site. A requirement with regard to water quality measurement that appears to be obvious, but which is frequently not sufficiently considered, is that the site selected be located to give the desired measurements. Does flow at the site provide information actually needed to fulfill given needs? Sometimes influent flows, diversions, or storage upstream or downstream from the selected site would bias the data in a manner not understood without a thorough study of the proposed site. Such study would include reference to surface maps and to sewer maps and plans. Sometimes groundwater infiltration or unrecorded connections may exist. For these reasons, a thorough field investigation should be made before establishing a specific measurement site.

A basic consideration in site selection is the possible availability of measurements or records collected by others. At times, data being collected by the USGS, by the State, or by other public agencies can be used. There are locations where useful data, although not currently being collected, may have been collected in prior years. Additional data to supplement those earlier records may be more useful than new data collected at a different site.

When compliance sampling is being performed, samples should be collected at the site specified in the NPDES permit. If inspection reveals that the specified site is not adequate for the collection of a representative sample, the specified site and the most representative one available should both be sampled, and the change should be highlighted in the inspection report and reasons therefore noted.

There can be no substitute for experienced judgment and common sense in the selection of a specific sampling site. For example, when attempting to obtain a sample of the influent to a wastewater treatment plant, the ideal location may be totally inaccessible. Given such a situation, alternative raw waste sampling points might be: the upflow siphon following a comminuter (in the absence of a grit chamber); the upflow distribution box following pumping from main plant wet well; an aerated grit chamber; the throat of a measurement flume; or the pump wet well. Obviously, samples should be collected upstream of recirculated plant supernatant and sludge in all cases.

Requirements that apply to all measurement sites are accessibility, personnel and equipment safety, and freedom from vandalism. If a car or other vehicle can be driven directly to the site at all times, the cost in time required for installation, operation, and maintenance of the equipment will be less, and it is possible that less expensive equipment can be selected. Consideration should be given to access during periods of adverse weather conditions and during periods of flood stage. Sites on bridges or at manholes where heavy traffic occurs should be avoided unless suitable protection for men and equipment is provided. If entry to sewers is required, the more shallow locations should be selected where possible. Manhole steps and other facilities for sewer access must be carefully inspected, and any needed repairs made. Possible danger from harmful gases, chemicals, or explosion should be investigated. With respect to sites at or near streams, historical flood marks should be determined and used for placement of access facilities and measurement equipment above flood level where this is possible. Areas of known frequent vandalism should be avoided.

In this last regard, the problem of vandalism can be serious and costly, both in terms of equipment damage and data loss. The selection of sites in open, rather than secluded, areas may help reduce vandalism as may illumination at night. Attempts to hide or camouflage equipment have been generally unsuccessful. Instrumentation should be sheltered to the extent possible, trading off the cost of protective facilities, the latitude afforded by the site, and the need for easy access. Occasionally, solid masonry or steel shelters surrounded by heavy fencing may be required for measurement sites, and these additional costs must be included in such instances. Finally, warning signs are generally unsuccessful; they may only encourage vandalism regardless of the type of threat -- high voltage, radiation hazard, fine, or imprisonment.

SAMPLE QUANTITY

Since the required sample volume is dependent upon the type and number of parameters to be analyzed for and the instrumentation and methods to be employed in the analysis at the laboratory, the laboratory analyst is the best person to specify the quantity needed. A preliminary estimate of sample volume can be obtained as follows. Determine the parameters to be analyzed for and, from Table 4, obtain the sample volume required for each analysis. Sum these to obtain the minimum volume, and increase this amount as necessary to allow for spillage, mistakes, sample splitting, and for analytical laboratory quality control purposes. In the absence of better information, doubling the minimum volume should be adequate. In general, a minimum volume of 500 mℓ is desired for discrete samples and 7.6ℓ (2 gal.) for composites.

SAMPLE PRESERVATION

Having collected a representative sample of the fluid mixture in question, there remains the problem of sample preservation and analysis. It is a practical impossibility either to perform instant analyses of

TABLE 4. RECOMMENDATIONS FOR PRESERVATION OF SAMPLES ACCORDING TO MEASUREMENT[1]

Measurement	Vol Req (mℓ)	Container	Preservative	Holding Time[6]
Acidity	100	P,G[2]	Cool, 4°C	24 Hrs
Alkalinity	100	P,G	Cool, 4°C	24 Hrs
Arsenic	100	P,G	HNO_3 to pH <2	6 Mos
BOD	1000	P,G	Cool, 4 C	6 Hrs[3]
Bromide	100	P,G	Cool, 4 C	24 Hrs
COD	50	P,G	H_2SO_4 to pH <2	7 Days
Chloride	50	P,G	None Req	7 Days
Chlorine Req	50	P,G	Det on site	No holding
Color	50	P,G	Cool, 4°C	24 Hrs
Cyanides	500	P,G	Cool, 4°C NaOH to pH 12	24 Hrs
Dissolved Oxygen				
Probe	300	G only	Det on site	No Holding
Winkler	300	G only	Fix on site	4-8 Hrs
Fluoride	300	P,G	Cool, 4°C	7 Days
Hardness	100	P,G	Cool, 4°C HNO_3 to pH <2	7 Days
Iodide	100	P,G	Cool, 4°C	24 Hrs
MBAS	250	P,G	Cool, 4°C	24 Hrs
Metals				
Dissolved	200	P,G	Filter on site HNO_3 to pH <2	6 Mos
Suspended			Filter on site	6 Mos
Total	100		HNO_3 to pH <2	6 Mos
Mercury				
Dissolved	100	P,G	Filter HNO_3 to pH <2	38 Days (Glass) 13 Days (Hard Plastic)
Total	100	P,G	Filter HNO_3 to pH <2	38 Days (Glass) 13 Days (Hard Plastic)
Nitrogen				
Ammonia	400	P,G	Cool, 4°C H_2SO_4 to pH <2	24 Hrs[4]
Kjeldahl	500	P,G	Cool, 4°C H_2SO_4 to pH <2	7 Days
Total	500	P,G	Cool, 4°C H_2SO_4 to pH <2	7 Days
Nitrate	100	P,G	Cool, 4°C H_2SO_4 to pH <2	24 Hrs[4]
Nitrite	50	P,G	Cool, 4°C	24 Hrs[4]

Measurement	Vol Req (mℓ)	Container	Preservative	Holding Time[6]
NTA	50	P,G	Cool, 4°C	24 Hrs
Oil and Grease	1000	G only	Cool, 4°C H_2SO_4 or HCL to pH <2	24 Hrs
Organic Carbon	25	P,G	Cool, 4°C H_2SO_4 to pH <2	24 Hrs
pH	25	P,G	Cool, 4°C Det on site	6 Hrs[3]
Phenolics	500	G only	Cool, 4°C H_3PO_4 to pH <4 1.0g $CuSO_4$/1	24 Hrs
Phosphorous				
Orthophosphate, Dissolved	50	P,G	Filter on site Cool, 4°C	24 Hrs[4]
Hydrolyzable	50	P,G	Cool, 4°C H_2SO_4 to pH <2	24 Hrs[4]
Total	50	P,G	Cool, 4°C	7 Days
Total, Dissolved	50	P,G	Filter on site Cool, 4°C	24 Hrs[4]
Residue				
Filterable	100	P,G	Cool, 4°C	7 Days
Nonfilterable	100	P,G	Cool, 4°C	7 Days
Total	100	P,G	Cool, 4°C	7 Days
Volatile	100	P,G	Cool, 4°C	7 Days
Settleable Matter	1000	P,G	None Req	24 Hrs
Selenium	50	P,G	HNO_3 to pH <2	6 Mos
Silica	50	P only	Cool, 4°C	7 Days
Specific Conductance	100	P,G	Cool, 4°C	24 Hrs[5]
Sulfate	50	P,G	Cool, 4°C	7 Days
Sulfide	500	P,G	2 mℓ zinc acetate	24 Hrs
Sulfite	50	P,G	Det on site	No holding
Temperature	1000	P,G	Det on site	No Holding
Threshold Odor	200	G only	Cool, 4°C	24 Hrs
Turbidity	100	P,G	Cool, 4°C	7 Days

NOTES:

1. Taken from EMSL (1974). This information is currently being updated; any questions should be referred to EMSL/Cin.
2. Plastic or glass.
3. If samples cannot be returned to the laboratory in less than 6 hours and holding time exceeds this limit, the final reported data should indicate the actual holding time.
4. Mercuric chloride may be used as an alternate preservative at a concentration of 40 mg/ℓ, especially if a longer holding time is required. However, the use of mercuric chloride is discouraged whenever possible.
5. If the sample is stabilized by cooling, it should be warmed to 25°C for reading, or temperature correction made and results reported at 25°C.
6. It has been shown that samples properly preserved may be held for extended periods beyond the recommended holding time.

the sample on the spot or to completely and unequivocally preserve it for subsequent examination. Preservative techniques can only retard the chemical and biological changes that inevitably continue following extraction of the sample from its parent source. In the former case, changes occur that are a function of the physical conditions: metal cations may precipitate as hydroxides or form complexes with other constituents; cations or anions may change valence states under certain reducing or oxidizing conditions; constituents may dissolve or volatize with time, and so on. In the latter case, biological changes taking place may change the valence state of an element or radical; soluble constituents may be converted to organically bound materials in cell structures; cell lysis may result in release of cellular material into solution, etc.

Preservation methods are relatively limited and are generally intended to retard biological action, retard hydrolysis of chemical compounds and complexes, and reduce volatility of constituents. They are generally limited to pH control, chemical addition, refrigeration, and freezing. EMSL (1974) has compiled a list of recommendations for preservation of samples according to the measurement analysis to be performed. In order to provide an overview for some common parameters, this list has been reproduced here as Table 4.

Prompt analysis is the most positive assurance against errors from sample deterioration. It is frequently impossible, however, especially in the case of composite and sequential discrete samples in which portions may be stored for as long as 24 hours before removal from the sampling equipment. It is important that stabilization of the sampled wastewater be provided during the sampling period wherever possible. Refrigeration to hold the sample temperature near 4°C is the minimum sample protection that should be provided. Since sample treatment to fix one constituent may affect another, preservation is sometimes complicated, thus necessitating the collection of multiple samples or the splitting of a single sample into multiple parts.

SAMPLE HANDLING

Proper sample handling is also essential to obtaining successful results from any monitoring program. A few general guidelines are given below.

1. Each sample container must have a designation, normally a number, that uniquely distinguishes it from all other samples in the survey.

2. When frequent sampling over a long time period is involved, consideration should be given to incorporating a temporal indication as a part of the sample identification number; e.g., the number of the week in a year, the last two digits of the year, etc. The temptation to code too much information about the sample into its identification number must be resisted, however, or else the risk of mixups due to unauthorized abbreviations becomes too great.

3. Consideration should be given to the use of waterproof, pre-printed, pressure-sensitive labels in many instances. Rubber-band and tie-on tags have also been used successfully.

4. The use of color-coded labels has been successful where sample splitting or different preservation techniques are employed. In the latter case, for example, a green label could indicate that nitric acid had been added and that, therefore, an analyst could obtain aliquots from this sample for metal analyses, etc.

5. Where possible, the type of sample, date, and any preservatives added should be written on the sample label prior to collecting the sample in the field. The time of day should be added when the sample is collected. Additional information should be noted in the field notebook and on supplemental forms where used. As a minimum, this should include:

   - Designation and location description of sample site.
   - Name of collector.
   - Date and time of collection.
   - Indication of sample type with appropriate time and volume information.
   - Indication of parameters to be analyzed.
   - Notation of conditions such as pH, temperature, and appearance that may change before the laboratory analysis, including the identification number of instruments used to measure parameter in the field.
   - Indication of any unusual condition at the sampling location and/or in the appearance of the wastewater.
   - Preservative used.
   - Any noteworthy additional information.

6. The foregoing should be observed in addition to any chain-of-custody procedures that are involved. See USEPA (1975) for recommendations for a chain-of-custody program.

QUALITY ASSURANCE

The proper cleaning of all equipment used in the sampling of wastewater is essential to ensuring valid results from laboratory analyses and is discussed in Section 5. However, the possibility of the container affecting the sample analyses should be checked periodically. Distilled or demineralized water should be placed in a typical container for a period of time similar to that of a normal sample. Then the particular constituent of interest should be measured in the water from this blank. Also, checks for sample adsorption on the container should be made by placing a known amount of a particular constituent in a typical container. After a specified holding time, analyses should be made to determine if any of the material was adsorbed into the container or changed in any other manner. These checks should be done after sample bottles have been used for a series of samples. In this way the cleaning techniques used can be tested for thoroughness.

Although outside the scope of this volume, each sampling activity must have a viable quality assurance program. The USEPA (1976) has published minimal requirements for a water quality assurance program and EMSL (1972) has written a handbook for analytical quality control in the laboratory. The recommendations in these two references should be followed by all activities engaged in water or wastewater sampling.

MANUAL VERSUS AUTOMATIC SAMPLING

The decision whether to sample manually or use automatic samplers is far from straightforward, and involves many considerations in addition to equipment costs. Experience has indicated that operator training is necessary if manual sampling is to produce reproducible results. Instances have been noted wherein two different operators were asked to obtain a sample at a particular site with no other guidance given. Analyses of samples taken at the same time have shown differences exceeding 50 percent. Other work conducted solely to compare manual sampling methods has indicated such discrepancies in results that suspicion must be cast upon manual methods that involve dipping of samples out of raw waste sources and has raised questions regarding the suitability of such manual grab sampling as a yardstick against which to measure other techniques.

The decision to use automatic sampling equipment does not represent the universal answer to water and wastewater characterization, however. For initial characterization studies, proper manual sampling may represent the most economical method of gathering the desired data. It is also prudent from time to time to verify the results of an automatic sampler with manual samples. Also, manual grab samples are often taken during visits to sites where automatic samplers are installed in order to obtain data on certain parameters, e.g., pH, temperature, residual chlorine, DO, oil and grease, coliform bacteria, etc., that cannot be meaningfully measured from samples taken by automatic equipment.

In general, manual sampling is indicated when infrequent samples are required from a site, when biological or sediment samples or both are also required from a site, when investigating special incidents (e.g., fish kills, hazardous material spills), where sites simply will not allow the use of automatic devices, for most bacteriological sampling, where concentrations remain relatively constant, etc. Manual sampling will often be the method of choice in conducting stream surveys, especially those of relatively short duration where only a single daily grab sample is required from each site. For large rivers, lakes, and estuaries, manual sampling will almost always be required.

The use of automatic samplers is indicated where frequent sampling is required at a given site, where long-term compositing is desired, where simultaneous sampling at many sites is necessary, etc. Automatic sampling will often be the method of choice for storm-generated discharge studies, for longer period outfall monitoring, for treatment plant efficiency studies, where 24-hour composite samples are required, and so on.

Typically, the wide spectrum of monitoring activities involved will require a capability for both manual and automatic sampling, and so the question is not which capability to obtain but when to use each. The answer should be determined in the design of each survey, using the above information as guidance.

SECTION 3

SAMPLER DESIGN CONSIDERATIONS

GENERAL

In a system breakdown of an automatic sewer sampler by functional attributes, it may be divided into five basic elements or subsystems. These will be identified and discussed in turn. The intent is to acquaint the reader with design considerations, so that he may be better prepared to judge the various commercially available automatic samplers on the market today and select from among them the one whose design attributes best suit his needs.

SAMPLER INTAKE SUBSYSTEM

The sample intake of many commercially available automatic liquid samplers is often only the end of a plastic suction tube, and the user is left to his own ingenuity and devices if he desires to do anything other than simply dangle the tube in the stream to be sampled. In the following paragraphs we wish to examine the functions of a sampler intake that is intended to be used in a wastewater application and the design considerations that arise therefrom.

Pollutant Variability

A general discussion of the character of wastewater flows was given in Section 1, where the variability of pollutant concentration is also treated. We wish to consider the latter factor here in somewhat more detail. Let us consider first some empirical data from FIASP (1941). In that study, a special pressurized circulating loop was assembled containing a 25 cm (10 in.) square test section some 4.6m (15 ft.) long. Careful measurements of the velocity contours were made and near uniformity was observed. Since the variability of a pollutant will be a function of velocity variations (among other factors), it is of interest to note the horizontal and vertical variations of sediment distribution observed experimentally in this test section with its very small velocity variation.

Four readily available commercial sands, differing principally in size, were used in the study. They are referred to by mean particle size (50 percent finer by weight) as 0.45 mm, 0.15 mm, 0.06 mm and 0.01 mm. Observed sediment distribution for the three coarsest sands are indicated in Figure 3. For all practical purposes the 0.01 mm sand was

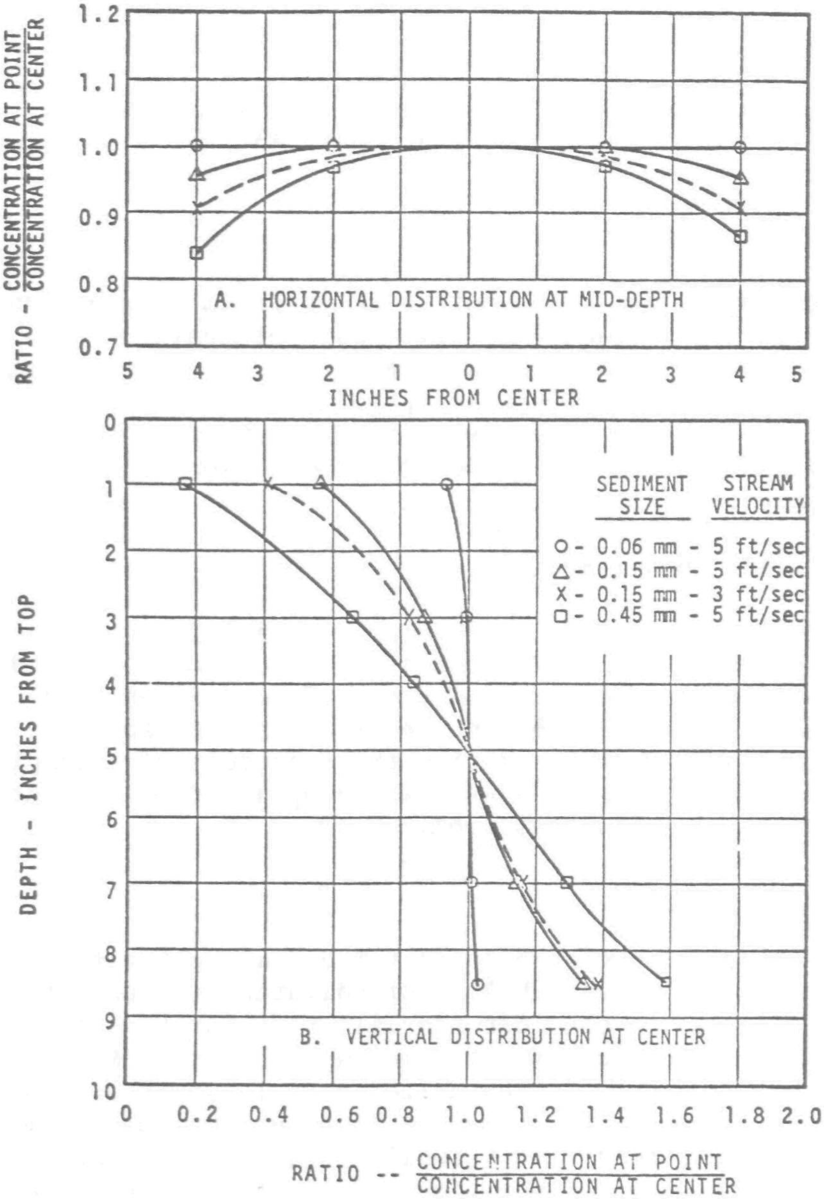


Figure 3. Sediment distribution at sampling station.*

* Taken from FIASP (1941).

uniformly distributed. It should be noted here that the vertical variation is probably enhanced due to the design of the test loop, which would tend to enhance concentrations of heavier particles to the outside (the bottom of the test section in this case) due to the action of centrifugal forces. Results reported by FIASP (1966) markedly indicate this effect.

The observation was made in FIASP (1966) that, in addition to variations in sediment concentration within the cross-section at a given time, the sediment concentration at any point in the cross-section was highly variable with respect to time, especially for the coarser sediments (0.45 mm). This observation was also made in FIASP (1941), where data are presented on concentration variation with respect to time as a function of sampling interval. The concentration of successive 20-second duration samples was found to vary over a range of 37 percent of the mean, and the concentration of successive 60-second duration samples varied over a range of 10.5 percent. Such variations arise from the natural turbulence of the flow as would be encountered in an actual sewer and from the non-uniform nature of recirculated flows in test loops which is peculiar to laboratory simulations.

So far we have focused our attention on relatively heavy (specific gravity approximately 2.65) solids and their distribution in a flow. For the lighter organic solids with specific gravities near unity, the particle distribution will be more nearly uniform in a turbulent flow. It would appear that one can expect a reasonable degree of uniformity in the distribution of particles which fall in the Stokes' Law range of settling velocities, i.e., for values of the external Reynolds' number less than unity. If one describes a particle in terms of its hydraulic size W, defined as the velocity of uniform fall in a fluid at rest, Stokes' Law can be written as

$$W = gd^2 \text{ (s.g.}-1)/18\nu \qquad [1]$$

where d is mean particle diameter, s.g. is the specific gravity of the particle material, ν is the kinematic viscosity of the fluid, and g is the acceleration of gravity. The external Reynolds' number (so called because the linear dimension upon which it is based is a particle dimension rather than a pipe dimension) can be expressed as

$$Re = Wd/\nu \qquad [2]$$

Combining equations [1] and [2] we can express the range of validity of Stokes' Law as

$$Re = gd^3 \text{ (s.g.}-1)/18\nu^2 < 1 \qquad [3]$$

If one considers water at 16°C (60°F) as the fluid (ν=1.217 x 10^{-5} ft^2/sec), a plot of equation [3] over the range of interest was given in Figure 1. There it can be noted that, within the range of Stokes' Law, the maximum particle diameter for sand with a specific gravity of 2.65 is less than 0.1 mm while for organic particles with a specific gravity of 1.05 it is about 0.3 mm.

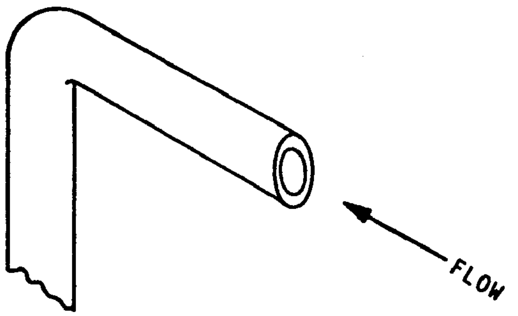
Since the kinematic viscosity of water is temperature dependent, the Stokes' Law particle diameter limit will also be a function of temperature. For sand, a decrease in water temperature from the upper eighties to the mid-forties results in a 50 percent increase in the maximum particle diameter.

Sampler Intake Functions

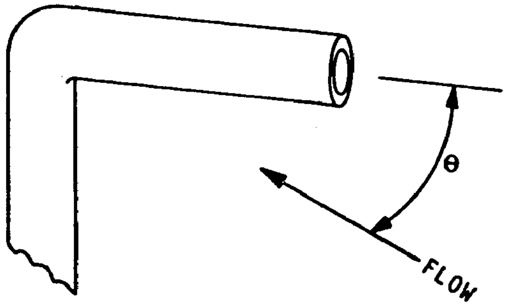
The operational function of a sampler intake is to reliably allow gathering a representative sample from the flow stream in question. Its reliability is measured in terms of freedom from plugging or clogging to the degree that sampler operation is affected, and invulnerability to physical damage due to large objects in the flow. It is also desirable, from the viewpoint of sewer operation, that the sampler intake offer a minimum obstruction to the flow in order to help prevent blockage of the entire sewer pipe by lodged debris, etc.

Let us first consider the ability of the intake to gather a representative sample of dense suspended solids in the sediment range, say up to 0.5 mm, with specific gravity of 2.65. The results of a rather thorough examination of relatively small diameter intake probes, 0.64 and 0.32 cm (1/4 and 1/8 in.), are given in FIASP (1941). The argument is developed that, for a nozzle pointing directly into the flow (Figure 4a), the most representative sample of a fluid/suspended-solids mixture will be obtained when the sampling velocity is equal to the flow velocity at the sampling point. Using this as the reference criteria, investigations were conducted to determine the effects of a) deviations from the normal sampling rate, b) deviations from the straight-into-flow position of the probe, c) deviations in size and shape of the probe, and d) disturbance of sample by nozzle appurtenances. The effect of the sampling velocity on the representativeness of the sample is indicated in Figure 5, which presents the results for 0.45 mm and 0.06 mm sand. For the latter size, which falls within the Stokes' Law range, less than ±4 percent error in concentration was observed over sampling velocities ranging from 0.4 to 4 times the stream velocity. For the 0.45 mm particles, the error at a relative sampling rate of 0.4 was +45 percent, and at a relative sampling rate of 4 the error was -25 percent.

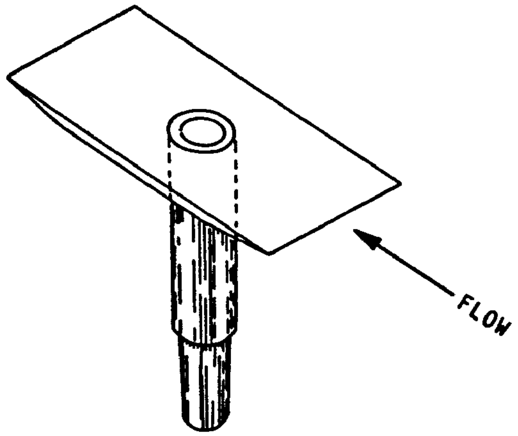
For probe orientations up to 20° to either side of head-on, (Figure 4b), no appreciable errors in concentration were observed. Similarly, introduction of 0.381 and 0.952 cm (0.150 and 0.375 in.) probes showed comparatively little effect on the representativeness of the sample. The probe inlet geometry, i.e., beveled inside, beveled outside, or



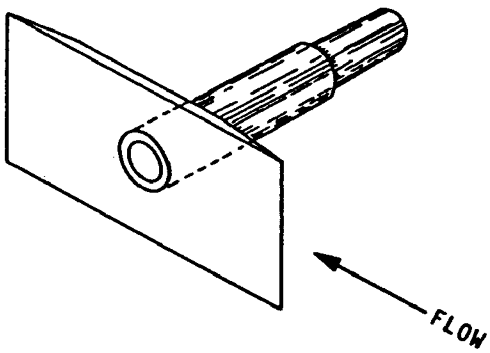
4a. Normal orientation directly into flow.



4b. Orientation at an angle to head-on.



4c. Vertical orientation (0°) - orifice in flat plate.



4d. Horizontal orientation (90°) - orifice in flat plate.

Figure 4. Sampler intake orientation angles.*

* Taken from Shelley (1976a)

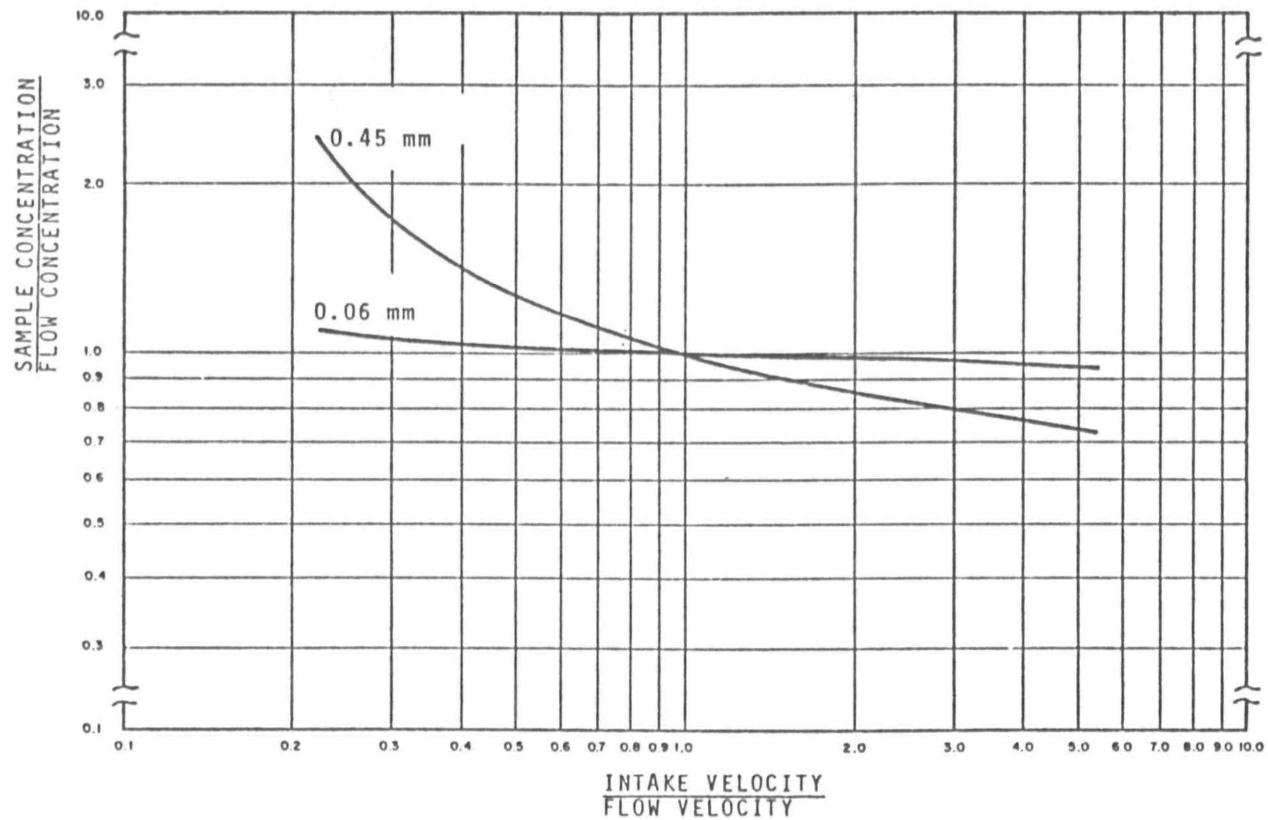


Figure 5. Effect of sampling velocity on representativeness of suspended solids.*

* Data taken from FIASP (1941).

rounded edge, also showed little effect on the representativeness of the sample, when compared to the standard probe. Finally, in instances where a sampler body or other appurtenance exists, the probe should be extended a short distance upstream if a representative sample is to be collected. In summary, it was found that for any sampler intake facing into the stream, the sampling rate is the primary factor to be controlled.

Tests were also run with the sampling intake probes in the vertical position (Figure 4c) to determine the effect such an orientation had upon the representativeness of the sample. With such intakes, the sample entering them must undergo a 90° change of direction, and consequently there is a tendency for segregation and loss of sediment to take place. Tests were run with the standard probe, a 0.64 cm (1/4 in.) diameter orifice in the center of a 2.5 x 5.1 cm (1 x 2 in.) flat plate oriented so that its longest dimension was in the direction of flow, and with an orifice in a crowned (mushroom shaped) flat plate 3.2 x 5.1 cm (1.25 x 2 in.). The results all showed negative errors in concentration, increasing with particle size and increasing with intake velocities less than the stream rate but nearly constant for intake velocities higher than the stream rate.

Since the smallest errors were found for the orifices in the flat and mushroom shaped plates (whose performances were nearly identical for intake volocities greater than one-half the stream velocity), it was decided to investigate the effect of lateral orientation, i.e., to rotate the plate 90° so that it might represent an orifice in the side of a conduit rather than in the bottom (Figure 4d). The results for 0.15 mm sand are presented in Figure 6. It can be noted that while side orientation caused greater errors (as was to be expected), these errors approached the nearly constant error of the 0° orientation as the relative sampling rate was increased above unity.

The work reported in FIASP (1966) was a laboratory investigation of pumping sampler intakes. Nine basic intake configurations, all representing an orifice of some type in the side wall of the flume, were examined. Sand sizes of 0.10 mm and 0.45 mm were used in the study. Reference samples were taken with a probe located near the wall and pointing into the direction of the flow. The reference sample intake velocity was equal to the stream velocity. The primary measurement was sampling efficiency, the ratio of the sediment concentration in the test sample to that of the reference sample computed for a point 1.3 cm (1/2 in.) from the wall. The reference sample was taken just before and just after the test sample was gathered. Although the data exhibited considerable scatter, several conclusions were drawn. With regard to the intake velocity, greater than 0.9 m/s (3 fps) is generally desirable and, for sands coarser than 0.2 mm, an intake velocity equal to or greater than the stream velocity is desirable.

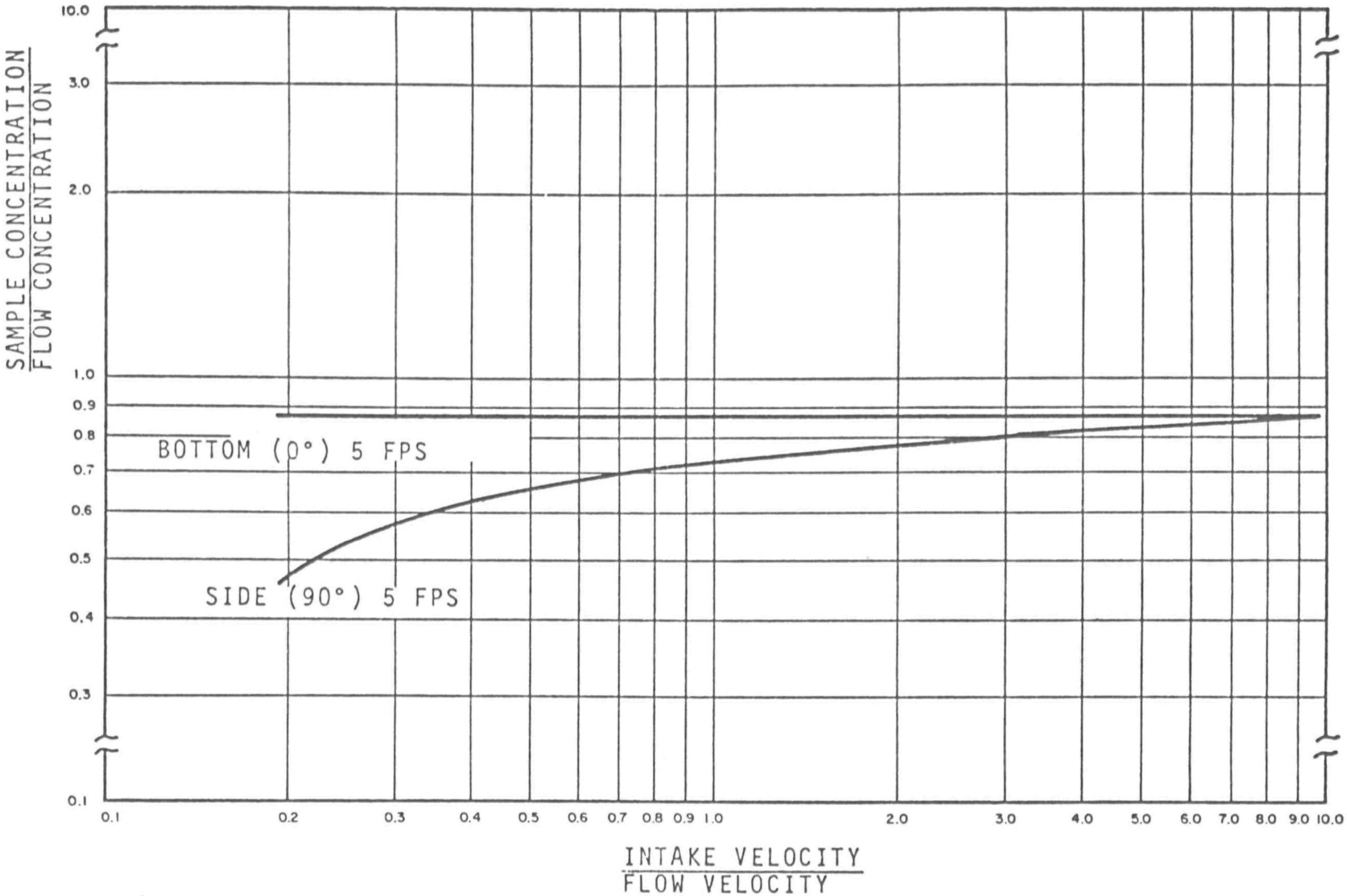


Figure 6. Effect of lateral orientation of sample intake.*

* Data taken from FIASP (1941).

With regard to intake configuration, for intake velocities greater than about 0.9 m/s (3 fps) the sampling efficiencies showed little effect of size of intake (range was 1.3 to 3.8 cm inside diameter), of rounding the intake edges, or of shape and orientation of the axis of an oval intake. Sampling efficiency was found to decrease with increasing particle size above 0.10 mm for all intakes tested. Similar observations were made in field tests with river water samples at St. Paul and Dunning, Nebraska, reported in FIASP (1962).

To summarize the foregoing as it relates to the sampler intake function of gathering a representative sample we note the following:

1) It becomes difficult to obtain a one-to-one representation, especially for inlets at 90° to the flow, for large, heavy suspended solids.

2) For particles that fall within the Stokes' Law range, consistent, representative samples can be obtained.

3) The geometry of the sampler intake has little effect on the representativeness of the sample.

4) The sample intake velocity should equal or exceed the velocity of the stream being sampled.

Sampler Intake Design

The foregoing suggest certain directions that the design of a sampler intake for many wastewater flows should take. At the outset, it appears unwise to attempt to sample suspended solids that fall much outside the Stokes' Law range. A realistic maximum size for sand with specific gravity of 2.65 would appear to be around 0.1 mm to 0.2 mm. High sample intake velocities will be required, perhaps in excess of 3 m/s (10 fps), if the sample is to be representative.

Although the flow may be nearly homogeneous, except for very coarse solids and large floatables, more than one sample intake is desirable for reliability of operation as well as insurance against some unforeseen gradient in the pollutant. In view of the changing water levels in the channel with changing flows, the changing velocity gradients within the flows, and the possibility of changing pollutant gradients not only with respect to these but also with type of pollutant, not even a dynamically adaptive sampler intake can be designed to gather a sample that is completely representative in every respect at the same time. In the absence of some consideration arising from the particular installation site, a regular distribution of sampling intakes across the flow, each operating at the same velocity, would appear to suffice.

In order to prevent unwanted material (rocks, sticks, rags, and similar debris) from entering the sampling train and possibly clogging or damaging the equipment, the sampler intake must provide some sort of a screening function. Due to the nature of most wastewater flows, a fine mesh screen does not seem desirable. Instead, a screen made up of a number of rather large holes, say 0.3 to 0.6 cm (1/8 to 1/4 in.) in diameter, appears more desirable.

SAMPLE GATHERING SUBSYSTEM

Three basic sample gathering methods or categories can be identified; mechanical, forced flow, and suction lift. Several different commercial samplers using each method are available today. The sample lift requirements of the particular site often play a determining role in the gathering method to be employed.

Mechanical Methods

There are many examples of mechanical gathering methods used in both commercially available and one-of-a-kind samplers. One of the more common designs is the cup on a chain driven by a sprocket drive arrangement. In another design, a cup is lowered within a guide pipe, via a samll automatic winch and cable. Other examples include a self closing pipe-like device that extracts a vertical "core" from the flow stream, a specially contoured box assembly with end closures that extracts a short length (plug) of the entire flow cross-section, a revolving or oscillating scoop that traverses the entire flow depth, etc.

Some of the latter units employ scoops that are characterized for use with a particular primary flow measurement device such as a weir or Parshall flume and extract an aliquot volume that is proportional to the flow rate. Another design for mechanically gathering flow proportional samples involves the use of a sort of Dethridge wheel with a sample cup mounted on its periphery. Since the wheel rotation is proportional to flow, the effect is that a fixed volume aliquot is taken each time a certain discharge quantity has passed, and total discharge can be estimated from the size of the resultant composite sample.

The foregoing designs have primarily arisen from one of two basic considerations. First, site conditions that require very high lifts have dictated the use of mechanical gathering units due to the limitations of suction lift pumps and space considerations. Some mechanical units are capable of lifts of 61m (200 ft.) or more. Second, the desire to gather samples that are integrated across the flow depth has led to some of the different mechanical approaches mentioned above. Unless vertical velocity and pollutant gradients are quantified and accounted for, their presence makes the results of such depth integrated samples questionable, at least in a mass discharge sense.

One of the penalties that one must trade-off in selecting a mechanical gathering unit is the necessity for some obstruction to the flow, at least, while the sample is being taken. The tendency for exposed mechanisms to foul, together with the added vulnerability of many moving parts, means that successful operation will require periodic inspection, cleaning, and maintenance.

Forced Flow Methods

All forced flow gathering methods require some obstruction to the flow, but usually it is less than with mechanical gathering methods. It may only be a small inlet chamber with a check valve assembly of some sort or it may be an entire submersible pump. The main advantage of submersible pumps is that their high discharge pressures allow sampling at greater depths, thereby increasing the flexibility of the unit somewhat insofar as site depth is concerned. Pump malfunction and clogging, especially in the sizes often used for samplers, is always a distinct possibility and, because of their location in the flow stream itself, maintenance is much more difficult and costly to perform than on above ground or more easily accessible units. They also necessarily present an obstruction to the flow and are thus in a vulnerable position as regards damage by debris in the flow.

Pneumatic ejection is a forced flow gathering method used by a number of commercial samplers. The gas source required by these units varies from bottled refrigerant to motor driven air compressors. The units that use bottled refrigerant must be of a fairly small scale to avoid an enormous appetite for the gas and, hence, a relatively short operating life before the gas supply is exhausted. Furthermore, concern has recently been expressed about the quantities of freon that are being discharged into the atmosphere. The ability of such units to backflush or purge themselves is also necessarily limited. The advantages of few moving parts, inherent explosion proof construction, and high lift capabilities must be weighed against low or variable line velocities, low or variable sample intake velocities, and relatively small sample capacities in some designs. Another disadvantage of most pneumatic ejection units is that the sample chamber fills immediately upon discharge of the previous sample. Thus, it may not be representative of flow conditions at the time of the next triggering and, if paced by a flowmeter, correlation of results may be quite difficult.

Suction Lift Methods

Suction lift units must be designed to operate in the environment near the flow to be sampled or else their use is limited to a little over 9m (30 ft.) due to atmospheric pressure. Several samplers that take their suction lift directly from an evacuated sample bottle are available today. Vacuum leaks, the variability of sample size with lift, the requirement for heavy glass sample bottles to withstand the vacuum, difficulty of cleaning due to the requirement for a separate line for each sample bottle, the necessity of placing the sample bottles near the flow stream (and hence in a vulnerable position), the varying velocities as the sample is being withdrawn, etc., are among the many disadvantages of this technique.

Other units are available that use a vacuum pump and some sort of metering chamber to measure the quantity of sample being extracted. These units in some designs offer the advantages of fairly high sample intake and transport velocities, the fluid itself never comes in contact with the pump, and the pump output can easily be reversed to purge the sampling line and intake to help prevent cross-contamination and clogging. Their chief disadvantage, shared with certain other suction lift designs arises from the following consideration.

With all suction lift devices a physical phenomenon must be borne in mind and accounted for if sample representativeness is to be maintained. When the pressure on a liquid (such as sewage) which contains dissolved gases is reduced, the gases will tend to pass out of solution. In so doing they will rise to the surface and entrain suspended solids in route. (In fact, this mechanism is used to treat water; even small units for aquariums are commercially available.) The result of this is that the surface layer of the liquid may be enhanced in suspended solids, and if this layer is a part of a small sample aliquot, the sample may not be at all representative. In the absence of other mitigating factors, the first flow of any suction lift sampler should therefore be returned to waste.

A variety of positive displacement pumps have been used in the design of suction lift samplers, including flexible impeller, progressive cavity rotary screw, roller or vane, and peristaltic types. Generally these pumps are self-priming (as opposed to many centrifugal pumps), but some designs should not be operated dry because of internal wearing of rubbing parts. The desirability of a low-cost pump that is relatively free from clogging has led many designers to use peristaltic pumps. A number of types have been employed including finger, nutating, and two- and three-roller designs using either molded inserts or regular tubing. Many of these operate at such low flow rates, however, that the representativeness of suspended solids is questionable. Newer high-capacity peristaltic pumps are now available and should find application in larger automatic samplers. The ability of some of these pumps to operate equally well in either direction affords the capability to blow down lines and help remove blockages. Also, they offer no obstruction to the flow since the transport tubing need not be interrupted by the pump; and strings, rags, cigarette filters and the like are passed with ease.

Overall, the suction lift gathering method appears to offer more advantages and flexibility than either of the others for many wastewater applications. The limitation on sample lift can be overcome by designing the pumping portion of the unit so that it can be separated from the rest of the sampler and thus positioned within 6m (20 ft) or so of the flow to be sampled. For many sites, however, even this will not be necessary.

SAMPLE TRANSPORT SUBSYSTEM

The majority of the commercially available automatic samplers have fairly small line sizes in the sampling train. Such tubes, especially at 0.3 cm (1/8 in.) inside diameter and smaller, are very vulnerable to plugging, clogging due to the build-up of fats, etc. It is also imperative that adequate sample flow rate be maintained throughout the sampling train in order to effectively transport the suspended solids. In horizontal runs the velocity must exceed the scour velocity, while in vertical runs the settling or fall velocity must be exceeded several times to assure adequate transport of solids in the flow.

The complexities inherent in the study of a two-phase mixture such as soil particles and water are such that rigorous analytical solutions have not yet been obtained for settling velocities except in certain limiting cases such as the work of Stokes mentioned earlier. Therefore, at the present time it is recommended that empirical fall velocity data be gathered for the wastewater in question. A less desirable alternative is to use results obtained by others and hope that they are applicable.

The transport of solid particles by a fluid stream is also an exceedingly complex phenomena, and no complete theory which takes into account all of the parameters has yet been formulated. Empirical formulae exist, however, some of which have a fairly wide range of applicability. An expression for the lowest velocity at which solid particles heavier than water still do not settle out onto the bottom of the pipe of channel has been developed by Knoroz (1951) on the basis of numerous experiments carried out under his direction at the All-Union Scientific Research Institute for Hydraulic Engineering.

A somewhat simpler expression for the adequate self-cleaning velocity of sewers derived by Camp from experimental findings of Shields as given in WPCF (1970) is:

$$V = \sqrt{6.4\ gd\ (s.g.-1)/f} = \frac{1.486}{n} R^{1/6} \sqrt{0.8d\ (s.g.-1)} \qquad [4]$$

where f is the friction factor, n is Manning's roughness coefficient, and all other terms are as previously identified. Using equation [4], for example, it is seen that a velocity of 0.6 m/s (2 fps) is required to adequately transport a 0.09 mm particle with a specific gravity of 2.65 and a friction factor of 0.025. By comparison, the fall velocity of such a particle is around 0.06 m/s (0.2 fps).

In summary, the sampling train must be sized so that the smallest opening is large enough to give assurance that plugging or clogging is unlikely in view of the material being sampled. However, it is not sufficient to simply make all lines large, which also reduces friction losses, without paying careful attention to the velocity of flow. For most wastewater applications, minimum line sizes of 0.95 to 1.3 cm (3/8 to 1/2 in.) inside diameter and minimum velocities of 0.6 to 0.9 m/s (2 to 3 fps) would appear warranted. Finally, sharp bends and twists or kinks in the sampling line should be avoided if there is any possibility of trash or debris in the sample that could become lodged and restrict or choke the flow. The same is true of valve designs. It also appears desirable to deliver the sample under pressure all the way from the pump to the sample container to further help reduce clogging.

SAMPLE STORAGE SUBSYSTEM

For highly variable wastewaters and storm and combined sewer applications, discrete sampling is generally desired. This allows characterization of the sewage throughout the time history of the storm event. If the samples are sufficiently large, manual compositing can be performed based on flow records or some other suitable weighting scheme. Although the quantity of samples required will be a function of the subsequent analyses that are to be performed, in general at least 1 liter and preferably 2 liters will be desired. An additional benefit arises because such relatively large samples are less vulnerable to errors arising from cross-contamination. Where composite samples can provide the necessary information, quantities of at least 7.6 liters are usually required. The sampling equipment must have the capability of taking and properly storing samples of these sizes.

The sample container itself should either be easy to clean or disposable. The cost of cleaning and sterilizing makes disposable containers attractive, especially if bacteriological analyses are to be performed. Although some of today's better plastics are much lighter than glass and can be autoclaved, they are not so easy to clean or inspect for cleanliness. Also, the plastics will tend to scratch more easily than glass and, consequently, cleaning a well-used container can become quite a chore.

The requirements for sample preservation were discussed earlier and will not be repeated here except to note that refrigeration is stated as the best single preservation and will, in all likelihood, be required unless the sampling cycle is brief and samples are retrieved shortly after being taken. It should be mentioned, however, that if the samples are allowed to become too cold, they may no longer be representative. For example, destruction of the organisms necessary for the development of BOD may occur, or freezing may cause serious changes in the concentration of suspended solids. Light can also affect samples and either a dark storage area or opaque containers would seem desirable. Unless disposable containers are used, however, it will be difficult to inspect an opaque container for cleanliness.

CONTROLS AND POWER SUBSYSTEM

The control aspects of some commercial automatic samplers have come under particular criticism as typified by comments reported by Shelley and Kirkpatrick (1975a). It is no simple matter, however, to provide great flexibility in operation of a unit while at the same time avoiding all complexities in its control system. The problem is not only one of component selection but packaging as well. For instance, even though the possibility of immersion may be extremely remote in a particular installation, the corrosive highly-humid atmosphere which will, in all likelihood, be present makes sealing of control elements and electronics desirable in most instances.

The automatic sampler for some applications (e.g., storm and combined sewer) will be used in an intermittent mode; i.e., it will be idle for some period of time and activated to capture a particular event. If field experience to date is any indication, the greatest need for an improved control element is for an automatic starter. While the sensor is not a part of the sampler proper, its proper function is essential to successful sampler utilization. Although remote rain gages, etc., can be used for sensing elements, one of the most attractive techniques would be to use the liquid height (or its rate of increase) to start a sampling cycle. This will avoid the difficulties associated with different run-off times due to local conditions such as dryness of ground, etc. In other instances it may be desirable to activate the sampler when some parameter being continuously monitored (say by an ion-selective electrode) exceeds some predetermined threshold value.

The controls determine the flexibility of operation of the sampler, its ability to be paced by various types of flow measuring devices, etc. Built-in timers should be repeatable and time periods should not be affected by voltage variations. The ability to repeatedly gather the required aliquot volume independent of flow depth or lift is very important if composite samples are to be collected. Provisions for manual operation and testing are desirable as is a clearly laid out control panel. Some means of determining the time when discrete samples were taken is necessary if synchronization with flow records is contemplated. An event marker could be desirable for a sampler that is to be paced by an external flow recorder. Reliability of the control system can dominate the total system reliability. At the same time, this element will, in all likelihood, be the most difficult to repair and calibrate. Furthermore, environmental effects will be the most pronounced in the control system.

The above tasks can probably be best executed, in the light of the current electronics state-of-the-art, by a solid state controller element. The unit should be of modular construction for ease of modification, performance monitoring, fault location, and replacement/repair. Such an approach also lends itself to encapsulation which will minimize environmental effects. Furthermore, solid state controllers can be easily designed with sufficient flexibility to accept start commands from a variety of types of remote sensors, telephone circuits, etc. Finally, one of the attributes essential to the control system of an automatic sampler to be used in a storm or combined sewer application is that it be able to withstand power outages and continue its program. Such power interruptions appear to be increasingly common as demand for electricity continues to grow.

The foregoing discussion as it relates to problems associated with interruptions in electrical service is, of course, directed to samplers that rely upon outside power for some aspect of their operation. The need for high sample intake and transport velocities, larger sample lines and capacities, together with the possible requirement for mechanical refrigeration make it unlikely that such a sampler can be totally battery operated today. Other approaches to self-contained power such as custom designed wet-cell packs, diesel generators, etc., while within the current state-of-the-art, introduce other problems and complexities that must be carefully weighed before serious consideration can be given to their incorporation in an automatic sampler design.

SECTION 4

REVIEW OF AUTOMATIC SAMPLING EQUIPMENT

REQUIREMENTS AND DESIRABLE FEATURES

Presently available automatic liquid samplers have a great variety of characteristics with respect to size of sample collected, lift capability, type of sample collected (discrete or composite), materials of construction, and numerous other both good and poor features. A number of considerations in selection of a sampler are:

- Rate of change of wastewater conditions
- Frequency of change of wastewater conditions
- Range of wastewater conditions
- Periodicity or randomness of change
- Availability of recorded flow data
- Need for determining instantaneous conditions, average conditions, or both
- Volume of sample required
- Need for preservation of sample
- Estimated size of suspended matter
- Need for automatic controls for starting and stopping
- Need for mobility or for a permanent installation
- Operating head requirements

In addition to the foregoing attributes of automatic sampling equipment, there are also certain desirable features that will enhance the utility and value of the equipment. For example, the design should be such that maintenance and troubleshooting are relatively simple tasks. Spare parts should be readily available and reasonably priced. The equipment design should be such that the unit has maximum inherent reliability. As a general rule, complexity in design should be avoided even at the sacrifice of a certain degree of flexibility of operation. A reliable unit that gathers a reasonably representative sample most of the time is much more desirable than an extremely sophisticated, complex unit that gathers a very representative sample 10 percent of the time, the other

90 percent of the time being spent undergoing some form of repair due to a malfunction associated with its complexity.

It is also desirable that the cost of the equipment be as low as practical both in terms of acquisition as well as operational and maintenance costs. For example, a piece of equipment that requires 5 man-hours to clean after every 24 hours of operation is very undesirable. It is also desirable that the unit be capable of unattended operation and remaining in a standby condition for extended periods of time. The ability to purge the intake system before and after taking each sample is very useful in most wastewater applications.

The sampler should be of sturdy construction with a minimum of parts exposed to the sewage or to the highly humid, corrosive atmosphere associated directly with the sewer. It should not be subject to corrosion or the possibility of sample contamination due to its materials of construction. The sample containers should be capable of being easily removed and cleaned; for some applications they should be disposable.

For portable automatic wastewater samplers, the list of desirable features is even longer. Harris and Keffer (1974) give a number of features of an "ideal" portable sampler, which are based upon sampler comparison studies and over 90,000 hours of field experience. Included were:

- Capability for AC/DC operation with adequate battery energy storage for 120-hour operation at 1-hour sampling intervals.
- Suitable for suspension in a standard manhole and still provide access for inspection and sample removal.
- Total weight including batteries under 18 kilograms (40 pounds).
- Sample collection interval adjustable from 10 minutes to 4 hours.
- Capability for collecting both simple and flow-proportional composite samples.
- Capability for multiplexing repeated aliquots into discrete bottles (i.e., sequential composite).
- Intake hose liquid velocity adjustable from 0.61 to 3 m/s (2.0 to 10 fps) with dial setting.
- Minimum lift of 6.1 meters (20 feet).
- Explosion proof.
- Watertight exterior case to protect components in the event of rain or submersion.

- Exterior case capable of being locked and with lugs for attaching steel cable to prevent tampering and provide some security.

- No metal parts in contact with waste source or samples.

- An integral sample container compartment capable of maintaining samples at 4° to 6°C for a period of 24 hours at ambient temperatures up to 38°C.

- With the exception of the intake hose, capable of operating in a temperature range between -10° to 40°C.

- Purge cycle before and after each collection interval and sensing mechanism to purge in event of plugging during sample collection and then collect complete sample.

- Capable of being repaired in the field.

COMMERCIALLY AVAILABLE EQUIPMENT

Some types of automatic liquid sampling equipment have been available commercially for quite a while. In the last few years, however, there has been a proliferation of commercial sampling equipment designed for various applications. New companies are being formed and existing companies are adding automatic sampling equipment to their product lines. In addition to their standard product lines, most manufacturers of automatic sampling equipment provide special adaptations of their equipment or custom designs to meet unique requirements of certain customers. Some designs that began in this way have become standard products, and this can be expected to continue.

The products themselves are also rapidly changing. Not only are improvements being made as field experience is gathered with new designs, but attention is also being paid to certain areas that have heretofore been largely ignored. For example, one company is introducing sampling probes that allow the gathering of oil or various other liquids from the flow surface; solid-state electronics are being used more and more in sampler control subsystems; new types of batteries are offering extended life between charges and less weight; and so on. Table 5 lists the names and addresses of some 47 manufacturers who are known to offer standard lines of automatic wastewater sampling equipment. In view of the burgeoning nature of this product area, it is inevitable that some omissions have been made.

An overall matrix, which summarizes the equipment characteristics to facilitate comparisons, is presented in Table 6. There are several column headings for each sampler model (or class of models). "Gathering Method" identifies the actual method used (mechanical, forced flow, suction lift) and type (peristaltic, vacuum, centrifugal pump, etc.).

TABLE 5. AUTOMATIC WASTEWATER SAMPLER MANUFACTURERS

A & H Enterprises
1711 South 133 Avenue
Omaha, Nebraska 68144

Advanced Instrumentation, Inc.
P.O. Box 2216
Santa Cruz, California 95063

Alar Engineering Corporation
7313 South Meade
Chicago, Illinois 60638

T. A. Baldwin Company, Inc.
16760 Schoenborn Street
Sepulveda, California 91343

Bestel-Dean Limited
92 Worsley Road North,
Worsley
Manchester, England M28 5QW

BIF Sanitrol
1800 12th Street S.E.
Largo, Florida 33546

Brailsford and Company, Inc.
Milton Road
Rye, New York 10580

Brandywine Valley Sales Co.
20 East Main Street
Honey Brook, Pennsylvania 19344

Chandler Development Company
1031 East Duane Avenue
Sunnyville, California 94086

Collins Products Co.
P.O. Box 382
Livingston, Texas 77351

Enviren Company
P.O. Drawer F
Alta Loma, Texas 77510

Environmental Marketing
Associates
3331 Northwest Elmwood Dr.
Corvallis, Oregon 97330

Environmental Research &
Technology, Inc.
696 Virginia Road
Concord, Massachusetts 01742

ETS Products
12161 Lackland Road
St. Louis, Missouri 63141

Fluid Kinetics, Inc.
4859 Production Drive
Fairfield, Ohio 45014

FMC Corporation
Environmental Equipment Division
1800 FMC Drive West
Itasca, Illinois 60143

Horizon Ecology Company
7435 North Oak Park Drive
Chicago, Illinois 60648

Hydraguard Automatic Samplers
850 Kees Street
Lebanon, Oregon 97355

Hydro-Numatic Sales Co.
65 Hudson Street
Hackensack, New Jersey 07602

Instrumentation Specialties Co.
Environmental Division
P.O. Box 5347
Lincoln, Nebraska 68505

Kahl Scientific Instrument Corp.
P.O. Box 1166
El Cajon, California 92022

Kent Cambridge Instrument Co.
73 Spring Street
Ossining, New York 10562

Krofta Engineering Corporation
58 Yokun Avenue
Lenox, Massachusetts 01240

Lakeside Equipment Corp.
1022 East Devon Avenue
Bartlett, Illinois 60103

Manning Environmental Corp.
120 DuBois Street
P.O. Box 1356
Santa Cruz, California 95061

Markland Specialty Eng. Ltd.
Box 145
Etobicoke, Ontario (Canada)

Nalco Chemical Company
180 N. Michigan Avenue
Chicago, Illinois 60601

Nappe Corporation
Croton Falls Industrial Complex
Route 22
Croton Falls, New York 10519

N-Con Systems Company
308 Main Street
New Rochelle, New York 10801

Paul Noascono Company
805 Illinois Avenue
Collinsville, Illinois 62234

NP Industries, Inc.
P.O. Box 746
Niagara Falls, New York 14302

Peri Pump Company, Ltd.
951 Killarney Drive
Pittsburgh, Pennsylvania 15234

Philips Electronic
Instruments, Inc.
750 South Fulton Avenue
Mount Vernon, New York 10550

Phipps and Bird, Inc.
P.O. Box 27324
Richmond, Virginia 23261

Protech, Inc.
Roberts Lane
Malvern, Pennsylvania 19355

Quality Control Equipment Co.
P.O. Box 2706
Des Moines, Iowa 50315

Rice Barton Corporation
P.O. Box 1086
Worcester, Massachusetts 01601

S.E.I.N. Ecologie
171 rue Vernon 94140
Alfortville, France

Sigmamotor, Inc.
14 Elizabeth Street
Middleport, New York 14105

Sirco Controls Company
8815 Selkirk Street
Vancouver, B.C.

Sonford Products Corporation
400 East Broadway, Box B
St. Paul Park, Minnesota 55071

Testing Machines, Inc.
400 Bayview Avenue
Amityville, New York 11701

Tetradyne Corporation
1681 South Broadway
Carrollton, Texas 75006

Thordarson, Inc.
11300 25th Avenue N.E.
Seattle, Washington 98125

Tri-Aid Sciences, Inc.
161 Norris Drive
Rochester, New York 14610

Universal Engineered Systems, Inc.
7071 Commerce Circle
Pleasanton, California 94566

Williams Instrument Co., Inc.
P.O. Box 4365, North Annex
San Fernando, California 91342

TABLE 6. AUTOMATIC SAMPLER CHARACTERISTIC SUMMARY MATRIX

Sampler	Gathering Method	Flow Rate (mℓ/min)	Line Velocity (m/s)	Lift (m)	Line Size (mm)	Sample Type	Installation	Cost Range ($)	Power
A & H WS-1000	S-peristaltic	1,680	1.5 or 0.9	7	4.9 or 6.4	TcVc, TvVc	Portable	1,500-2,200	AC
A & H WS-2000	S-peristaltic	1,680	1.5 or 0.9	7	4.9 or 6.4	TcVc, TvVc	Portable	2,000-2,700	AC
A & H WS-3000	S-peristaltic	1,680	1.5 or 0.9	7	4.9 or 6.4	TcVc, TcVv	Portable	3,000-3,700	AC
Advanced 521	S-vacuum pump	9,400	2.2	6.4	9.5	TcVc, TvVc	Fixed	2,250-2,800	AC
Advanced 524	S-vacuum pump	9,400	2.2	6.4	9.5	D, S	Fixed	3,480-4,000	AC
Advanced 551	S-vacuum pump	9,400	2.2	5.5	9.5	TcVc, TvVc	Fixed	4,500	Air
Advanced 554	S-vacuum pump	9,400	2.2	5.5	9.5	D, S	Fixed	7,600	Air
Bestel-Dean Mk II	S-Watson-Marlow	690	0.4	6.1	6.4	D, TcVc, TvVc	Portable	Unk	AC/DC
Bestel-Dean Crude	S-screw type	Unk	Unk	6.1	19.1	D, TcVc, TvVc	Portable	Unk	AC
BIF 41	M-cup on chain	NA	NA	7.6	25.4	TcVc, TvVc	Fixed	670-2,200	AC
BIF 43	user supplied	189,000	1.6	NA	25.4	TcVc, TvVc	Fixed	2,490-2,890	AC
BIF 46 Vacuum	S-vacuum pump	10,000	2.4	6	9.5	TcVc, TvVc	Portable	1,990-4,400	AC/DC
BIF 46 Pumping	S-peristaltic		-	9	6.4 - 1.3	TcVc, TvVc	Portable	1,490-3,000	AC/DC
Brailsford DC-F & EP	S-piston type	10	<0.1	<2	4.8	Continuous	Portable	296-373	DC
Brailsford EVS	S-vacuum pump	5	<0.1	3.7	4.8	TcVc, TvVc	Portable	520-672	AC/DC
Brailsford DV-2	S-piston type	10	<0.1	<2	4.8	TcVc, TvVc	Portable	373	DC
Bristol M-4	S-piston	NA	NA	0	9.5	TcVc, TvVc	Fixed	~1,000	Air & AC
BVS PP-100	F-pneumatic	*	*	85	3.2	TcVc, TvVc	Portable	853-1,525	AC/DC
BVS PE-400	F-submersible pump	7,600	1.0	9.8	12.7	TcVc, TvVc	Portable	1,500-2,510	AC/DC
BVS SE-800	F-submersible pump	7,600	1.0	9.8	12.7	D, TcVc, TvVc	Fixed	5,650	AC
BVS PPE-400	F-pneumatic	*	*	85	3.2	TcVc, TvVc	P or F	1,450-3,350	AC/DC
Collins 40	user supplied	<5,000	0.7	NA	2.4	TcVc, TvVc	P or F	835-2,328	AC
Collins 42	user supplied	>3,785	>0.3	NA	15.9	TcVc, TvVc	P or F	1,500-2,800	AC
EMA 200	F-piston type	Unk	Unk	<1	9.5	TcVc, TvVc	Portable	199-456	AC/DC
ETS FS-4	S-peristaltic	~20	<0.1	8.8	6.4	Continuous	Portable	1,095-up	AC
FMC Tru Test	user supplied	189,000	1.6	NA	25.4	TcVc, TvVc	Fixed	2,200-2,600	AC
Horizon S7570	S-peristaltic	600	>0.2	9.1	8.0	Grab	Portable	~505	AC/DC
Horizon S7576	S-peristaltic	100	<0.1	9.1	8.0	TcVc	Portable	~250	AC
Horizon S7578	S-peristaltic	100	<0.1	9.1	4.9	Continuous, TcVc	Portable	620	DC
Horizon S7579	S-peristaltic	~20	<0.1	8.8	6.4	Continuous	Portable	1,095-2,400	AC
Hydraguard HP	F-pneumatic	*	*	>9	6.4	TcVv	Portable	246-541	Air
Hydraguard A	F-pneumatic	*	*	>9	6.4	TvVc	Portable	286-668	Air & AC
Hydra-Numatic	S-centrifugal	5,700	0.3	4.6	6.4	TcVc, TvVc	Portable	1,800	AC
ISCO 1480	S-peristaltic	NA	NA	7.9	6.4	TcVc, TvVc	Portable	645-1,020	AC/DC
ISCO 1580	S-peristaltic	2,300	1.2	7.9	6.4	TcVc, TvVc	Portable	825-1,200	AC/DC
ISCO 1680	S-peristaltic	2,300	1.2 or 0.5	7.9	6.4 or 9.5	D, TcVc, TvVc, S	Portable	1,295-1,750	AC/DC
Kent SSA	S-peristaltic	150	<0.1	4.9	6.4	Discrete	Portable	1,240	AC/DC
Kent SSB	S-peristaltic	200	<0.1	4.0	6.4	D, TcVc, TvVc, S	Fixed	2,354	AC
Kent SSC	S-screw type	33,000	1.1	5.0	25.4	D, TcVc, TvVc, S	Fixed	2,354	AC
Krofta PN & PF	F-pneumatic	*	*	9	9.5	TcVv	Fixed	945-1,060	Air & AC
Krofta CO	F-pneumatic	*	*	9	9.5	TcVv	Fixed	635	Air & AC
Krofta Portable	S-positive displacement	Unk	Unk	7.6	6.4	TcVc	Portable	720-1,100	AC/DC
Lakeside T-2	M-scoop	NA	NA	0	12.7	TcVv	Fixed	700-up	AC
Manning S-3000	S-vacuum pump	7,600	1.8	7	9.5	TcVc, TvVc	Portable	895-1,000	AC/DC
Manning S-4040	S-vacuum pump	7,600	1.8	7	9.5	D, S	Portable	1,290-1,550	AC/DC
Manning S-5000	S-vacuum pump	10,800	0.9	6	15.9	TcVc, TvVc	Fixed	1,550-2,270	AC
Manning S-6000	S-vacuum pump	10,800	0.9	6	15.9	D, S	Fixed	2,930-3,250	AC
Markland 1301	F-pneumatic	*	*	18.3	6.4	TcVc, TvVc	Portable	1,095-1,350	Air & DC
Markland 101 & 102	F-pneumatic	*	*	18.3	6.4	D, TcVc	Fixed	594-2,189	Air & DC
Markland 104T	F-pneumatic	*	*	18.3	6.4	D, TcVc, TvVc	Fixed	1,094-2,644	Air & AC
Nalco S-100	F-submersible pump	28,400	3.7	7.6	12.7	TcVc, TvVc	Portable	Unk	AC
Nappe Porta-Positer	S-flexible impeller	11,400	1.5	1.8	6.4	TcVc	Portable	225-285	AC/DC
Nappe Series 46	S-flexible impeller	13,200	3.1	4.6	9.5	TcVc, TvVc	Fixed	1,100-1,800	AC
Noascono Shift	S-peristaltic	8	<0.1	9.1	4.8	Continuous	Portable	300	AC
N-Con Surveyor II	S-flexible impeller	20,000	2.6	1.8	6.4	TcVc, TvVc	Portable	290-590	AC
N-Con Scout II	S-peristaltic	150	<0.1	5.5	6.4	TcVc, TvVc	Portable	575-935	AC/DC
N-Con Sentry 500	S-peristaltic	150	<0.1	5.5	6.4	D, S	Portable	1,125-1,205	AC/DC

TABLE 6. AUTOMATIC SAMPLER CHARACTERISTIC SUMMARY MATRIX (CONT'D)

Sampler	Gathering Method	Flow Rate (mℓ/min)	Line Velocity (m/s)	Lift (m)	Line Size (mm)	Sample Type	Installation	Cost Range ($)	Power
N-Con Trebler	M-scoop	NA	NA	0	12.7	TcVv	Fixed	1,050-1,350	AC
N-Con Sentinel	user supplied	63,000	0.5	NA	25.4	TcVc, TvVc	Fixed	~2,600	AC
Peri 704	S-peristaltic	160	<0.1	7.6	6.4	TcVc	Portable	Unk	DC
Philips	F-submersible pump	60,000	2.0	15	12.7	D, Continuous, S	Fixed	Unk	AC
Phipps and Bird	M-cup on chain	NA	NA	18.3	NA	TcVc, TvVc	Fixed	~1,000-up	AC
ProTech CG-110	F-pneumatic	1,000	2.1	9.1	3.2	TcVc	Portable	485	- -
Protech CG-125	F-pneumatic	1,000	2.1	9.1	3.2	TcVc	Portable	695-1,205	-/AC
ProTech CG-125FP	F-pneumatic	1,000	2.1	9.1	3.2	TcVc, TvVc	Portable	925-1,610	AC/DC
ProTech CEG-200	F-pneumatic	1,000	2.1	16.8	3.2	TcVc, TvVc	P or F	1,354-2,445	Air/AC
ProTech CEL-300	F-submersible pump	~6,000	0.8	9.1	12.7	TcVc, TvVc	P or F	1,495-2,750	AC
ProTech DEL-4005	F-submersible pump	~6,000	0.8	9.1	12.7	Discrete	Fixed	3,995-4,765	AC
QCEC CVE	S-vacuum pump	3,000	1.6	6.1	6.4	TcVc, TvVc	Portable	570-1,030	AC/DC
QCEC CVE-76	S-vacuum pump	3,000	1.6	6.1	6.4	TcVc, TvVc	Portable	~1,000-up	AC/DC
QCEC E	M-cup on chain	NA	NA	18.3	NA	TcVc, TvVc	Fixed	~1,000-up	AC
Rice Barton	S-vacuum pump	Unk	Unk	3.7	25.4	TcVc	Fixed	Unk	AC
S.E.I.N. APAE 241	user supplied	6,700	2.3	NA	7.9	Sequential	Portable	Unk	AC/DC
SERCO NW-3	S-evacuated jars	Varies	-	3	6.4	Discrete	Portable	1,195-1,695	- or AC
SERCO TC-2	user supplied	76,000	0.6	NA	~19.0	TcVc, TvVc	Fixed	~2,600	Air & AC
Sigmamotor 7034	S-peristaltic	1,750	0.9	5.5	6.4	TcVc, TvVc	Fixed	2,980	AC
Sigmamotor 7042	S-peristaltic	1,750	0.9	5.5	6.4	Discrete	Fixed	3,280	AC
Sigmamotor 7080	user supplied	>38,000	0.6	NA	9.5	TcVc, TvVc	Fixed	800-up	AC
Sigmamotor HV-1A	S-vacuum pump	7,600	1.8	5.5	9.5	TcVc	Portable	1,295-1,695	AC/DC
Sigmamotor HVP-1A	S-vacuum pump	7,600	1.8	5.5	9.5	TcVc, TvVc	Portable	1,385-1,785	AC/DC
Sigmamotor HV-24A	S-vacuum pump	7,600	1.8	5.5	9.5	Discrete	Portable	1,575-1,975	AC/DC
Sigmamotor WA-2	S-peristaltic	60	0.1	6.7	3.2	TcVc	Portable	530-1030	AC/DC
Sigmamotor WAP-2	S-peristaltic	60	0.1	6.7	3.2	TcVc, TvVc	Portable	750-1,190	AC/DC
Sigmamotor WM-3-24	S-peristaltic	60	0.1	6.7	3.2	Discrete	Portable	1,050-1,600	AC/DC
Sigmamotor WA-5	S-peristaltic	80	<0.1	5.5	6.4	TcVc	Portable	970-1,370	AC/BC
Sigmamotor WAP-5	S-peristaltic	80	<0.1	5.5	6.4	TcVc, TvVc	Portable	1,150-1,590	AC/DC
Sigmamotor WM-5-24	S-peristaltic	80	<0.1	5.5	6.4	Discrete	Portable	1,400-1,975	AC/DC
Sirco B/ST-VS	S-vacuum pump	12,000	2.8	6.7	9.5	D, TcVc, TvVc, S	P or F	1,900-3,000	AC/DC
Sirco B/IE-VS	M-cup on cable	NA	NA	61	9.5	TcVc, TvVc	Fixed	1,500-3,000	AC
Sirco B/DP-VS	user supplied	-	-	NA	9.5	TcVc, TvVc	P or F	1,600-3,000	AC/DC
Sirco MK-VS	S-vacuum pump	6,000	1.4	6.7	9.5	D, TcVc, TvVc, S	Portable	~1,300-up	AC/DC
Sirco Pioneer	S-vacuum pump	12,000	2.8	6.7	9.5	Discrete	Fixed	Unk	AC
Sonford HG-4	M-dipper	NA	NA	0.5	19.0	TcVc, TvVc	Portable	325-495	AC/DC
StreamGuard DA-24S1	user supplied	NA	NA	NA	6.4	Discrete	Portable	775	-
StreamGuard CSO-242	S-peristaltic	380	0.2	9	6.4	TcVc, TvVc	Portable	1,450	AC
StreamGuard DA-VTE 1	user supplied	NA	NA	NA	9.5	Discrete	Portable		AC/DC
StreamGuard FTV-503	S-vacuum pump	12,000	2.8	6	9.5	TcVc, TvVc	Portable		AC/DC
StreamGuard PP-60 & 80	S-peristaltic	840	0.2	9	9.5	TcVc, TvVc	Portable		AC/DC
TMI Fluid Stream	F-pneumatic	*	*	7.6	12.7	TcVc	Fixed	~800	Air & AC
TMI Mk 3B (Hants)	S-evacuated jars	Varies	-	3	3.2	Discrete	Portable	~700-up	-
Tri-Aid	S-peristaltic	500	0.1	7.5	9.5	TcVc, TvVc	P or F	650-985	AC
UES 8000	S-vacuum pump	1,000	0.3	6.7	7.9	TcVc, TvVc	P or F		AC/DC
Williams Oscillamatic	S-diaphragm type	60	<0.1	3.6	6.4	TcVc	P or F	438	-

Legend:
M - Mechanical
F - Forced Flow
S - Suction Lift
* - Depends on pressure and lift
NA - Not Applicable
Unk - Unknown at time of writing

To convert m/s to fps, multiply by 3.3.

* Taken from Shelley (1977).

Depending upon the gathering method employed, the sample flow rate may vary while a sample is being taken, vary with parameters such as lift, etc. Therefore, the "Flow Rate" column typically lists the upper end of the range for a particular piece of equipment, and values significantly lower may be encountered in a field application. "Lift" indicates the maximum vertical distance that is allowed between the sampler intake and the remainder of the unit (or at least its pump, in the case of suction lift devices).

"Line Size" indicates the minimum line diameter of the sampling train. "Sample Type" indicates which type or types of sample the unit (or series) is capable of gathering. Not all types can necessarily be taken by all units in a given model class; e.g., an optional controller may be required to enable taking a TvVc type sample, etc. The "Installation" column is used to indicate if the manufacturer considers the unit to be portable or if it is primarily intended for a fixed installation. "Cost Range" indicates either the approximate cost for a typical unit or the lowest price for a basic model and a higher price reflecting the addition of options (solid state controller, battery, refrigerator, etc.) that might enhance the utility of the device. Finally, the "Power" column is used to indicate whether line current (AC), battery (DC), or other forms of power (e.g., air pressure) are required for the unit to operate. Detailed descriptions of all the devices listed in Table 6 are given in the Appendix.

CUSTOM DESIGNED EQUIPMENT

Despite the seeming plethora of automatic samplers on the market today, there are still no suitable units for some wastewater sampling applications, most notably storm and combined sewers. As a result, project engineers have and continue to develop custom-built and one-of-a-kind automatic samplers to meet particular program needs. The number of special features embodied by one or more of these units is surprising and includes:

- Programmable operation via paper or magnetic tape
- Controllable via telephone lines
- No requirements for power or moving parts
- Sample delivered under pressure all the way to the storage container
- Very high flow rates
- Multiple intakes
- Sample quantity determined by weight

- Backflush capability
- Ability to sequentially take continuous samples of various sizes
- Ability to simultaneously take flow proportional composite and sequential discrete samples
- Ability to take large numbers (e.g., 72) of large (e.g., 2 liter) discrete samples
- Ability to take large (e.g., 100 liter) composite samples

Some features of such custom units have become available on commercial equipment today. Others are either so costly to implement or limited in appeal that manufacturers do not offer them in any standard way.

Table 7 is a custom sampler characteristic matrix along the same lines as Table 6. The only difference is that there is no meaningful way to associate price with these custom units, so that column is omitted. The samplers covered have largely been developed for the USEPA storm and combined sewer program and have been given a designation that corresponds either with the developer or the project location.

The units are listed in approximate chronological order starting with the oldest. The most recent design is of 1973 vintage. Full descriptions of these devices are given in the Appendix.

It should be mentioned here that most manufacturers of automatic sampling equipment today are very happy to work with project engineers in solving particularly difficult sampling problems and will produce custom designs and one-of-a-kind items, often at quite reasonable prices.

TABLE 7. CUSTOM SAMPLER CHARACTERISTIC SUMMARY MATRIX

Sample	Gathering Method	Flow Rate (mℓ/min)	Line Velocity (m/s)	Lift (m)	Line Size (mm)	Sample Type	Installation	Power
Avco	S-peristaltic	<100	<0.2	<6	3.2	Sequential Continuous	Portable	DC
Springfield	S-screw type	15,000	0.3	4.3	38.1	TcVv	Fixed	AC
Milk River Influent	F-submersible pump	High	-	NA	50.8	D, TcVc, TcVv, TvVc	Fixed	AC
Milk River Effluent	S-centrifugal pump	High	-	Unk	25.4	D, TcVc, TcVv, TvVc	Fixed	AC
Envirogenics	M-bulk on winch	NA	NA	NA	NA	Discrete	Portable	Air
Rohrer	S-diaphragm pump	High	-	>6	Unk	D and TvVc	Fixed	AC
Weston	F and S	Varies	-	NA	6.4	Discrete	Fixed	AC
Pavia-Byrne	S-screw type	11,400	0.7	6	19.0	Discrete	Fixed	AC
Rex Chainbelt	S-positive displacement	11,400	1.5	4.6	12.7	Discrete	Fixed	Unk
Colston	F-submersible	Varies	-	NA	6.4	Discrete	Portable	AC
Rohrer Model II	S-diaphragm pump	76,000	0.4	>6	19.0	D and TcVc	Portable	AC
Near	M-piston tube	NA	NA	2.4	12.7	D, TcVc, TvVc	Portable	AC/DC
Freeman	User supplied	5,700	0.7	NA	6.4	Discrete	Fixed	AC
PS-69	S-screw type	26,000	1.5	6.1	6.4	Discrete	Portable	DC
Recomat	F-pneumatic	*	*	10	6.4	Sequential	Fixed	AC
EG&G	S-peristaltic	9,500	2.2	5	9.5	Discrete	Fixed	AC
EPA Region VII	S-peristaltic	Varies	-	7.5	12.7	TcVc	Portable	AC

Legend: M - Mechanical; F - Forced Flow; S - Suction Lift; * - Depends on pressure and lift; NA - Not Applicable; Unk - Unknown at time of writing

To convert m/s to fps, multiply by 3.3.

SECTION 5

FIELD PROCEDURES FOR SAMPLING

MANUAL SAMPLING PROCEDURES

The preferred method of gathering manual samples from a raw waste stream is to use a pump to actually extract the fluid and tubing of appropriate size to transport it to the sample container. Pump and tubing sizes should be such that effective collection and transport of all suspended solids of interest is ensured. Both small, flexible impeller centrifugal pumps and progressive cavity screw pumps have been successfully used with good repeatability of results. It should be noted, however, that the collection of flow proportional or sequential composite samples can become quite tedious if performed manually at the sampling site. In the absence of better information, locate the intake at approximately the three-quarters depth point (i.e., one-fourth of the way up from the bottom) and point it upstream into the flow. Adjust the pump speed until intake velocity approximately equals the mean flow velocity (obtained from a flow-measuring device or current meter) and, after about 60 seconds, direct the stream into the sample container. Avoid using an intake screen unless absolutely necessary.

When manually sampling natural streams, use a depth-integrating sampler at the center of the stream if the flow is laterally homogeneous. Check the site for this by occasionally taking samples from the quarter points and comparing results. If significant differences are found, either choose another site or take a number (5 to 20 depending upon stream width) of depth integrated samples along a transect perpendicular to the flow. Based on the results, choose the minimum number of transverse stations that will yield acceptable results.

Depth integrating samplers for use in more swiftly running streams are relatively heavy, and so some type of hoist or winch is normally used to facilitate handling. These can be mounted on boats for river and estuary cruises, on trucks or trollies for bridge sampling, etc. Contact the nearest USGS field office for more information on availability and use of different depth integrating samplers.

Samples may be manually gathered at a given depth in the water column by using a Juday bottle or one of its modifications (e.g., Kemmerer, Van Dorn). This type is essentially a cylinder with stoppers that leave the ends open while the sampler is being lowered to allow free passage of water through the cylinder. When the desired depth is reached (as determined by markings on the line, for instance) a messenger is sent down the line and causes the stoppers to close the cylinder, which is then raised and the sample transferred to its container. These devices can be used to approximate depth integration through the water column, to investigate stratification in lakes, or wherever a sample from a particular depth is desired. When using such devices from bridges, take precautions so that the messenger, when dropped from the height of the bridge, does not batter and ruin the triggers that release the stoppers. One simple way to avoid this is to support the messenger a few feet above the sampler with a string and release it when the desired depth is reached.

If vertical concentration gradients are not severe, a single grab sample will suffice. It is recommended that a container smaller in volume than the desired total sample volume be used, and that the required sample volume be obtained by repeated dippings at one-minute intervals. Rinse the container two or three times in the water to be sampled prior to taking the first aliquot. Comparison of the results between depth integrated and simple grab samples will indicate when the latter technique will suffice.

For reproducibility of manual sampling results, operator training is absolutely essential; one can ill afford to entrust this task to well-intentioned but untrained staff or volunteers. Also, it is time that we forget about using a beer can nailed to a stick as a sample gathering device. All in all, the manual pumping sampler described earlier in this section will produce the most reproducible results, and its use is recommended whenever feasible.

One subject that should also be touched on briefly is manual compositing according to flow records. Given a series of discrete samples of equal volume taken at regular time intervals and a flow record, the question is what size aliquot should be taken from each discrete sample container to form the flow proportional composite sample? Recall from Section 2 that this can be done in one of two ways: either extract an aliquot volume that is proportional to the instantaneous flow rate at the time the discrete sample was taken, or extract an aliquot volume that is proportional to the total discharge that has occurred since the last discrete sample was taken. The formula used for this can be written as:

$$a_i = g_i \, V_c / \Sigma f_i \qquad [5]$$

where:

a_i = aliquot volume to be extracted from the i-th discrete sample, i.e., the one taken at time t_i

i = index indicating the order in which the discrete samples were taken, $1 \leq i \leq n$

f_i = flow variable; either the flow rate when the i-th discrete sample was taken (q_i) or the total discharge that has occurred since the (i-1)-th sample was taken ($\Delta Q_i = Q_i - Q_{i-1}$)

V_c = composite sample volume desired

n = number of discrete samples taken

The desired composite sample volume is determined based on the requirements for the analyses to be conducted. The subtle problem is that one does not have complete freedom in selecting V_c because of the fixed discrete sample volume (V_d), and the entire sequential discrete series may be wasted if this is not recognized, because there might not be enough sample in one bottle to fulfill its aliquot requirements. This is best illustrated by an example (see Table 8). Note that if steps 3 and 4 had not been carried out, when the operator came to bottle number 5 he would not have been able to continue, since he would be 250 mℓ short. This has happened. Also, it is incorrect to use leftover liquid from the adjacent discrete samples to make up the deficit (which has also occurred).

In actuality, one can compute the maximum composite sample volume that can be formed from a series of discrete samples. The formula is

$$(V_c)_{max} = V_d \; \Sigma f_i / (f_i)_{max} \qquad [6]$$

If this quantity is greater than the amount desired, the formula given as equation [5] for determining aliquot volume can be used. If not, the aliquot size should be computed from

$$a_k = f_i \; V_d / (f_i)_{max} \qquad [7]$$

This will be illustrated by a second example, shown in Table 9. Since the available composite sample is nearly half a liter less than was desired, a new decision on how to allocate the available volume must be made.

Example III (Table 10) is included to indicate how to manually prepare a time-constant, volume-proportional-to-discharge-since-last-sample-was-taken composite when a record of flow rate rather than discharge is available. The results of Examples II and III agree because the same flow function (q=5,000 sin $\pi t/8$) was used in each case and the trapezoidal integration scheme worked well.

The details for manually preparing a time-constant, volume-proportional-to-instantaneous-flow-rate composite sample using the flow rate record given in Example III will not be presented (a_i=191, 354, 462, 500, 462, 354, 191, 0; Σa_i=2,514 mℓ), but it is of interest to contrast the

TABLE 8. MANUAL COMPOSITE SAMPLE EXAMPLE I

Example: Manually preparing a time-constant, volume-proportional-to-instantaneous-flow-rate composite sample.

Given: A 500 mℓ discrete sample was taken at the end of each hour over an 8-hour shift. A 2-liter composite is desired. A recording of flow rate is available.

Sample No. (i)	q_i	a_i	a_ix500/750
1	300	47	31
2	600	94	63
3	1,200	188	125
4	2,400	375	250
5	4,800	750	500
6	2,000	312	208
7	1,000	156	104
8	500	78	52
Σq_i =	12,800	2,000	1,333

Steps:

1. Enter q_i from record and sum.
2. Calculate $a_i = q_i V_c / \Sigma q_i = 2000 q_i / 12{,}800$.
3. Check to see if maximum a_i exceeds discrete sample volume.
4. Compute new aliquot volume = a_ix500/750.

TABLE 9. MANUAL COMPOSITE SAMPLE EXAMPLE II

Example: Manually preparing a time-constant, volume-proportional-to-discharge-since-last-sample-was-taken composite.

Given: A 500-mℓ discrete sample was taken at the end of each hour over an 8-hour shift. A 3-liter composite is desired. A recording of totalized flow is available.

Sample No. (i)	Q_i	ΔQ_i	a_i
0	0	-	-
1	969	969	99
2	3,729	2,760	284
3	7,860	4,130	424
4	12,732	4,873	500
5	17,605	4,873	500
6	21,736	4,130	424
7	24,496	2,760	284
8	25,465	969	99
	$\Sigma \Delta Q_i$ =	25,464	2,614

Steps:

1. Enter Q_i from record and calculate $\Delta Q_i = Q_i - Q_{i-1}$.
2. Calculate $(V_c)_{max}$ = (500) (25,464)/4,873 = 2,614 mℓ.
3. Since $(V_c)_{max}$ is less than desired, calculate aliquot size from a_i = 500 ΔQ_i/4,873.

TABLE 10. MANUAL COMPOSITE SAMPLE EXAMPLE III

Example: Manually preparing a time-constant, volume-proportional-to-discharge-since-last-sample-was-taken composite.

Given: A 500-mℓ discrete sample was taken at the end of each hour over an 8-hour shift. A 3-liter composite is desired. A recording of flow rate is available.

Sample No. (i)	q_i	ΔQ_i	a_i
0	0	-	-
1	1,913	957	99
2	3,536	2,725	283
3	4,619	4,078	424
4	5,000	4,810	500
5	4,619	4,810	500
6	3,536	4,078	424
7	1,913	2,725	283
8	0	957	99
	$\Sigma\Delta Q_i$ =	25,140	2,612

Steps:

1. Enter q_i from record and use trapezoidal rule to calculate $\Delta Q_i = (q_i+q_{i-1})/2$ (another integration scheme could be used if warranted).
2. Calculate $(V_c)_{max}$ = (500) (25,140)/4,810 = 2,613
3. Calculate a_i = 500 ΔQ_i/4,810

measured concentration of a constituent of interest obtained by this method as opposed to the method of Example II. For this purpose, assume that the constituent behavior is a simple linear decay (i.e., conc=9=t). The true concentration in the flow rate proportional sample would be 5.0 (assuming the discrete samples from which the composite was formed were 100 percent representative). The corresponding true concentration of the discharge proportional composite (Example II) would be 4.5, a difference of around 10 percent due solely to the method of compositing. Unless great care is exercised, however, errors of this size would be eclipsed by handling errors attributable to manual compositing (e.g., failure to withdraw a representative aliquot from each sample container).

The general subject of sediment sampling is outside the scope of the present volume, as discussed in Section 1. There is, however, an increasing interest in measuring sediment oxygen demand (SOD), and a few comments are in order. The possible importance of SOD measurements is well illustrated by Butts (1974) who noted, as a result of an extensive SOD study, that "... it is doubtful that the aquatic ecology of the (Illinois) waterway can be measurably enhanced solely by achieving current water quality standards." The subject of SOD measurement remains somewhat controversial, but it is recommended that determinations be made in situ rather than in the laboratory. Ascertaining the relationship between SOD rates and DO content of the overlying waters is better accomplished by performing in situ measurements. This can be done, for example, by setting a bell-shaped shallow cover over the spot on the bottom where the measurement is to be made, circulating the water within this "sampler" with a small pump, and measuring the change in DO with time.

The design of an in situ SOD measuring device developed by the Illinois State Water Survey is described by Butts (1974), who also reports favorably on its use. The cover was made from a 14-inch-diameter by 24-inch-long steel pipe split longitudinally in half. End plates were welded on, and angle iron was welded around the lower edge to act as cutting edges and seating flanges. Fittings for raising and lowering the device, two hose attachments to allow connection of a pump for water circulation, and a split collar to hold the DO/temperature probe were also welded in place. The "sampler" covered a flat bottom area of about 0.2 square meter (336 sq in.), and the total volume of water within the system was around 31 liters. The device is handled with a USGS bridge winch adapted for use on a boat.

AUTOMATIC SAMPLING PROCEDURES

When using automatic samplers, the greatest problem comes in mounting the intake. Screened intakes should be used in waters containing large solids, trash, or debris to prevent clogging. Screen openings should be slightly smaller than the smallest opening in the sampling train.

More and more commercial devices are now provided with intake screens by their manufacturers. When using these, the end of the intake hose should be approximately at the center of the screen. If intake screens are not provided with the sampler, they can be fabricated quite simply by drilling a large number of appropriately sized holes in a piece of plastic pipe, cementing on end covers, and drilling out one end to accept the sample tube and fastening it with a hose clamp and fitting. Clear plastic is recommended to facilitate inspection. A typical size for an intake screen to accommodate a 0.95 cm (3/8 in.) ID tube is approximately 3.8 to 5 cm (1.5 to 2 in.) in diameter by 15 to 25 cm (6 to 10 in.) long. Hole diameters could be 0.64 cm (1/4 in.) if the rest of the sampling train is larger.

The flexible plastic intake tubing commonly used in most commercial automatic samplers will require some protection in many installations, or wear from particles in the flow and damage from debris will necessitate frequent replacement. Flexible electrical conduit and reinforced garden hose have been successfully used to armor intake tubing. Rigid tubing has also been used with good results in some installations. Even with such protection, it is recommended that sample intake lines be trenched in where they run over earthen surfaces.

One of the most challenging sample intake mounting problems is in a natural, wet weather stream. If the intake is allowed to rest on the bottom where it could obtain samples at very low flows and, hence, more readily determine first flush effects, there is a possibility that flow fields around the intake may induce scour and cause artificially high solids readings. Mounting the intake well above the bottom obviates this problem but prevents acquiring samples of very low flow. The best compromise seems to be to mount the intake horizontally, at right angles to the flow, in the middle of the stream and with its lowest surface around 5 cm (2 in.) above the bottom (higher if significant bedload depths are anticipated). The stream bottom at this point should be reasonably flat and free of stones or other flow-altering obstructions upstream of the intake. For cobble-strewn bottoms, follow the above procedure but measure from a sheet of plywood resting on the stones.

To anchor the sample intake to the bottom, use screw augers or metal T-posts or rods driven well into the soil. Simple clamps can be used to affix the intake screen to these supports. Sash weights have been successfully used as anchors also.

For continuously flowing natural streams, similar considerations pertain. The main difference will be in the vertical location of the intake. In the absence of other factors, mount the intake near the low flow mid-depth. If stream depth allows, the intake should be mounted with its center line vertical, and suction taken from the bottom. In this configuration, a single mounting rod can be used. It should be located to one side of the intake (never in front of it).

The foregoing has been written with smaller streams, typical of those that would be encountered in an urban runoff study, in mind. As indicated in Section 2, it is not expected that automatic samplers will find wide use in occasional river surveys.

In man-made channels and conduits, there is no longer a concern for bottom scour. For those carrying intermittent flows, the intake screen can be allowed to rest on the bottom unless significant bedload depths are anticipated. Where large debris is likely to be encountered, a spring-loaded intake screen mounting should be considered to help prevent destruction. It is a fairly common practice to simply let the intake screen trail downstream by its tubing. In very low or no-flow periods it will rest on the invert and, during higher flows, hydrodynamic forces will tend to lift it up. The chief objection to this practice is that intakes facing downstream do not gather representative solids due to momentum effects. Data on the degree of under-representation caused by this practice are virtually nonexistent, however. Use this practice as a last resort.

Where the flow is continuous (but variable), position the intake screen near the low flow mid-depth. As opposed to natural streams, however, in many man-made conduits it will be more convenient to dangle the intake from above with the suction tube pointing down. Although the vertically up orientation is preferable, this latter practice is also acceptable. The chief disadvantage of "dangling" approaches to intake mounting is that you never really know where the intake is. Be certain that there is no possibility of full flow positioning the intake where it could be left "high and dry" as the flow recedes. Manhole benches, steps, weirs, and the like have taken their toll in careless intake installations. It is mandatory that a weight be used on the intake if it is merely dangled in the flow.

For the (rare) case where relatively steady flow is anticipated in either natural or man-made channels, position the intake at about the three-quarter depth point unless site-specific information indicates otherwise. If two automatic sampling devices are used for redundancy at a critical site, position one intake at the eight-tenths depth point and one at the four-tenths depth point. Shelley (1976a) discusses the rationale for sample intake location in some detail and presents designs for maintaining intakes at a constant percentage of depth in variable flows, noninvasive intakes, etc.

All of the foregoing has been written primarily with suction lift intakes in mind, but similar considerations apply if forced-flow devices are used. For samplers employing mechanical gathering methods, follow the manufacturer's directions.

Mounting the main body of the automatic sampler is rather straightforward; be sure to follow the manufacturer's directions. Keep the lift as short as possible commensurate with the likelihood of submergence. If excess sample tubing exists, cut it off. Do not simply coil it out of the way, thinking that the extra length might be useful at the next installation. Avoid twists or kinks in the line and guard against sags or loops where liquid might remain following sample extraction and contaminate the next sample to be taken (cross-contamination).

After setting up the controls and power subsystem according to the operator's manual for the particular sampler being used, manually cycle it a few times and measure the quantity of sample actually being taken. This is especially important where fixed aliquot volume composite samples are to be collected. Verify sample volume gathered on each site visit. Partial plugging, intake blockage, or other occurrences that might not be immediately obvious can affect the sample quantity in most designs. Also, use a stopwatch to record the time that it takes to gather the sample and verify this on subsequent visits. For battery-operated units, frequent voltage checks are in order until service life can be established for the installation. Manufacturers are not noted to be conservative in estimating battery life, and it will be affected by a number of factors such as sample lift, temperature, etc. Always inspect the sample intake at each visit.

For operation in warm weather, some sort of cooling must be provided to help maintain sample integrity. Where electric power lines are available this usually presents little problem; simply use a device with an automatic refrigeration option. Typically, these are merely transportable (as opposed to portable) at best and, due to their bulk, will not, be suited for all locations. Some designs have provisions for ice cooling of the collected sample. Temperature checks are wise, since cooling ability varies widely among designs and will also be affected by the wastewater temperature, ambient air temperature, and degree of exposure to direct sunshine. In this last regard, some manufacturers (for reasons best known to themselves) use very dark colored enclosures for their devices. Cooling requirements can be considerably reduced by painting such units white or silver if they are to be placed in the sun. If the manufacturer has not provided for ice cooling, an ordinary picnic cooler of suitable size may be used. The drain hole can be used to thread the discharge line from the sampler to the sample container. Ordinary ice or freezer packs may be used for cooling.

For operation in very cold weather, a heated enclosure for the sampler body will be required. This can be as simple as an insulated housing containing a thermostatically controlled light bulb. The heat given off by the bulb will normally be sufficient to prevent problems caused by freezing. Most manufacturers offer winterizing options also. Do not use catalytic-type heaters. They give off vapors that can affect sample composition. Sample lines should be wrapped with heater tape and insulated -- large plastic trash bags work well for this. Alternately, heated Teflon lines which have recently become available can be used to eliminate the problem. They tend to be expensive, however. In designs where the intake line is blown down after each sample is taken, this may not be necessary. Check for possible ice buildup at each visit. Should frozen (or partially frozen) samples be encountered, do not discard them, but immediately enter the facts in the field log and also report the condition to the analytical laboratory when the samples are delivered.

Maintenance and troubleshooting of automatic samplers are so design-dependent that little general guidance can be given other than to follow manufacturer's instructions and recognize the importance of these activities in contributing to project success. No sampler should be taken into the field unless it has been thoroughly checked out first. One word of caution pertaining to suction lift samplers using peristaltic pumps must be made. Some of these pump designs require that the tubing be lubricated. This must be done or tube life will be considerably shortened; failures after less than 2 hours of operation have been reported for some designs when inadequate lubrication was applied. Finally, with care and consideration, most automatic samplers can be made to work reasonably well; with carelessness and disregard, almost none will.

SAMPLE EQUIPMENT CLEANING

The proper cleaning of all equipment used in the sampling of water and wastewater is essential to ensuring valid results from laboratory analyses. Cleaning protocols should be developed for all sampling equipment early in the design of the wastewater characterization program. Here also, the laboratory analyst should be consulted, both to ensure that the procedures and techniques are adequate, as well as to avoid including practices that are not warranted in view of the analyses to be performed.

As an example, Lair (1974) has set down the standard operating procedures for the cleaning of sample bottles and field equipment used by USEPA Region IV Surveillance and Analysis field personnel engaged in NPDES compliance monitoring. They are reproduced below for a typical automatic sampler and related sampling equipment.

<u>2-1/2-Gallon Pyrex Glass Composite Bottles</u>

1. Rinse twice with spectro grade acetone.

2. Rinse thoroughly with hot tap water using a bottle brush to remove particulate matter and surface film.

3. Rinse thoroughly three times with tap water.

4. Acid wash with at least 20-percent hydrochloric acid.

5. Rinse thoroughly three times with tap water.

6. Rinse thoroughly three times with distilled water.

7. Rinse thoroughly with petroleum ether and dry by pulling room air through bottle.

8. Dry in drying oven overnight.

9. Cap with aluminum foil.

ISCO* Glass Sample Bottles

1. One spectro grade acetone rinse.

2. Dishwasher cycle (wash and tap water rinse, no detergent).

3. Acid rinse with at least 20-percent hydrochloric acid.

4. Dishwasher cycle, tap and distilled water rinse cycles, no detergent.

5. Replace in covered ISCO bases.

Sample Tubing (1/4, 3/8, or 1/8 Pexcon or Tygon)

1. Do not reuse sample tubing. No cleaning required. New sample tubing is to be used for each new sampling setup.

2. Use Teflon tubing where samples for organics are to be collected.

ISCO Pump Tubing

1. Rinse by pumping hot tap water through tubing for at least 2 minutes.

2. Acid wash tubing by pumping at least a 20-percent solution of hydrochloric acid through tubing for at least 2 minutes.

3. Rinse by pumping hot tap water through tubing for at least 2 minutes.

4. Rinse by pumping distilled water through tubing for at least 2 minutes.

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* Instrumentation Specialties Company sampler is used for illustrative purposes.

Teflon Sample Tubing

1. Teflon sample tubing should be cleaned in the same manner as the 2-1/2 gallon Pyrex sample containers.

ISCO Rotary Funnel and Distributor

1. Clean with hexane to remove any grease deposits.

2. Rinse thoroughly with hot water and a bottle brush to remove particulate matter and surface films.

3. Use a squeeze bottle of 20-percent hydrochloric acid and rinse thoroughly, rinse funnel as well as funnel and distributor depressions.

4. Rinse thoroughly with tap water.

5. Rinse thoroughly with distilled water.

6. Replace in sampler.

ISCO Sample Headers

1. Rinse entire header with hexane or petroleum ether.

2. Disassemble header and rinse thoroughly with hot tap water, using a bottle brush to remove particulate matter and surface films.

3. Rinse the plastic portion of the header with at least a 20-percent solution of hydrochloric acid. Do not use acid on the metal parts.

4. Rinse thoroughly with tap water.

5. Reassemble header.

6. Rinse all header parts thoroughly with distilled water.

One-Gallon Plastic Sample Containers

1. Use only new bottles when sampling wastewater sources.

One-Quart Wide-Mouth Bottles for Organics, Pesticides, and Oil and Grease Samples

1. Use only new bottles with Teflon liners.

2. Rinse twice with petroleum ether and allow to dry.

One-Pint Narrow-Mouth Bottles for Phenol Samples

1. Use new bottles only.

One-Pint Narrow-Mouth Mercury Sample Bottles

1. Use only new bottles.
2. Rinse with at least 20-percent nitric acid.
3. Rinse at least three times with distilled water.

One-Liter Plastic Storemore Cyanide Sample Bottles

1. Use only new bottles.

SECTION 6

REVIEW OF AUTOMATIC SAMPLER EXPERIENCE

REVIEW OF IN-USE FIELD EXPERIENCE

In order to assess the efficacy of both commercially available samplers and custom engineered units in actual field usage, a survey of USEPA projects, many of which were in the storm and combined sewer pollution control area, was conducted. None of these projects was undertaken solely to compare or evaluate samplers, but all required determination of water quality. In the following paragraphs, difficulties encountered with various elements of the liquid samplers are described.

The small diameter, low intake velocity probes found in several commercial units were felt to be unable to gather as representative a sample of the flow as could be obtained manually. There were many instances of inlet tube openings being blocked by rags, paper, disposable diapers, and other such debris. Although less a fault of the equipment than an installation practice, there were several instances of intake tubes being flushed over emergency overflow weirs, up onto manhole steps, etc., during periods of high flow and left high and dry and unable to gather any samples when the flow subsided.

There were numerous instances of pre-evacuated bottle samplers losing their vacuum in 24 to 48 hours, resulting in little or no data. Furthermore, personnel find these units with their 24 individual intake tubes virtually impossible to clean in the field. The low suction lifts on many commercial units render some sites inacessible. In one project, three sites required manual sampling because none of the samplers on hand could meet the 5- to 6-meter lifts required at these locations. There were several instances of sample quantity varying with sewage level as well as with the lift required at the particular site. On at least two occasions, submersible pumps were damaged or completely swept away by heavy debris in the flow.

Within the sampling train itself, line freezing during winter operation was a problem in several projects with instances of up to 60-percent data loss reported. In one project, the intake line was too large, which which allowed solids to settle out in it until it ultimately became clogged. There were numerous instances of smaller suction tubes becoming plugged with stringy and large-sized material. A very frequent complaint, applied especially to discrete samplers, was that they gathered inadequate sample volumes for the laboratory analyses required.

On one project, although not directly the fault of the sampling equipment itself, data were lost for 14 storms due to improper sterilization of nondisposable sample bottles.

The control subsystems of commercial units probably came in for more criticism than any other. Comments on automatic starters ranged from poor to unreliable to absolutely inadequate. There were instances where dampness deteriorated electrical contacts and solenoids causing failure of apparently well-insulated parts. The complexity of some electrical systems made them difficult to maintain and repair by field personnel. Inadequate fuses and failures of microswitches, relays, and reed switches were commonly encountered. The minimum time between collection of samples for some commercial units was too long to adequately characterize some rapidly changing flows.

Collected USEPA experience in one region reported by Harris and Keffer (1974) involved over 90,000 hours use of some 50 commercial automatic liquid aamplers of 15 makes and models. They found that the mean sampler failure rate was approximately 16 percent with a range of 4 to 40 percent among types. They also found that the ability of an experienced team to gather a complete 24-hour composite sample is approximately 80 percent. When one factors in the possibility of mistakes in installation, variations in personnel expertise, excessive changes in lift, surcharging, and winter operation, it is small wonder that projects on which more than 50 to 60 percent of the desired data were successfully gathered using automatic samplers were, until recently, in the minority.

In fairness to present day equipment, it must be pointed out that some of the foregoing complaints stem from equipment designs of up to 10 years ago, and many commercial manufacturers, properly benefitting from field experience, have modified or otherwise improved their products' performance. The would-be purchaser of commercial automatic samplers today, however, should keep in mind the design deficiencies that led to the foregoing complaints when selecting a particular unit for his application.

Improved field procedures and lessons learned from past experience have also contributed to improved performance. At the present time, Keffer (1976) reports an over 95 percent success rate in gathering a complete 24-hour composite sample. Conversations with other USEPA regional Surveillance and Analysis personnel, laboratory personnel, project engineers, and other sampling equipment users indicate similar capabilities, the improvement being attributed to better equipment and more experience with its use. The storm and combined sewer application remains an exception, due to the extreme demands it places on both equipment and personnel.

REVIEW OF TESTING EXPERIENCE

The review of field experience just presented was primarily concerned with the ability of automatic equipment to reliably gather a sample. We are concerned here with the representativeness of such samples.

When proper quality assurance provisions are made, there appears to be little reason to suspect that samples taken by automatic equipment from water supply or adequately treated wastewater effluent sources are not reasonably representative (within ±30-50% or better). For raw and partially treated wastewater, however, the situation is quite different. This is especially true as concerns suspended solids. With all of the analytical difficulties discussed or alluded to in Section 1, it is obvious that there must be great reliance upon empirical data in the study of the sampling of suspended solids. Despite the wide variety of sampling equipment designs available, none of them is universally acceptable for representatively sampling all flows of interest (Shelley; 1975a); differences in designs can produce marked differences in results. For example, Harris and Keffer (1974) report differences of over 200 percent in the results of samples gathered by samplers of different designs when used simultaneously on the same wastewater stream.

Shelley (1975b) designed a modular, multilevel intake prototype sampler that can be used to gather either instantaneous or integrated samples at each point. In laboratory tests of this prototype device involving a variety of suspended solids, Shelley (1976a) used a facility that had the following capabilities: a test flume with a semicircular invert, the ability to create stable flows over the velocity range of 0.3 to 2.4 m/s while maintaining a constant depth in the test section, an accurate means of determining flume discharge (i.e., flow velocity), a method for constantly adding suspended solids to the flow to create and maintain a known solids concentration in the flume, the ability to provide suitable synthetic solids representative of these encountered in many wastewater flows, and the ability to provide laboratory analysis of samples taken during the testing program.

The facility used for the testing consisted of a water supply taken from a fixed pumping station in the laboratory, the flow channel or flume itself, a settling basin with a calibrated overflow weir, and an exit to a return channel to the pump. The flow channel was 12.2m long with a cross section 0.3m wide by 0.6m deep, including a semicircular invert. A test section was provided 3.7m from the downstream end where a 2.54-cm recess in the wall was provided to allow routing the 1.6-cm O.D. tubes from the intakes of the prototype sampler to its pump box. This was done, in view of the channel width, to minimize any effects of these lines on the flow stream itself. Point gages upstream from the test section could measure the water level to ensure that depth control was maintained.

The normal water supply was taken directly from the pump. The flume and overflow weir were calibrated by a temporary supply that took its flow directly from one of the calibrated V-notch weir towers in the laboratory. The solids injection system consisted of a dry solids vibratory feeder with a plexiglass hopper fixed over it. The rate of vibration (and hence solids injection) could be controlled by a rheostat.

A wide range of suspended solids were used for creating the synthetic flows. They include:

a. Silica sand, specific gravity 2.65

fine - 120 mesh $\geq$d $\geq$140 mesh (0.105-0.125 mm)

medium - 30 mesh $\geq$d $\geq$35 mesh (0.500-0.595 mm)

course - 10 mesh $\geq$d $\geq$12 mesh (1.68-2.00 mm)

b. Pumice, specific gravity 1.35

A single broad grain size distribution used in earlier storm and combined sewer flow synthesization was tested

6 mesh $\geq$d $\geq$ about 100 mesh (0.149-3.36 mm)

c. Gilsonite, specific gravity 1.06

fine - 12 mesh $\geq$d $\geq$30 mesh (0.595-168 mm)

medium - 10 mesh $\geq$d $\geq$12 mesh (1.68-2.00 mm)

coarse - 6 mesh $\geq$d $\geq$8 mesh (2.38-3.36 mm)

d. Alathon, specific gravity 0.99

Uniform size of 3.0 mm

e. Polythene, specific gravity 0.92

Uniform size of 4.0 mm

The initial phase of the controlled laboratory testing program involved using the prototype sampler over a wide range of test parameters (flow velocity, solids type and size, and concentration). Of the four sampling intakes used for the large majority of the testing, two were located near mid-depth, while the other two were positioned near the water surface and near the invert, respectively. This arrangement is essentially similar to the preferred three-point method of sampling discussed in FIASP (1963).

In addition to the prototype sampler, a so-called reference sampler was used in part of this testing phase. The reference sampler consisted of a "standard" sedimentation probe (provided through the courtesy of the Federal Inter-Agency Sedimentation Project Office at St. Anthony Falls) connected to a peristaltic pump with a variable speed drive arrangement. This reference sampler had been calibrated so that any desired sample intake velocity could be set in order to allow isokinetic sampling to be achieved. The intake probe could be positioned at any desired point in the cross section of the flow with its inlet pointed directly upstream into the flow. The reference sampler was used primarily to investigate vertical and horizontal concentration profiles. Two results from the testing effort will be mentioned here. First, it is of interest to note the results of using this prototype device to gather samples of the relatively light (s.g. = 1.06) gilsonite when operating in an instantaneous mode. Four-second samples were gathered every 30 seconds for flume velocities of 0.6 and 1.2 m/s, and typical results are presented in Figure 7 (taken from Shelley; 1976a). The range of total flume concentration (suspended solids plus bedload) is indicated by the shaded band. In an extended period of testing with gilsonite at various concentrations and flume velocities, it was found that the average of only five instantaneous samples would generally fall within the range of flume concentrations, and typical deviations from flume averages were less than +10 percent.

The second result arises from another phase of the testing effort in which several of the more popular commercially available sampler designs were tested in a side-by-side fashion with the prototype. Although the testing was far from exhaustive, enough data were gathered to demonstrate that there can be marked differences in results obtained with different sampler designs, even under identical, controlled flow conditions as indicated by Table 11 (taken from Shelley; 1976a). As can be noted, the performance of these commercial units ranged from overstatements of concentration by a factor of 4 to understatements by 70 percent or more.

The last testing experience to be reviewed here is a study done by Reed (1976) to examine the ability of a sampler to gather a sample that is representative in nonfilterable solids (NFS) in a raw waste stream. The tests were conducted using a 832,000 liters per day (270,000 gpd) raw domestic wastewater flow. The purpose of the study was to determine if standard sampling procedures would accurately recover an artificial wastewater solid that was present in the flow at a known concentration. A chelating resin tagged with copper was used as the artificial wastewater solid. The concentration of applied solids in the wastewater could be determined by the amount of copper found to be present in excess of the background concentrations. The resin used was a styrene lattice with an iminodiacetic acid exchange group. It had an equivalence of 0.104 mg of copper per mg of resin. The particles were spherical and had a wetted specific gravity of 1.15. Several different size particles were used to provide different suspension and settling characteristics.

Four sampling points were examined, three were one-foot upstream from a Parshall flume, located in the center of the approach channel at the 0.2 and 0.6 depth points and on the bottom of the channel, and one downstream of the flume in the center of an existing hydraulic jump. The tube opening in the jump was located 15 to 30 cm (6 to 12 in.) downstream from the leading edge of the stationary wave. In addition, background copper samples were collected in the sewer upstream from the

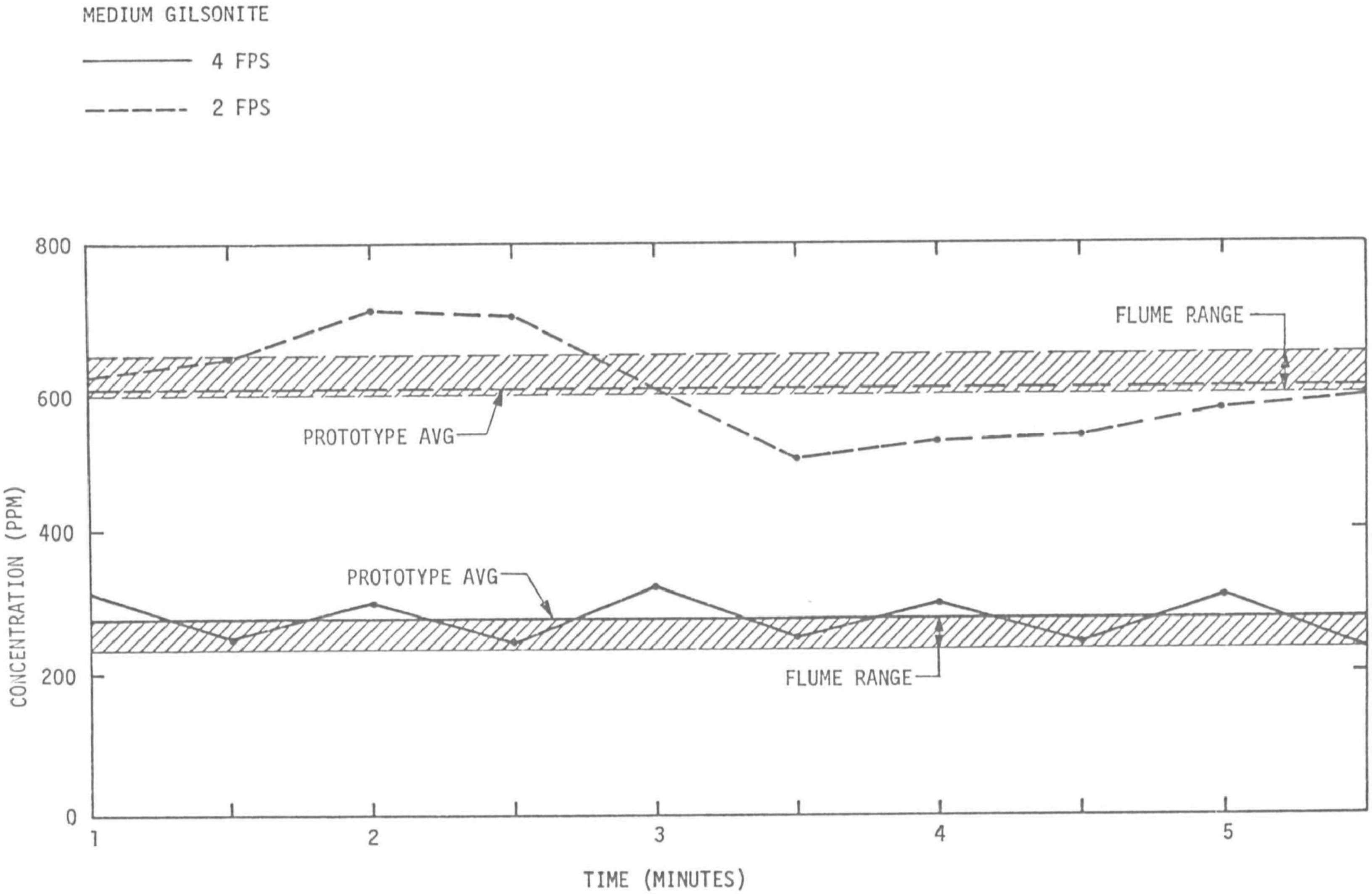

Figure 7. Variation of Gilsonite concentration with time.*

* Taken from Shelley (1976a).

TABLE 11. AVERAGE SAMPLING REPRESENTATIVENESS (%)

Solids Type Flow Velocity (fps) Nominal Concentrations (ppm)	MG 2 300	MG 2 600	MG 4 300	MG 4 600	FS 4 300	FS 4 600	FS 8 300	FS 8 600
Prototype	100	116	104	99	40	37	138	157
Model A	76	74	100	61	2	0	9	12
Model B	74*	93	14	1	5	3	26	33
Model C	159	199	90	68	74	343*	60	16
Model D	440	411	298	156	36	30*	12	3

Notes:

- Sampling representativeness is analyzed sample concentration divided by average actual flume concentration times 100.

- Prototype data based upon 10-point average; all others are 5-point averages except (*) where one data point was disregarded leaving a 4-point average.

- MG is medium gilsonite (s.g. = 1.06, $1.68 \leq d \leq 2.00$ mm); FS is fine sand (s.g. = 2.65, $0.105 \leq d \leq 0.125$ mm).

- Multiply feet per second by 0.3 to obtain meters per second.

- Table taken from Shelley (1976a).

resin feeder by an automatic sampler. All of the intake tubes were 0.95 cm (3/8 in.) I.D. Tygon tubing positioned to open directly into the flow stream. The samples were withdrawn directly from the flow stream into one-liter containers by a variable-speed sampler built in the USEPA Region VII laboratory. The required lift was less than 0.5m (18 in.). Both isokinetic velocities and a higher fixed velocity of 0.76 m/s (2.5 fps) were investigated.

Appreciable data scatter typical of all such tests conducted to date was observed, but a strong overriding conclusion could be drawn. The best that can be expected from such a sampling procedure at the 0.6 depth point or in the hydraulic jump is approximately 75 percent recovery. Samples taken at the 0.2 depth point are grossly under-representative, and bottom samples are so erratic as to be of dubious value. The impact on results, and treatment plant efficiency studies in particular, is obvious.

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APPENDIX

DESCRIPTIONS OF SOME COMMERCIALLY AVAILABLE AND CUSTOM BUILT AUTOMATIC LIQUID SAMPLERS

INTRODUCTION

In this Appendix, the author has gathered together descriptions of some commercially available and custom built automatic liquid samplers of which he has personal knowledge. This material was prepared in early 1977, but should not necessarily be considered as complete. Many new companies are introducing commercially available equipment, and existing companies are adding liquid samplers to their product lines. The products themselves are rapidly changing also. Not only are innovations being made as field experience is gathered with new designs, but attention is also being paid to certain areas that had earlier been largely ignored. For example, several companies have introduced high velocity pumps that allow the gathering of a more representative sample when suspended solids are present, complete solid-state control electronics have been introduced by most manufacturers, multilevel sampling intakes are now available from at least one manufacturer, and the like. It is hoped that this material, even though somewhat incomplete, will be of interest and helpful to anyone with an automatic liquid sampling requirement, and that it can serve as a preliminary shopper's guide.

In order to facilitate the reader's comparison of the 102 descriptions that are presented, covering over 250 models of commercially available automatic samplers, a common format has been designed. A few words about the headings of this format are in order.

<u>Designation</u>: Identifies the particular sampler model that is being considered. In some instances, several models are described under the same general heading. This occurs when there does not appear to be a fundamental difference in the geometry or basic

principles of operation, but rather the manufacturer has chosen to give separate designations based upon the addition of certain features such as refrigeration or a weatherproof case.

Manufacturer: Lists the company that supplies the particular model in question, its address, and its telephone number.

Sampler Intake: Describes the part of the sampler that actually extracts fluid from the stream being sampled. It may be, for example, a supplied custom-designed intake probe, or a dipping bucket or scoop. However, many of the samplers do not provide any form of intake other than the end of a tube through which a sample is to be transported to the equipment.

Gathering Method: Addresses the method for gathering the sample and transporting it to its container. Three basic categories are identified: Mechanical, where dippers, scoops, etc. are utilized; Suction Lift, employing either evacuated vessels, vacuum pump, or mechanical pump; and Forced Flow, utilizing pneumatic ejection, a submerged pump, etc.

Sample Lift: Addresses the maximum vertical lift that the particular piece of equipment is capable of in operation.

Line Size: Describes the minimum line diameter of the sampling train wherever it may occur in the particular piece of equipment. Due to the presence of tube fittings, screens, valves, etc., in some designs, it does not necessarily represent maximum particle size.

Sample Flow Rate: Gives the flow rate of the sample as it is being transported within the sampling train of the piece of equipment in question.

Sample Capacity:	Addresses the size of the sample that is being collected. In the case of composite samplers, the aliquot size is also given.
Controls:	Addresses those controls within the sampler that can be utilized to vary its method of operation. For example, built-in timers and utilization of inputs from external flowmeters.
Power Source:	Gives the power source or sources that may be utilized to operate the equipment.
Sample Refrigerator:	Addresses the type of cooling that may be available to provide protection to collected samples.
Construction Materials:	Primary attention here has been devoted to the sampling train proper, although certain other materials such as case construction are also noted.
Basic Dimensions:	The overall package is described here in order to give the reader a general feel for the size of the unit. For those units that might be considered portable, a weight is also given. For units that are designed for fixed installations only, this fact is also noted.
Base Price:	The base price as quoted and effective in early 1977 is given here. Certain options or accessories that may be of general interest are also included with their prices. Prices are often far from static, and it is recommended that specific quotes be obtained, even for planning purposes.
General Comments:	Here any additional comments that are felt to be pertinent to the particular piece of equipment in question are given. This includes any additional descriptions that

are felt necessary in order to understand better the operating principles that are involved. Also included are certain performance claims that may be made by the manufacturer.

An index of the 102 descriptions of commercially available automatic liquid samplers is given, starting on page 78.

For a number of reasons, it has been the practice of some project engineers to custom design one-of-a-kind samplers for use in their projects. In this Appendix several examples of such equipment are reviewed. Inasmuch as there is no dearth of examples, it was necessary to be rather selective in order to keep the overall size of this Appendix within manageable bounds. Several practical considerations also favor less than 100 percent coverage. For example, no attempt has been made to dig back into history in order to examine older concepts and notions. It is felt that any good features in older designs, having proved themselves to be effective, would be incorporated in present day equipment. Furthermore, the major emphasis has been placed on recent USEPA project experience.

The same description and evaluation formats used for reviewing the commercially available samplers are used here with one exception. For these custom designed one-of-a-kind samplers, prices in terms of today's dollars are generally not available and, furthermore, the inevitable engineering changes that one would introduce in building equipment following a prototype would have cost impacts that are not easily assessed.

The samplers have been given names to correspond with either the developer or the project location. The descriptive forms and evaluations presented on the following pages are arranged roughly in chronological order of development, and an index is provided, starting on page 81.

INDEX OF COMMERCIALLY AVAILABLE SAMPLERS

INDEX OF COMMERCIALLY AVAILABLE SAMPLERS (Cont'd)

INDEX OF COMMERCIALLY AVAILABLE SAMPLERS (Cont'd)

INDEX OF CUSTOM DESIGNED SAMPLERS

Designation:	A&H MODEL WS-1000
Manufacturer:	A&H Enterprises 1711 South 133 Avenue Omaha, Nebraska 68144 Phone (402) 334-1976
Sampler Intake:	Weighted plastic strainer approximately 2.5 cm (1 in.) in diameter x 15 cm (6 in.) long and perforated with 0.3 cm (1/8 in.) holes.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	Up to 7m (24 ft).
Line Size:	Either 0.49 cm (3/16 in.) I.D. x 1 cm (3/8 in.) O.D. or 0.64 cm (1/4 in.) I.D. x 1 cm (3/8 in.) O.D.
Sample Flow Rate:	Up to 143 cm/sec (4.7 fps) or 85 cm/sec (2.8 fps); 1,000 or 1,680 mℓ/min factory selectable.
Sample Capacity:	Aliquot size selectable via a nine-position thumbwheel switch (timer); composited in a 3.8- to 18.8-ℓ (1- to 5-gal) container.
Controls:	All solid-state controller in separate enclosure from pump has switches for power, manual, reset/run, sample volume setting, time between samples, and timer or flowmeter pacing. Nonvolatile indicators for elapsed time and sample totalizer. Automatically provides 7-sec purge before and 20-sec purge after taking sample. Maximum sampler cycle is 2 min. Unit may be paced by any flowmeter providing a 60-ms minimum pulse duration (contact closure). TTL logic is computer compatible.
Power Source:	115 VAC.
Sample Refrigerator:	115 VAC refrigerator is available.

Construction Materials:	All plastic sampling train; case is 14-gage steel continuous hinge NEMA Type 12, JIC Standard EGP-1-1967.
Basic Dimensions:	36 x 30 x 15 cm (14x12x6 in.); weighs 11 kg (25 lb).
Base Price:	$1,500; automatic refrigerator is $375, additional pump head is $120, heater is $100, aluminum case is $125, stainless steel case is $225.
General Comments:	Has three-pump-head capability to allow sampling from three positions in flow to obtain better cross-sectional average or, alternately, to simultaneously gather three separate samples with one sampler. Simple or flow proportional compositing capability is switch selectable. Power fail and end-of-cycle alarm. Third- and fourth-generation integrated circuits; modular construction. Aliquot size for a given setting, although repeatable, will vary with lift and line length from site to site. Adjustable pre- and post-purge time periods available as an option.

Designation:	A&H MODEL WS-2000
Manufacturer:	A&H Enterprises 1711 South 133 Avenue Omaha, Nebraska 68144 Phone (402) 334-1976
Sampler Intake:	Weighted plastic strainer approximately 2.5 cm (1 in.) in diameter x 15 cm (6 in.) long and perforated with 0.3 cm (1/8 in.) holes.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	Up to 7m (24 ft).
Line Size:	Either 0.49 cm (3/16 in.) I.D. x 1 cm (3/8 in.) O.D. or 0.64 cm (1/4 in.) I.D. x 1 cm (3/8 in.) O.D.
Sample Flow Rate:	Up to 143 cm/sec (4.7 fps) or 85 cm/sec (2.8 fps); 1,000 or 1,680 mℓ/min factory selectable.
Sample Capacity:	Sensing cell allows digital metering of aliquot size, making it independent of lift or line length; aliquot size is selectable via a nine-position thumbwheel switch; composited in a 3.8- to 18.8-ℓ (1- to 5-gal) container.
Controls:	All solid-state controller in separate enclosure from pump has switches for power, manual, reset/run, sample volume setting, time between samples, and timer or flowmeter pacing. Nonvolatile indicators for elapsed time and sample totalizer. Automatically provides 7-sec purge before and 20-sec purge after taking sample. Optional anticlog cycle. Maximum sample cycle is 2 min. Unit may be paced by any flowmeter providing a 60-ms minimum pulse duration (contact closure). TTL logic is computer compatible.
Power Source:	115 VAC.

Sample Refrigerator:	115 VAC refrigerator is available.
Construction Materials:	All plastic sampling train; case is 14 gage steel continuous hinge NEMA Type 12, JIC Standard EGP-1-1967.
Basic Dimensions:	36 x 30 x 15 cm (14x12x6 in.); weighs 11 kg (25 lb).
Base Price:	$2,000; anticlog cycle is $200, other options priced as for Model WS-1000.
General Comments:	This unit is essentially similar to Model WS-1000 except that aliquot size is independent of lift or line length and anticlog cycle option is available. With this option, the sampler will revert to anticlog cycle after 40 sec of attempting to gather a sample. This consists of a purge period followed by a second attempt to gather a sample. If no sample is acquired after four times, the sampler will automatically reset and sound an alarm.

Designation:	A&H MODEL WS-3000
Manufacturer:	A&H Enterprises 1711 South 133 Avenue Omaha, Nebraska 68144 Phone (402) 334-1976
Sampler Intake:	Weighted plastic strainer approximately 2.5 cm (1 in.) in diameter x 15 cm (6 in.) long and perforated with 0.3 cm (1/8 in.) holes.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	Up to 7m (24 ft).
Line Size:	Either 0.49 cm (3/16 in.) I.D. x 1 cm (3/8 in.) O.D. or 0.64 cm (1/4 in.) I.D. x 1 cm (3/8 in.) O.D.
Sample Flow Rate:	Up to 143 cm/sec (4.7 fps) or 85 cm/sec (2.8 fps); 1,000 or 1,680 mℓ/min factory selectable.
Sample Capacity:	Sensing cell allows digital metering of aliquot size making it independent of lift or line length; aliquot size is manually selectable via a nine-position thumbwheel switch or by input from external flowmeter, depending on mode; composited in a 3.8- to 18.8-ℓ (1- to 5-gal) container.
Controls:	All solid-state controller in separate enclosure from pump has switches for power, manual, reset/run, sample volume setting, time between samples, and timer or flowmeter pacing. Nonvolatile indicators for elapsed time and sample totalizer. Automatically provides 7-sec purge before and 20-sec purge after taking sample. Optional anticlog cycle. Maximum sample cycle is 2 min. Unit may be paced by any flowmeter providing a 60-ms minimum pulse duration (contact closure). TTL logic is computer compatible.

Power Source:	115 VAC.
Sample Refrigerator:	115 VAC refrigerator is available.
Construction Materials:	All plastic sampling train; case is 14 gage steel continuous hinge NEMA Type 12, JIC Standard EGP-1-1967.
Basic Dimensions:	36 x 30 x 15 cm (14x12x6 in.); weighs 11 kg (25 lb).
Base Price:	$3,000; options priced as for Model WS-2000.
General Comments:	This unit is essentially similar to Model WS-2000 except that, in the flow proportional compositing mode, the aliquot size is varied in proportion to the instantaneous flow rate (TcVv). An appropriate external flowmeter is also required to accomplish this.

Designation:	ADVANCED MODEL 521
Manufacturer:	Advanced Instrumentation, Inc. P.O. Box 2216 Santa Cruz, California 95063 Phone (408) 423-8317
Sampler Intake:	Weighted intake at end of 6.4m (21 ft) sampling tube.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	Up to 6.4m (21 ft).
Line Size:	0.95 cm (3/8 in.) I.D.
Sample Flow Rate:	0.6-2 m/s (2-6 fps); adjustable.
Sample Capacity:	Composites adjustable size aliquots, from 50 to 1000 mℓ, in a 19ℓ (5 gal) container. Adaptable to 57ℓ (15 gal) containers.
Controls:	Unit may be paced by the contact closure output of an external flowmeter or by an internal crystal controlled timer with fixed intervals from 2.5 minutes to 24 hours. Sample size is adjustable by positioning end of syphon in metering chamber. Sample-taking sequence times are readily field adjustable.
Power Source:	115 VAC.
Sample Refrigerator:	Automatic refrigerator to maintain sample at 40°C is available.
Construction Materials:	Sampling train is all plastic, polyethylene or glass sample containers are available; standard housing is ventilated NEMA 3R with urethane coating suitable for outdoor use.
Basic Dimensions:	Basic controller and metering chamber are 64 x 57 x 20 cm (25x22.5x 8 in.); weighs 12 kg (26 lbs). Case is 157 x 84 x 65 cm (62x33x 26 in.); total weight 105 kg (230 lbs). Fixed installation.

Base Price: $2,250; add $525 for refrigerator.

General Comments: Typical cycle begins with compressor purging metering chamber and intake line with air for 6 seconds. A solenoid valve inverts compressor lines to create a vacuum in the metering chamber, and liquid is drawn up until it is full as detected by an electronic sensor (up to 30 seconds). The solenoid valve then reverses and the metering chamber is again pressurized, forcing the excess sample back out the intake hose (6 seconds). A pinch valve then opens, permitting the premeasured sample remaining to be forced into the sample bottle (6 seconds), and then closes, permitting purge to continue for 6 seconds. Unit automatically recycles once if metering chamber is not filled within 30 seconds. Sampler ceases operation when a present sample quantity (as determined by weight) is in the container. Housing also available fully insulated with thermostatically controlled heater for winter operation.

Designation:	ADVANCED MODEL 524
Manufacturer:	Advanced Instrumentation, Inc. P.O. Box 2216 Santa Cruz, California 95063 Phone (408) 423-8317
Sampler Intake:	Weighted intake at end of 6.4m (21 ft) sampling tube.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	Up to 6.4m (21 ft).
Line Size:	0.95 cm (3/8 in.) I.D.
Sample Flow Rate:	0.6-2 m/s (2-6 fps); adjustable.
Sample Capacity:	Collects 24 sequential composite one liter samples made up one to ten aliquots per bottle.
Controls:	Unit may be paced by the contact closure output of an external flow-meter or by an internal crystal controlled timer with fixed intervals from 2.5 minutes to 24 hours. Sample size is adjustable by positioning end of syphon in metering chamber. Sample-taking sequence times are readily field adjustable. Controller can put up to ten aliquots into each bottle or put one sample in each of up to ten bottles.
Power Source:	115 VAC.
Sample Refrigerator:	Automatic refrigerator to maintain sample at 40°C is available.
Construction Materials:	Sampling train is all plastic, polyethylene or glass sample containers are available; standard housing is ventilated NEMA 3R with urethane coating suitable for outdoor use.
Basic Dimensions:	Basic controller and metering chamber are 64 x 57 x 20 cm (25x22.5x 8 in.); weighs 12 kg (26 lbs).

Case is 157 x 84 x 65 cm (62x33x26 in.); total weight 105 kg (230 lbs). Fixed installation.

Base Price: $3,480; add $490 for refrigerator.

General Comments: Basic operation is similar to Model 521. The discrete sample storage module consists of 24 one-liter, square sample bottles, arranged 12 bottles in each of two identical carry boxes. Polyethelene or glass "French square" bottles are supplied. The unit ceases operation after the 24th bottle is filled. A combination composite/discrete sampler, that has features of both Model 521 and 524 is available, designated as Model 527. Conversion from one mode to the other takes less than 15 minutes.

Designation:	ADVANCED MODEL 551
Manufacturer:	Advanced Instrumentation, Inc. P.O. Box 2216 Santa Cruz, California 95063 Phone (408) 423-8317
Sampler Intake:	Weighted intake at end of 6.4m (21 ft) sampling tube.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	Up to 5.5m (18 ft).
Line Size:	0.95 cm (3/8 in.) I.D.
Sample Flow Rate:	0.6-2 m/s (2-6 fps); adjustable.
Sample Capacity:	Composites adjustable size aliquots, from 50 to 1000 mℓ, in a 19ℓ (5 gal) container. Adaptable to 57ℓ (15 gal) containers.
Controls:	Unit may be paced by a pressure pulse output from an external flowmeter or by an internal, all pneumatic timer adjustable from 5 to 100 minutes. Sample size is adjustable by positioning end of syphon in metering chamber. Sample-taking sequence times are readily field adjustable.
Power Source:	80 psig compressed air; maximum delivery rate of 2 SCFM for 30 seconds.
Sample Refrigerator:	Insulated housing suitable for ice cooling is available.
Construction Materials:	Sampling train is all plastic, polyethylene or glass sample containers are available; standard housing is ventilated NEMA 3R with urethane coating suitable for outdoor use.
Basic Dimensions:	Basic controller and metering chamber are 64 x 57 x 20 cm (25x22.5x 8 in.); weighs 12 kg (26 lbs).

Case is 157 x 84 x 65 cm (62x33x 26 in.); total weight 105 kg (230 lbs). Fixed installation.

Base Price: $4,500.

General Comments: This is an explosion proof, all pneumatic device. Operation is otherwise similar to Model 521. Unit requires approximately 1 SCF of air per cycle. Explosion proof, all pneumatic heating/cooling available. Repeated purge option is available, but must be ordered with the unit.

Designation:	ADVANCED MODEL 554
Manufacturer:	Advanced Instrumentation, Inc. P.O. Box 2216 Santa Cruz, California 95063 Phone (408) 423-8317
Sampler Intake:	Weighted intake at end of 6.4m (21 ft) sampling tube.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	Up to 5.5m (18 ft).
Line Size:	0.95 cm (3/8 in.) I.D.
Sample Flow Rate:	0.6-2 m/s (2-6 fps); adjustable.
Sample Capacity:	Collects 24 sequential composite one-liter samples made up of one to ten aliquots per bottle.
Controls:	Unit may be paced by a pressure pulse output from an external flowmeter or by an internal, all pneumatic timer adjustable from 5 to 100 minutes. Sample size is adjustable by positioning end of syphon in metering chamber. Sample-taking sequence times are readily field adjustable. Controller can put up to ten aliquots into each bottle or put one sample in each of up to ten bottles.
Power Source:	80 psig compressed air; maximum delivery rate of 2 SCFM for 30 seconds.
Sample Refrigerator:	Insulated housing suitable for ice cooling is available.
Construction Materials:	Sampling train is all plastic, polyethylene or glass sample containers are available; standard housing is ventilated NEMA 3R with urethane coating suitable for outdoor use.
Basic Dimensions:	Basic controller and metering chamber are 64 x 57 x 20 cm (25x22.5x 8 in.); weighs 12 kg (26 lbs).

	Case is 157 x 84 x 65 cm (62x33x 26 in.); total weight 105 kg (230 lbs). Fixed installation.
Base Price:	$7,600.
General Comments:	Basic operation is similar to Model 551. The discrete sample storage module consists of 24 one-liter, square sample bottles, arranged 12 bottles in each of two identical carry boxes. Polyethelene or glass "French square" bottles are supplied. The unit ceases operation after the 24th bottle is filled. A combination composite/discrete sampler, that has features of both Model 551 and 554 is available, designated as Model 557. Conversion from one mode to the other takes less than 15 minutes.

Designation:	BESTEL-DEAN MARK II
Manufacturer:	Bestel-Dean Limited 92 Worsley Road North, Worsley Manchester, England M28 5QW Phone FARNWORTH 75727
Sampler Intake:	End of 6.10m (20 ft) long suction tube installed to suit by user.
Gathering Method:	Suction lift (from a Watson-Marlow type MHRK fixed speed flow inducer).
Sample Lift:	6.10m (20 ft) maximum lift.
Line Size:	0.64 cm (1/4 in.) I.D.
Sample Flow Rate:	Approximately 690 mℓ per minute.
Sample Capacity:	Composites adjustable size aliquots from 5 mℓ to 2 liters in an external user-supplied sample container. With optional portable bottler, the unit takes 24-250 mℓ discrete samples.
Controls:	Sample timer which controls sample volume is adjustable from 1 to 4 minutes, interval timer from 5 to 60 minutes, and purge timer from 1 to 4 minutes, all being controlled by a solid state unit having three adjustable timers. The sampling cycle can be initiated by a test button, by the internal pre-set timer, or by remote pulse from an external flowmeter.
Power Source:	115/230 VAC or 12 VDC.
Sample Refrigerator:	None.
Construction Materials:	Casing and base are reinforced fiberglass, tubing is neoprene.
Basic Dimensions:	61 x 37 x 28 cm (24x14.5x11 in.) in operational state; weight is 10.65 kgs (23.5 lbs) less battery; portable unit. Bottler is 30.5 cm (12 in.) H x 38 cm (15 in.) dia.

<u>Base Price</u>:	Not available at time of writing.
<u>General Comments</u>:	Unit is also designed to work as a discrete sampler when used in conjunction with the Bestel-Dean portable bottler unit. All controls are front panel, solid state. Unit is fully portable. Battery unit and sample container must be supplied by user.

Designation:	BESTEL-DEAN CRUDE SEWAGE SAMPLER
Manufacturer:	Bestel-Dean Limited 92 Worsley Road North, Worsley Manchester, England M28 5QW Phone FARNWORTH 75727
Sampler Intake:	End of 6.10m (20 ft) long suction tube fitted with a special deflector and strainer and installed to suit by user.
Gathering Method:	Suction lift from progressive cavity screw-type pump.
Sample Lift:	6.10m (20 ft) maximum lift.
Line Size:	1.9 cm (3/4 in.) I.D.
Sample Flow Rate:	Unknown.
Sample Capacity:	Collects either 24 discrete 250 mℓ samples or a 25 liter composite made up of 250 mℓ aliquots.
Controls:	Cycle timer is adjustable for settings from 0-4-1/2 hours with minimum time setting of 12 minutes. Purge timer can be set for up to 13-1/2 minutes with a minimum of 30 seconds. May also be paced by an external flowmeter.
Power Source:	240 VAC.
Sample Refrigerator:	None.
Construction Materials:	The pipework system with valves and sample container are plastic. Casing is weatherproof sheet steel with an epoxy resin coating. Pump rotor is stainless steel and stator is nitrile rubber.
Basic Dimensions:	76 x 76 x 107 cm (30x30x42 in.). Designed for fixed installation.
Base Price:	Not available at time of writing.

General Comments: Discharge line should be located downstream from suction line to prevent possible contamination of new sample. On installations where flow integrating equipment does not have available a suitable pulsing contact, a load-free impulse device which can be adapted to any flowmeter is optionally available. A solid state electronic power unit is available as an option for use with the impulse unit. Standard equipment is set to take a 250 mℓ volume aliquot. Other volumes, between 250 mℓ and 100 mℓ, can be supplied by special order. Thermostat for heater is optionally available.

Designation:	BIF SANITROL FLOW-RATIO MODEL 41
Manufacturer:	BIF Sanitrol 1800 12th Street S.E. Largo, Florida 33540 Phone (813) 584-2157
Sampler Intake:	Dipping bucket.
Gathering Method:	Mechanical; dipper on sprocket-chain drive.
Sample Lift:	41 cm (16 in.) to 7.6m (25 ft).
Line Size:	2.5 cm (1 in.) O.D. tube connects collection funnel to sample container.
Sample Flow Rate:	Not applicable.
Sample Capacity:	Dipping buckets hold either 30 or 177 mℓ (1 or 6 oz); aliquots composited in either a 3.8, 7.6 or 18.9ℓ (1, 2 or 5 gal) container.
Controls:	Cam-type programmer allows samples to be taken at fixed, selected intervals from a built-in timer (15, 7.5, 3.75, or 1.88 minutes) or in response to signals from an external flowmeter.
Power Source:	115 VAC.
Sample Refrigerator:	Separate automatic refrigerated sample compartment available.
Construction Materials:	Dipper and funnel are stainless steel; sprockets and chain are stainless steel; housing is fiberglass or stainless steel. New, all plastic model features fiberglass case and cover, Hytrel belt, and nylon pulleys and hardware.
Basic Dimensions:	Upper portion is approximately 24 x 24 x 20 cm (9x9x8 in.); lower portion is 24 x 10 cm (9x4 in.); fixed installation.

Base Price: Prices start at $670 for standard plastic unit 16 in. long; add $50 per foot (0.3m) for additional length. For stainless steel price is $825 plus $60 per foot (0.3m).

General Comments: Manufacturer states unit was designed to sample raw or effluent wastes. Two basic models are available, standard and industrial, the latter intended for applications where mixed wastes are present such as a paper mill where wood chips and fiber are present in waste liquid. Sampling cup can come within 5 cm (2 in.) of the invert. Adapters for manhole operation are available as are heaters and thermostats for winter operation. One refrigerated model, fed at 15-20 gpm by user supplied head, contains a tank housing with an adjustable overflow weir that compensates for changes in the flow to maintain a constant liquid depth from which samples are taken.

Designation:	BIF MODEL 43
Manufacturer:	BIF Sanitrol 1800 12th Street S.E. Largo, Florida 33540 Phone (813) 584-2157
Sampler Intake:	Provided by user; sampler has standard 5 cm (2 in.) pipe inlet.
Gathering Method:	External head to provide flow through a sampling chamber from which a rotating dipper extracts a sample aliquot and transfers it to a funnel where it is gravity fed to a composite bottle.
Sample Lift:	Not applicable.
Line Size:	2.5 cm (1 in.) I.D.
Sample Flow Rate:	38 to 189 ℓ/m (10 to 50 gpm).
Sample Capacity:	Standard scoop is 25 mℓ, larger sizes available; 3.8, 7.6 or 18.9ℓ (1, 2, or 5 gal) sample containers.
Controls:	Unit is paced by external flowmeter or built-in crystal timer with sampling intervals adjustable to 99.99 minutes in 0.01 minute steps.
Power Source:	115 VAC.
Sample Refrigerator:	Automatic refrigerator to maintain sample at 4°C is available.
Construction Materials:	Sampling train is all plastic, fiberglass case.
Basic Dimensions:	70 x 70 x 152 cm (27.5x27.5x60 in.); fixed installation.
Base Price:	$2,490; add $400 for refrigerator.
General Comments:	All solid state electronics. Sampling chamber has adjustable weir plate to regulate liquid level.

Designation:	BIF SERIES 46 VACUUM SAMPLER
Manufacturer:	BIF Sanitrol 1800 12th Street S.E. Largo, Florida 33540 Phone (813) 584-2157
Sampler Intake:	End of suction tube.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	Probably up to around 6m (20 ft).
Line Size:	1 cm (3/8 in.) I.D.
Sample Flow Rate:	Probably around 12 ℓps (3 gpm) or less depending upon lift.
Sample Capacity:	Composites adjustable size aliquots, from 50 to 1000 mℓ, in a 9.5ℓ (2-1/2 gal) container.
Controls:	Unit may be paced by an internal crystal controlled timer adjustable from 1 to 99 minutes or by an external flowmeter providing a pulse for each 100 or 1000 gallons of flow, in which case the sampling interval is adjustable from 100 to 9,900 or 1000 to 99,000 gallons in 100 or 1000 gallon steps. The purge duration can be set from 1 to 30 seconds in 1 second steps. Sample size is adjustable by positioning end of sensor in metering chamber.
Power Source:	115 VAC or 12 VDC or both.
Sample Refrigerator:	Automatic refrigerator to maintain sample at 4°C is available.
Construction Materials:	Sampling train is all plastic, glass, and stainless steel; NEMA 12 cabinet with epoxy paint finish.
Basic Dimensions:	53 x 66 x 165 cm (21x26x65 in.); portable.

Base Price:	$1,990; add $400 for refrigerator, $1,500 for weatherproof outdoor version, $2,000 for walk-in outdoor version.
General Comments:	Unit is manufactured for BIF by Fluid Kinetics, Inc. and is essentially similar to their Stream-Guard Model FTV.

Designation:	BIF SERIES 46 PUMPING SAMPLER
Manufacturer:	BIF Sanitrol 1800 12th Street S.E. Largo, Florida 33540 Phone (813) 584-2157
Sampler Intake:	End of suction tube.
Gathering Method:	Suction lift by peristaltic or positive displacement pump.
Sample Lift:	9m (30 ft) maximum.
Line Size:	0.64 cm (1/4 in.) I.D. or larger depending upon requirements.
Sample Flow Rate:	Depends upon lift and pump chosen.
Sample Capacity:	Composites adjustable size aliquots, based on pump running time, in a 9.5ℓ (2-1/2 gal) container.
Controls:	Unit may be paced by an internal crystal controlled timer adjustable from 1 to 99 minutes or by an external flowmeter providing a pulse for each 100 or 1000 gallons of flow, in which case the sampling interval is adjustable from 100 to 9,900 or 1000 to 99,000 gallons in 100 to 1000 gallon steps. The backflush duration is continuously adjustable up to 120 seconds.
Power Source:	115 VAC or 12 VDC or both.
Sample Refrigerator:	Automatic refrigerator to maintain sample at 4°C is available.
Construction Materials:	Sampling train is all plastic, silicon, rubber, and stainless steel; steel cabinets with epoxy paint finish.
Basic Dimensions:	Controllers and pump are housed in three separate cases that are installed in a cabinet sized to suit user requirements.

Base Price: $1,490; add $400 for refrigerator, $1,500 for weatherproof outdoor version, $2,000 for walk-in outdoor version.

General Comments: This sampler is manufactured for BIF by Fluid Kinetics, Inc. and is similar to their StreamGuard Model CSO-142.

Designation:	BRAILSFORD MODEL DC-F
Manufacturer:	Brailsford and Company, Inc. Milton Road Rye, New York 10580 Phone (914) 967-1820
Sampler Intake:	End of 1.8m (6 ft) long sampling tube; weighted and fitted with 50 mesh strainer.
Gathering Method:	Suction lift by positive displacement pump.
Sample Lift:	Pump is capable of 3m (10 ft) lift but manufacturer recommends that lift be restricted to 0.9 to 2.1m (3 to 7 ft).
Line Size:	0.48 cm (3/16 in.) I.D.
Sample Flow Rate:	Adjustable from about 1.6 to 9.8 mℓ (0.1 to 0.6 cu in.) per minute.
Sample Capacity:	Pump output is collected in a 7.6ℓ (2 gal) jug.
Controls:	Pump stroke is adjustable by means of a slotted yoke on the piston rod. On/Off Switch.
Power Source:	6 VDC dry cell battery.
Sample Refrigerator:	None.
Construction Materials:	Stainless steel, teflon, vinyl, polyethylene; case is laminated Formica-wood construction, plastic rain boot.
Basic Dimensions:	48 x 30.5 x 24 cm (19x12x9.5 in.); weighs 8.5 kg (19 lbs) empty; portable.
Base Price:	$296.
General Comments:	Pump is valveless oscillating cylinder type. No lubrication is required for the life of the unit. Driven by a brushless D.C. motor of

patented design with a service life in excess of 3,000 hours. Continuous running pump is automatically shut off when sample jug is full.

Model EP is an explosion proof unit that is basically similar to the DC-F except for the housing. It also provides the pressure of a 10 cm (4 in.) water column on the sample to prevent the loss of volatile fractions or dissolved gases. A choice of 3.8ℓ (1 gal) sample containers (rectangular can or polyethylene bottle) is available. Price is $373.

A Model DU-2 is also available at $373. It is essentially a Model DC-F with the addition of an electronic timing circuit which can set the pumping rate for a sample frequency of between 1.75 and 13 minutes. An optional head detector is available for use with a weir to achieve a form of flow proportional sampling. Plugging in the head detector disconnects the timing circuit. The head detector is basically an array of magnetic switches connected to a series string of resistors and sealed within an insulating strip. A float containing a magnet slides up and down the strip as the water level changes, thereby altering the resistance in the circuit and, hence, the pumping rate. Price of the head detector is $98. The DU-2 can also be paced by an external flowmeter which provides momentary contact closures at a rate proportional to flow.

Designation:	BRAILSFORD MODEL EVS
Manufacturer:	Brailsford and Company, Inc. Milton Road Rye, New York 10580 Phone (914) 967-1820
Sampler Intake:	End of 3.7m (12 ft) long sampling tube fitted with a molded plastic inlet scoop-strainer to help prevent blockage by rags, paper, etc.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	3.7m (12 ft) maximum.
Line Size:	0.48 (3/16 in.) I.D.
Sample Flow Rate:	Depends upon lift, but under 5 mℓ per minute.
Sample Capacity:	A 3.8ℓ (1 gal) composite sample is accumulated from small adjustable size aliquots.
Controls:	A control switch permits the choice of four timing intervals which will cause a 3.8ℓ (1 gal) sample to be collected in either 8, 16, 24 or 48 hours. The unit may also be paced by the head detector described under Model DC-F or an external flowmeter.
Power Source:	115 VAC or 12 VDC electricity.
Sample Refrigerator:	None.
Construction Materials:	Sampling train is all plastic; case is laminated Formica-wood construction.
Basic Dimensions:	30.5 x 23 x 48 cm (12 x 9 x 19 in.); weighs 8.5 kg (19 lbs) empty; portable.
Basic Price:	\$520 115 VAC \$627 with N. Cad battery \$672 with N. Cad battery and AC power unit.

General Comments: Unit was designed for flows with a high percentage of suspended solids or where volatiles are present. Sample never passes through pump or valves or orifices which could become clogged. In operation, a small vacuum pump evacuates air from a small metering chamber to which the sample bottle and inlet tube are connected. When chamber is filled to a predetermined level, a magnetic sensing switch stops the pump and opens a vacuum relief valve so a portion of the sample flows into the jug and the remainder backflushes the inlet tube.

Designation:	BRISTOL ISOLOK SERIES M-4
Manufacturer:	Bristol Engineering Company 204 South Bridge Street Yorkville, Illinois 60560 Phone (312) 553-7161
Sampler Intake:	A dual piston plunger acting through a hole in the pipe wall.
Gathering Method:	Positive displacement action; cannot provide lift or pump any appreciable lateral distance.
Sample Lift:	Unit must be mounted on a pressurized pipe or below free liquid surface.
Line Size:	Smallest passage appears to be approximately 1 cm (318 in.).
Sample Flow Rate:	Not applicable.
Sample Capacity:	Fixed size aliquots, 3 mℓ or 9 mℓ, are composited in a suitable container from 0.1 to 3.8ℓ (4 to 128 oz) or larger.
Controls:	Unit may be paced by internal timer from 20 samples per minute to one sample every 6 minutes or by an external flowmeter.
Power Source:	80 psig air for all pneumatic models; 115 VAC required for electronic controller model.
Sample Refrigerator:	None.
Construction Materials:	All stainless steel and plastic.
Basic Dimensions:	Approximately 5 cm (2 in.) diameter by 20 cm (8 in.) long plus size of sample container; weighs 2.3 kg (5 lbs) base; fixed installation.
Base Price:	Typically under $1,000 for a complete system.

General Comments: Unit was designed to sample hostile process flows and slurries. Pneumatic ejection of sample is optional. Manufacturer claims unit will handle solids up to 0.8 cm (5/16 in.) diameter.

Designation:	BVS MODEL PP-100
Manufacturer:	Brandywine Valley Sales Company 20 East Main Street Honey Brook, Pennsylvania 19344 Phone (215) 273-2841
Sampler Intake:	Plastic cylindrical sampling probe which is gravity filled. A row of small holes around the circumference near the bottom forms an inlet screen; weighted base.
Gathering Method:	Forced flow due to pneumatic ejection.
Sample Lift:	Up to 85m (280 ft); requires one pound of pressure for every 0.6m (2 ft) of vertical lift.
Line Size:	0.3 cm (1/8 in.) I.D.
Sample Flow Rate:	Depends upon pressure setting and lift.
Sample Capacity:	Sample chamber volume is 50 mℓ; sample composited in 9.5ℓ (2.5 gal) jug in standard model or 5.7ℓ (1.5 gal) jug in refrigerated model.
Controls:	Pressure regulator connecting gas supply is set between 0.35 and 9.8 kg/sq cm (5 and 140 psi) depending upon lift required; sampling interval timer is adjustable to allow from 2 seconds to 60 minutes to elapse between aliquots; manual on/off switch standard. Optional control package accepts signals from external flowmeter or totalizer.
Power Source:	One 6.8 kg (15 lb) can of refrigerant is standard gas source; 12 VDC or 117 VAC required for refrigerated models or flow proportional control option.
Sample Refrigerator:	Model PPR-100 offers an absorption refrigerator cooled sample case.

<u>Construction Materials</u>:	Sampling probe is PVC standard, Teflon or stainless steel available; plastic sampling line standard, Teflon available; polyethylene sample container; Armorhide finished aluminum case.
<u>Basic Dimensions</u>:	Non-refrigerated - 35.6 x 35.6 x 53.3 cm (14x14x21 in.); refrigerated - 43.2 x 55.9 x 43.2 cm (17x22x17 in.); both models portable.
<u>Base Price</u>:	\$853 for basic unit including 50 mℓ sampling probe, one 6.8 kg (15 lb) cylinder of R-12, and three 6.1m (20 ft) lengths of tubing. Refrigerated model PPR-100 is \$1150. Add \$100 for winterizing system; \$275 for solid state control package for flow proportional operation.
<u>General Comments</u>:	Timing circuits are controlled by fluidic and pneumatic components. Absorption refrigerator has no moving parts. After each aliquot is gathered, the inlet strainer of the sampling probe is purged by vent pressure from timing valve. Two year parts and labor warranty. Alternate sampling probes available include a surface sampling probe for surface oil, vertical stratum sampling probe for sampling at 15 cm (6 in.) depth intervals, and float mounted probes for sample quantity accuracy that is independent of head.

Designation: BVS MODEL PE-400

Manufacturer: Brandywine Valley Sales Company
20 East Main Street
Honey Brook, Pennsylvania 19344
Phone (215) 273-2841

Sampler Intake: PVC screen over pump inlet.

Gathering Method: Forced flow from submersible pump.

Sample Lift: 9.8m (32 ft) maximum.

Line Size: 1.3 cm (1/2 in.) I.D. inlet hose.

Sample Flow Rate: 3.8-7.6 ℓpm (1-2 gpm) typical.

Sample Capacity: Aliquot volume is a function of the preset diversion time; sample composited in 9.5ℓ (2.5 gal) container.

Controls: Unit operates on a continuous flow principle, returning uncollected flow to waste. Sample is pumped through a stainless steel, nonclogging diverter valve. Upon receiving a signal from either the built-in timer or an external flowmeter, the unit diverts the flow for a preset period of time (adjustable from 0.02 to 1.0 seconds) to the sample container.

When operating in the timed sampling mode, the sampling frequency rate is continuously adjustable from 0.2 seconds to 60 hours. When operating in the flow-proportional mode the sampler is triggered directly by the external flowmeter.

Power Source: 115 VAC electricity.

Sample Refrigerator: Model PER-400 is refrigerated, but case is not weather-proof.

Construction Materials: Sampling train, PVC, stainless steel, plastic, polyethylene, cabinet is aluminum with Armorhide finish.

Basic Dimensions: Non-refrigerated - 35.6 x 35.6 x 53.3 cm (14x14x21 in.); refrigerated - 53.3 x 58.4 x 96.5 cm (21x 23x38 in.); both models portable.

Base Price: $1,500 including 6.1m (20 ft) of 2.1 cm (13/16 in.) O.D. x 1.3 cm (1/2 in.) I.D. nylon reinforced plastic inlet tubing, 6.1m (20 ft) of 3.5 cm (1-3/8 in.) O.D. x 2.5 cm (1 in.) I.D. nylon reinforced plastic tubing for waste return, clamps, pump support bracket, pump strainer, pump with 11m (36 ft) cord, and flow proportional connection cable. For refrigerator add $300; for 30 day strip chart recorder add $260. Model PE-500 at $1,700 is similar but designed for high flow rates and solids sizes to 1.9 cm (3/4 in.) and does not include pump, tubing, clamps or sample container. Model PE-600 at $1,950 is similar to Model PE-500 but has dual-solenoid diversion valve and passes solids to 4.4 cm (1.75 in.).

General Comments: Submersible pump has magnetic drive, is self-priming. Manufacturer claims design will handle solids to 0.95 cm (3/8 in.) diameter.
Model SE-400 is a refrigerated version designed for fixed installations and priced at $3,000. It is housed in a 66 x 76 x 122 cm (26x 30x48 in.) weather-proof case on 20 cm (8 in.) legs with a thermostatically controlled heater, vent system to control moisture, and manual sample take-off line.
Model SE-800 is similar to SE-400 but can take 24-500 mℓ discrete samples or a 19ℓ (5 gal) composite sample. It has an inkless strip-chart event recorder and is priced at $5,650. Model SE-500 is similar to PE-500 with additional features of SE-400 and is priced at $3,200; Model SE-600 is similar to PE-600 with additional features of SE-400 except 19ℓ (5 gal) sample container

and is priced at $3,600. SE prices include installation, start-up, and operator training by BVS. Two-year warranty on parts and labor for all models. Life-time warranty on sample diversion valve.

Designation:	BVS MODEL PPE-400
Manufacturer:	Brandywine Valley Sales Company 20 East Main Street Honey Brook, Pennsylvania 19344 Phone (215) 273-2841
Sampler Intake:	Plastic cylindrical sampling probe which is gravity filled. A row of small holes around the circumference near the bottom forms an inlet screen; weighted base.
Gathering Method:	Forced flow due to pneumatic ejection.
Sample Lift:	Up to 85m (280 ft); requires one pound of pressure for every 0.6m (2 ft) of vertical lift.
Line Size:	0.3 cm (1/8 in.) I.D.
Sample Flow Rate:	Depends upon pressure setting and lift.
Sample Capacity:	Sample chamber volume is 50 mℓ; sample composited in 9.5ℓ (2.5 gal) container.
Controls:	Pressure regulator connecting gas supply is set between 0.35 and 9.8 kg/sq cm (5 and 140 psi) depending upon lift required; 0.5 to 100 second sample duration; otherwise similar to Model PE-400.
Power Source:	115 VAC plus pressurized gas supply.
Sample Refrigerator:	Model PPER-400 is refrigerated, but case is not weatherproof.
Construction Materials:	Sampling probe is PVC standard; teflon and stainless steel are available. Plastic sampling line standard; teflon is available;

Polyethylene sample container; Armorhide finished aluminum case.

Basic Dimensions: Non-refrigerated - 35.6 x 35.6 x 53.3 cm (14x14x21 in.); refrigerated - 53.3 x 58.4 x 96.5 cm (21x23x28 in.); both models portable.

Base Price: Basic unit handling up to 0.3 cm (1/8 in.) solids is $1,450; Model PPE-500 for solids up to 0.6 cm (1/4 in.) is $1,600; Model PPE-600 for solids up to 0.95 cm (3/8 in.) is $1,750; Model PPE-700 for solids up to 1.3 cm (1/2 in.) is $2,000; add $300 for refrigerated version. Stationary (SPE) models with features of the SE-400 (except for flow-regulating valves and manual sample take-off line) are about $1,600 more than comparable PPE models.

General Comments: Basic unit is similar to PE-400 but utilizes pressure to lift the sample as does model PP-100.

Designation: COLLINS MODEL 40 COMPOSITE SAMPLER

Manufacturer: Collins Products Company
P.O. Box 382
Livingston, Texas 77351
Phone (713) 327-4200

Sampler Intake: Provided by user.

Gathering Method: External head to provide continuous flow through the sampler. A portion of this flow is diverted to a metering standpipe from which it is periodically dumped into the sample container.

Sample Lift: Not applicable.

Line Size: The smallest passage is 0.2 cm (3/32 in.) in the solenoid valve; 0.5 cm (3/16 in.) with optional ball valve.

Sample Flow Rate: User must provide a minimum pressure of 0.14 kg/sq cm (2 psi) for a flow of 3.8-7.6 ℓpm (1-2 gpm).

Sample Capacity: Fixed size (normally 3 mℓ) aliquots are composited in a 9.5ℓ (2.5 gal) collapsible plastic container.

Controls: Same as Model 42 except built-in timer normally triggers every 30 seconds.

Power Source: 115 VAC.

Sample Refrigerator: Automatic refrigerator to maintain sample at 4-10°C is available as an option.

Construction Materials: Sampling train would appear to be plastic, stainless steel, and brass. Casing is corrosive-resistant fiberglass. The refrigerated model has a baked enamel-covered steel enclosure with plastic interior.

Basic Dimensions: Weatherproof enclosures for refrigerator models are 76 x 61 x 183 cm (30x24x72 in.); designed for fixed installation.

Base Price: \$835; add \$610 for refrigerator in weather-proof enclosure; \$210 for ball valve model; and \$27 for delay relay, \$300 for predetermined counter, or \$630 for integrating flow proportional operation.

General Comments: This unit uses a single three-way valve and a vertical standpipe through which a portion of the continuous flow from an external pump or other pressure source is circulated before going to drain.

The standpipe assembly measures the amount of sample taken. Flow is maintained in a turbulent state to keep solids suspended. Sample through sampler continuously purges out system when sample pulse switch is in off position. Sampler was originally designed to take samples from pressurized systems such as pipelines. A wood or angle iron frame is optionally available for mounting the sampler, pump, and motor. In the refrigerated Model 40, the electronics and standpipe assembly is mounted on top of the refrigerator with the collection tube running inside. The refrigerated model is non-explosionproof and housing should be provided for it. A thermostat-controlled heater is optionally available for cold weather operation.

Designation:	COLLINS MODEL 42 COMPOSITE SAMPLER
Manufacturer:	Collins Products Company P.O. Box 382 Livingston, Texas 77351 Phone (713) 327-4200
Sampler Intake:	Provided by user.
Gathering Method:	External head to cause sample to flow continuously through a standpipe assembly until two, three-way valves are energized, whereupon incoming and return flows are blocked and the sample trapped in the standpipe drains into the collection container. Suction lift from vacuum pump available.
Sample Lift:	Not applicable.
Line Size:	The smallest passage is 1.6 cm (5/8 in.) in the sampling valve.
Sample Flow Rate:	As provided by user; minimum of 3.8 ℓpm (1 gpm) at a minimum pressure of 0.14 kg/sq cm (2 psi).
Sample Capacity:	Fixed size (10, 15, 20, or 25 mℓ) aliquots are composited in a 9.5ℓ (2.5 gal) collapsible plastic container. 19ℓ (5 gal) container available.
Controls:	Constant rate sampling adjustable range of 0.1 to 99 minutes is controlled by built-in timer; flow proportional operation achieved by connecting to external flow totalizer providing either a contact closure or a pulse (24 VDC, 115 VDC, or 115 VAC), or to a 0.2 to 1.1 kg/sq cm (3 to 15 psi) pressure source proportional to flow depth (linear, 1/2, 3/2, and 5/2 exponent laws available).
Power Source:	115 VAC.

<u>Sample Refrigerator</u>:	Automatic refrigerator to maintain samples at 4-10°C is available as an option.
<u>Construction Materials</u>:	Sampling train is all plastic and stainless steel. Casing is corrosive-resistant fiberglass. The refrigerated model has a baked enamel-covered steel enclosure with plastic interior.
<u>Basic Dimensions</u>:	76 x 61 x 140 cm (30x24x55 in.); weatherproof enclosures for refrigerator models are 76 x 61 x 183 cm (30x24x72 in.); designed for fixed installation.
<u>Base Price</u>:	Start around $1,500; add $300 for refrigerator in weatherproof enclosure; and $27 for delay relay, $300 for predetermined counter, or $630 for integrating flow proportional operation.
<u>General Comments</u>:	In normal operation a continuous sample stream flows through the D-Y sampling valve, which is essentially a rotating cylinder containing a drilled port sized for the desired aliquot volume. On signal, the cylinder rotates 180° to allow the trapped sample to flow into the sample container. After a 10 second dwell, it returns to the purge position. Inserts for cutting strings, etc., are available for trashy flows. With the optional vacuum system a switchable compressor is used to purge lines and draw the sample. A recycle timer is used to program the sampling sequence of air purge, sample fill-sample collection, and air purge cycles. On signal the sample line is immediately purged with air pressure for a preset period. The cycle is changed to the vacuum position. Sample flows through the sample valve into vacuum chamber until the weight of

the sample in the chamber overcomes the spring resistance counterbalancing the chamber. The switch under the vacuum chamber is closed by the chamber and the sample valve operates. The vacuum cycle continues for a short time and then the recycle timer switches back to the air purge position. The sample valve rotates back to the purge position when the recycle timer switches to air purge. After the sample line is purged, the Air Purge/Vacuum Unit is off until another pulse is received. Manufacturer notes that using this method of sampling, there is not an erroneous increase in solids concentration that may occur in other air purge/vacuum systems that overfill the vacuum chamber and then pump out to a measured lower level. All pneumatic explosion-proof model available.

Designation:	EMA MODEL 200
Manufacturer:	Environmental Marketing Associates 3331 Northwest Elmwood Drive Corvallis, Oregon 97330 Phone (503) 752-1541
Sampler Intake:	Perforated end of suction pipe attached to an adjustable mounting bracket.
Gathering Method:	Forced flow from solenoid activated piston.
Sample Lift:	Less than 0.9m (1 ft).
Line Size:	0.95 cm (3/8 in.) I.D.
Sample Flow Rate:	Unknown.
Sample Capacity:	21 mℓ aliquots are composited in a suitable container.
Controls:	Aliquots can be taken at intervals from 2 to 30 minutes paced by an adjustable timer, or as paced by an external flowmeter.
Power Source:	110 VAC or 12 VDC.
Sample Refrigerator:	Sample container is housed in an insulated chest that allows for ice cooling.
Construction Materials:	Housing is PVC, piston is lucite, and piston shaft is aluminum.
Basic Dimensions:	Basic model appears to be about 107 cm (3.5 ft) high.
Base Price:	Model 200 ac - $199 Model 200 dc - $249 (without battery) Model 200 dc floating - $456 (without battery)

General Comments: A battery operated floating model is available mounted on a pontoon float. Unit must be mounted at point of sampling since it is not designed to discharge to higher elevations. The sampler is furnished with an adjustable mounting bracket that supports both the sampler and sample container.

Designation:	ETS FIELDTEC MODEL FS-4
Manufacturer:	ETS Products 12161 Lackland Road St. Louis, Missouri 63141 Phone (314) 878-1703
Sampler Intake:	Plastic inlet strainer installed to suit by user.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	8.8m (29 ft) maximum.
Line Size:	0.6 cm (1/4 in.) I.D. typical.
Sample Flow Rate:	Approximately 1.2ℓ (1/3 gal) per hour depending on tube size used.
Sample Capacity:	Continuous flow from pump sequentially fills 12 individual 3.8ℓ (1 gal) sample containers over a 24-hour period.
Controls:	On/off switch. A kit is available for changing the timing sequence (time period represented in one bottle).
Power Source:	115 VAC.
Sample Refrigerator:	Automatic refrigerator is available as an option.
Construction Materials:	Sampling train is all plastic; frame and case are aluminum with enamel finish.
Basic Dimensions:	46 x 112 x 53 cm (18x44x21 in.); weighs approximately 32 kg (70 lbs); portable.
Base Price:	\$1,095; time conversion kit is \$16, refrigerator/heater accessory is \$400.

General Comments: Refrigeration or heating accessory available. Motor and pump can be easily removed to a remote location. Pump will discharge up to 14m (46 ft) head. A synchronous timing motor pulls a nylon rider holding the discharge tube along a track over a distribution tray to fill bottles. Alternate versions that allow filling a 3.8ℓ (1 gal) sample container in shorter time periods (to one every five minutes), offer different sizes and numbers of sample containers, etc., are available.

Designation:	FMC "TRU TEST"
Manufacturer:	Environmental Equipment Division FMC Corporation 1800 FMC Drive West Itasca, Illinois 60143 Phone (312) 893-1800
Sampler Intake:	Provided by user, a screen with maximum openings of 1.3 cm (0.5 in.) recommended; sampler has standard 5 cm (2 in.) pipe inlet.
Gathering Method:	External head to provide flow through a sampling chamber from which a rotating dipper extracts a sample aliquot and transfers it to a funnel where it is gravity fed to a composite bottle.
Sample Lift:	Not applicable.
Line Size:	Smallest line in sampling train is the one connecting the funnel to the sample bottle; it appears to be about 2.5 cm (1 in.).
Sample Flow Rate:	Recommended flow rate through sampler is 95 to 190 ℓpm (25 to 50 gpm) with 133 ℓpm (35 gpm) as optimum. Minimum velocity in inlet line, 5 cm (2 in.) diameter recommended, should be 0.6m (2 ft) per second. Below 95 ℓpm (25 gpm) fungus growth and settling in sampling chamber will affect the sample quality.
Sample Capacity:	Sampling dipper collects a 25 mℓ sample; a 7.6ℓ (2 gal) composite container is provided.
Controls:	Constant rate sampling (between 3 and 20 samples per hour) is controlled by built-in timer; flow proportional sampling provided by either transmitter control or totalizer control from external flow measuring device.
Power Source:	115 VAC.

Sample Refrigerator:	Automatic refrigerator to maintain samples at 4° to 10°C is available.
Construction Materials:	Bisphenol polyester resin, polypropylene, stainless steel, and polyethylene; case is laminated fiberglass.
Basic Dimensions:	49 x 53 x 132 cm (19x21x52 in.); designed for fixed installation.
Base Price:	$2,200 non-refrigerated. $2,600 refrigerated.
General Comments:	Sampling chamber has adjustable weir plates to regulate liquid level. Manufacturer recommends that intake line be limited to 15.2m (50 ft) or less in length. All solid state electronics. Counter top models also available.

Designation:	HORIZON MODEL S7570
Manufacturer:	Horizon Ecology Company 7435 North Oak Park Avenue Chicago, Illinois 60648 Phone (312) 647-7644
Sampler Intake:	Weighted end of suction tube installed to suit by user.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	9m (30 ft) maximum.
Line Size:	Varies from 0.08 to 0.8 cm (0.0315 to 0.313 in.) I.D., depending upon pump head chosen.
Sample Flow Rate:	Depends upon lift and pump head chosen, but typically under 600 mℓ per minute.
Sample Capacity:	Collects a grab sample whose size depends upon pump running time.
Controls:	On/off switch plus power selection switch for internal battery operation, AC operation, 12 VDC operation, recharge on 12 VDC, or recharge on AC.
Power Source:	Internal battery, 12 VDC, or 115 VAC.
Sample Refrigerator:	None.
Construction Materials:	Sampling train is uninterrupted Tygon tube; silicone or other tube materials available.
Basic Dimensions:	Approximately 30 x 20 x 18 cm (12x 8x7 in.); weighs 9.5 kg (21 lbs); portable.
Base Price:	$505 for a complete unit; S7570 is $425, pump head is $40, tubing is typically $22 for a 15.2m (50 ft) coil, and intake weight is $17.50.
General Comments:	Actually a field sampling pump rather than a complete system.

Designation:	HORIZON MODEL S7576
Manufacturer:	Horizon Ecology Company 7435 North Oak Park Avenue Chicago, Illinois 60648 Phone (312) 647-7644
Sampler Intake:	Weighted end of suction tube installed to suit by user.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	9m (30 ft) maximum.
Line Size:	Varies from 0.08 to 0.8 cm (0.0315 to 0.313 in.) I.D. depending upon pump head chosen.
Sample Flow Rate:	Depends upon lift and pump head chosen, but typically under 100 mℓ per minute.
Sample Capacity:	Collects aliquots (whose size depends upon pump running time) every 15 minutes and composites them in a user supplied container.
Controls:	On/off switch plus timer that controls duration of pump run as a percentage of 15 minutes.
Power Source:	115 VAC
Sample Refrigerator:	None.
Construction Materials:	Sampling train is uninterrupted Tygon tube; silicone or other tube materials available.
Basic Dimensions:	Approximately 30 x 20 x 18 cm (12x8x7 in.); weighs 4 kg (9 lbs); portable.
Base Price:	Approximately $250 for a complete unit; S7576 is $170, pump head is $40, tubing is typically $22 for a 15.2m (50 ft) coil, and intake weight is $17.50.

General Comments:	User must supply sample container and protection to complete this unit.

Designation:	HORIZON MODEL S7578
Manufacturer:	Horizon Ecology Company 7435 North Oak Park Avenue Chicago, Illinois 60648 Phone (312) 647-7644
Sampler Intake:	Weighted end of suction tube installed to suit by user.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	9m (30 ft) maximum.
Line Size:	0.49 cm (0.192 in.) I.D.
Sample Flow Rate:	Depends upon lift, but typically under 100 mℓ per minute.
Sample Capacity:	Collects adjustable size aliquots (30, 89, or 118 mℓ) and composites them in a 9.7ℓ (2.5 gal) container.
Controls:	Time intervals at which unit samples are switch selectable for once every 15 minutes, once every 30 minutes, or continuously; aliquot size is switch selectable.
Power Source:	Internal battery, 115 VAC charger.
Sample Refrigerator:	None.
Construction Materials:	Sampling train is uninterrupted Tygon tube (silicone or other tube materials available); sample container is polyethylene; case is ABS plastic.
Basic Dimensions:	Approximately 41 x 23 x 56 cm (16x 9x22 in.); weighs 12.6 kg (28 lbs); portable.
Base Price:	\$620. Battery charger is \$82.
General Comments:	Tube directs any accidental overflow outside the case to prevent damage.

Designation:	HORIZON MODEL S7579
Manufacturer:	Horizon Ecology Company 7435 North Oak Park Avenue Chicago, Illinois 60648 Phone (312) 647-7644
Sampler Intake:	Plastic inlet strainer installed to suit by user.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	8.8m (29 ft) maximum.
Line Size:	0.64 cm (1/4 in.) I.D. typical.
Sample Flow Rate:	Approximately 1.2ℓ (1/3 gal) per hour depending on tube size used.
Sample Capacity:	Continuous flow from pump sequentially fills 12 individual 3.8ℓ (1 gal) sample containers over a 24-hour period.
Controls:	On/off switch. A kit is available for changing the timing sequence (time period represented in one bottle).
Power Source:	115 VAC.
Sample Refrigerator:	Automatic refrigerator is available as an option.
Construction Materials:	Sampling train is all plastic; frame and case are aluminum with enamel finish.
Basic Dimensions:	46 x 112 x 53 cm (18x44x21 in.); weighs approximately 32 kg (70 lbs); portable.
Base Price:	$1,095; time conversion kit is $16, refrigerator/heater accessory is $400.

General Comments:	Refrigeration or heating accessory available. Motor and pump can be easily removed to a remote location. Pump will discharge up to 14m (46 ft) head. A synchronous timing motor pulls a nylon rider holding the discharge tube along a track over a distribution tray to fill bottles. Time conversion kit allows filling the 12 sample containers in 12 hours. This unit is manufactured for Horizon by ETS Products.

Designation:	HYDRAGUARD AUTOMATIC LIQUID SAMPLER
Manufacturer:	Automatic Samplers 850 Kees Street Lebanon, Oregon 97355 Phone (503) 258-2628
Sampler Intake:	End of rigid metal metering chamber.
Gathering Method:	Forced flow due to pneumatic ejection.
Sample Lift:	Depends upon pressure, but in excess of 9m (30 ft).
Line Size:	0.6 cm (0.25 in.) I.D. (standard).
Sample Flow Rate:	Depends upon pressure and lift.
Sample Capacity:	Aliquots of volume proportional to flow depth or rate are composited in a user-supplied container.
Controls:	Sampling interval is adjustable via a needle valve. An optional electronic control unit is available to operate sampler from flowmeter contacts.
Power Source:	Regulated 1.4 kg/sq cm (20 psi) air supply. 115 VAC required with optional electronic control unit.
Sample Refrigerator:	None.
Construction Materials:	Sampling train is all stainless steel, inlet valve is rubber; control unit is cast aluminum.
Basic Dimensions:	Depends upon model, but all are under 91 cm (36 in.) long and will pass through a 15 cm (6 in.) diameter opening.

Base Price: Model HP-1 (aliquot size linear with flow depth) is $246; Model HP-2 (HP-1 with enlarged sample chamber, lines, and inlet hole) is $286; FP Series (aliquot size characterized for depth in Parshall flume or weirs) is $379; FPE Series (FP series with enlarged sample chamber, lines, and inlet hole) is $401; Model A-1 (adjustable aliquot size is independent of flow depth) is $286; air compressor is $140; portable air tank with pressure regulator is $76.

General Comments; At the start of sampling cycle, liquid flows through the inlet port, displacing the inlet valve, and rises in the sample chamber and outlet tube, to the height of liquid flowing through the flume or weir. Air pressure, in the control chamber of the control relay, holds a diaphragm over the air supply port. This pressure bleeds to atmosphere through a needle valve. When the pressure in the control chamber bleeds low enough, the diaphragm moves away from the air inlet port, allowing air to enter the sample chamber. Air pressure exerted on the liquid in the sample chamber will seal the inlet valve, and force the sample out the outlet tube, to the sample container. As air enters the sample chamber, some air flows through the check valve (in the control relay) into the control chamber. When air pressure in the control chamber is equal to the pressure in the operating chamber, a spring forces the diaphragm back over the air inlet. The air is now shut off, and the sample again rises in the sample chamber, ready for the next cycle.

Designation:	HYDRA-NUMATIC COMPOSITE SAMPLER
Manufacturer:	Hydra-Numatic Sales Company 65 Hudson Street Hackensack, New Jersey 07602 Phone (201) 489-4191
Sampler Intake:	End of suction tube installed to suit by user.
Gathering Method:	Suction lift from centrifugal pump.
Sample Lift:	Up to 4.6m (15 ft).
Line Size:	1.3 cm (1/2 in.) I.D.
Sample Flow Rate:	5.7 ℓpm (1.5 gpm).
Sample Capacity:	Aliquot size is adjusted (based upon anticipated flow rates where external flowmeter is to be employed) to fill the 19ℓ (5 gal) composite container in 24 hours.
Controls:	Sampler receives signals from external flow meter through a primary relay and clock system, the clock serving as a memory-collecting impulses representing a given flow - at which time a known, pre-set volume of sample is drawn. The volume of sample is controlled by a finely calibrated clock which opens a free-port solenoid valve for a preset time period thereby diverting the flow to the sample container. A built-in timer can be used to pace the sampler when no flow meter is available. It can either be programmed if rough estimates of daily flow variations are known or function as a fixed time interval pacer.
Power Source:	115 VAC electricity.
Sample Refrigerator:	None

Construction Materials:	Polyethylene sample container, Tygon sampling lines with bronze fittings and connections, bronze valves and pump, stainless steel available as alternate; cabinet is stainless steel.
Basic Dimensions:	91 x 33 x 91 cm (36x13x36 in.); portable.
Base Price:	$1,800.

Designation:	ISCO MODEL 1480
Manufacturer:	Instrumentation Specialties Co. Environmental Division P.O. Box 5347 Lincoln, Nebraska 68505 Phone (402) 464-0231
Sampler Intake:	Weighted plastic cylindrical strainer with four rows of five 0.3 cm (1/8 in.) holes evenly spaced around its periphery.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	7.9m (26 ft) maximum lift.
Line Size:	0.64 cm (1/4 in.) I.D.
Sample Flow Rate:	Not applicable.
Sample Capacity:	Uniform aliquots of about 7 mℓ are composited in a 11.4ℓ (3 gal) container (standard) or 18.9ℓ (5 gal) container (optional). The base itself can be used to collect 38ℓ (10 gal) samples and can be replaced by a 57ℓ (15 gal) polyolefin barrel for larger sample requirements.
Controls:	Solid state electronics allow sample collection rate to be varied continuously from 0.2 liters per day to 10.4 liters per hour in timed mode; may also be paced by ISCO Model 1470 flowmeter. Optional automatic starter also available.
Power Source:	115 VAC, 12 VDC auto battery, or internal NiCad or sealed lead-acid battery.
Sample Refrigerator:	Base has 2.5 cm (1 in.) foamed-in-place insulation and ice cavity

that will keep a 11.4ℓ (3 gal) sample below 13°C (55°F) for over 24 hours in a 56°C (100°F) environment.

<u>Construction Materials</u>: All plastic construction including insulated case, tubing, and sample container; stainless steel hardware.

<u>Basic Dimensions</u>: 48 cm (19 in.) diameter x 65 cm (25.5 in.) H; weighs 14 kg (31 lbs); portable.

<u>Base Price</u>: $645; $145 for NiCad or $60 for lead-acid battery; Model 1640 automatic starter is $138.

<u>General Comments</u>: Sampler will withstand accidental submersion for short periods of time. All electrical and mechanical components are waterproofed; the programming unit is sealed in a water-tight housing that contains a regenerable dessicant. Model 1480 is not designed to provide true proportions of heavy suspended solids due to its intermittent pumping action. The peristaltic pump turns in one-half revolution increments with two rollers pinching the tubing at the end of each movement so that the sample will not drain back through the intake.

The optional Model 1470 flowmeter enables the sampler to collect a composite based on the volume of passing fluid rather than on time. Flowmeters other than ISCO are not suited for use with the Model 1480 sampler. Up to 151ℓ (40 gal) of sample may be taken on an 18 hour battery charge.

Designation:	ISCO MODEL 1580
Manufacturer:	Instrumentation Specialties Company Environmental Division P.O. Box 5347 Lincoln, Nebraska 68505 Phone (402) 464-0231
Sampler Intake:	Weighted plastic cylindrical strainer with four rows of five 0.3 cm (1/8 in.) holes evenly spaced around its periphery.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	7.9m (26 ft) maximum lift.
Line Size:	0.64 or 0.95 cm (1/4 or 3/8 in.) I.D.
Sample Flow Rate:	Up to 0.8 m/s (2.7 fps) standard or 1.2 m/s (4 fps) superspeed, depending upon lift.
Sample Capacity:	Adjustable size aliquots (between 40 and 600 mℓ) are composited in a 11.4ℓ (3 gal) container (standard) or 18.9ℓ (5 gal) container (optional). The base itself can be used to collect 38ℓ (10 gal) samples and can be replaced by a 57ℓ (15 gal) polyolefin barrel for larger sample requirements.
Controls:	Sample aliquot size is switch selectable in eight increments from 40 to 600 mℓ; sampling frequency can be adjusted from 2.5 to 320 minutes when operating in the timed mode. A switch multiplies the volume that is transmitted by an external flowmeter by a factor of from 1 to 9 when used in the flow mode. Any flowmeter that provides a contact closure at fixed volumetric intervals can be used.
Power Source:	115 VAC, 12 VDC auto battery, or internal NiCad or sealed lead-acid battery.

Sample Refrigerator:	Base has 2.5 cm (1 in.) foamed-in-place insulation and ice cavity that will keep a 11.4ℓ (3 gal) sample below 13°C (55°F) for over 24 hours in a 56°C (100°F) environment.
Construction Materials:	All plastic construction including insulated case, tubing, and sample container; stainless steel hardware.
Basic Dimensions:	48 cm (19 in.) diameter x 65 cm (25.5 in.) H; weighs 14 kg (31 lbs); portable.
Base Price:	$825; options priced as for Model 1680. An explosion-proof Model 1631W is available at $1,450.
General Comments:	Sampler will withstand accidental submersion for short periods of time. All electrical and mechanical components are waterproofed; the programming unit is sealed in a water-tight housing that contains a regenerable dessicant. The intake line is purged before and after each aliquot is taken to help minimize cross-contamination and ensure that the sample is representative of the time at which it was taken. The optional automatic starter allows the unit to be activated when the flow depth reaches some predetermined level.

Designation:	ISCO MODEL 1580RW
Manufacturer:	Instrumentation Specialties Company Environmental Division P.O. Box 5347 Lincoln, Nebraska 68505 Phone (402) 464-0231
Sampler Intake:	Weighted plastic cylindrical strainer with four rows of five 0.3 cm (1/8 in.) holes evenly spaced around its periphery.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	7.9m (26 ft) maximum lift.
Line Size:	0.64 or 0.95 cm (1/4 or 3/8 in.) I.D.
Sample Flow Rate:	Up to 0.8 m/s (2.7 fps) standard or 1.2 m/s (4 fps) superspeed, depending upon lift.
Sample Capacity:	Same as Model 1580.
Controls:	Same as Model 1580.
Power Source:	115 VAC.
Sample Refrigerator:	Automatic refrigerator provides selectable temperature from 0° to 8°C.
Construction Materials:	Same as Model 1580. Refrigerated compartment is lined with rigid foamed-in-place insulation that will not support bacterial growth or retain odors.
Basic Dimensions:	62 x 65 x 108 cm (24x26x42 in.); weighs 52.6 kg (116 lbs); fixed installation.
Base Price:	$1,375; options priced as for Model 1680.
General Comments:	This is basically a fixed installation, refrigerated version of the portable Model 1580.

Designation:	ISCO MODEL 1680
Manufacturer:	Instrumentation Specialties Co. Environmental Division P.O. Box 5347 Lincoln, Nebraska 68505 Phone (402) 464-0231
Sampler Intake:	Weighted plastic cylindrical strainer with four rows of five 0.3 cm (1/8 in.) holes evenly spaced around its periphery.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	7.9m (26 ft) maximum lift; 96% delivery at 2.4m (8 ft), 80% at 5.5m (18 ft).
Line Size:	0.64 or 0.95 cm (1/4 or 3/8 in.) I.D.
Sample Flow Rate:	Up to 0.8 m/s (2.7 fps) standard or 1.2 m/s (4 fps) superspeed, depending upon lift.
Sample Capacity:	Adjustable discrete sample volume to maximum of 500 mℓ with 28 plastic bottles and 350 mℓ with 28 glass bottles, selected to within ±10 mℓ by a 9 position switch. The switch scale indicates volumes for head heights to 6.4m (21 ft). Another switch provides for the selection of 6 different suction line lengths. An optional multiplexer permits compositing 1, 2, 3, or 4 samples into each bottle, allowing a maximum of 112 samples to be placed into the 28 bottles. The multiplexer also can be used to distribute the sample over 1, 2, 3, or 4 bottles, permitting a larger sample volume or the use of several different preservatives. An automatic shut-off stops the sampling program after the last bottle is filled. An accessory base for taking 11.4ℓ (3 gal) composite samples is available.

Controls: Samples may be collected at intervals determined by a 1 to 999 minute quartz crystal timer or by any ISCO flowmeter. The controller can combine up to 999 signals from the flowmeter for each sample. This greatly expands the range of flowstream volumes originally available in the flowmeter, and simplifies interfacing with flowmeters of other manufacture. Sampling normally commences immediately upon setup, but the initial sample can be delayed up to 999 minutes if desired. All values are entered with a pushbutton digital switch. An LED display shows the interval remaining before the next sample is taken.

A simplified controller is available as a lower cost option. Timed intervals from 3.75 minutes to 24 hours are selected with a 10 position rotary switch. The flow proportioned cycle operates in the conventional manner, i.e., a sample is taken for each signal from the flowmeter. There is no provision for delaying the program initiation or counting repeated flowmeter pulses per sample.

Power Source: 115 VAC, 12 VDC auto battery, or internal NiCad or sealed lead-acid battery.

Sample Refrigerator: Has ice cavity for cooling; will maintain samples up to 22°C (40°F) below ambient for at least 12 hours and 17°C (30°F) below ambient for 24 hours.

Construction Materials: All plastic construction including insulated case, tubing, and sample bottles; stainless steel hardware.

Basic Dimensions: 49.5 cm (19.5 in.) diameter x 53 cm (21 in.) H; weighs 18.1 kg (40 lbs); portable.

Base Price: $1,295; add $145 for NiCad or $60 for lead-acid batteries, $110 for multiplexer, $75 for superspeed pump, $20 for glass bottles, $138 for automatic starter. Deduct $50 for simplified controller. Composite base is $125.

General Comments: Sampler will withstand accidental submersion for short periods of time. All electrical and mechanical components are waterproofed; the programming unit is sealed in a water-tight housing that contains a regeneratable dessicant. A rotating "clog-proof" funnel delivers samples to the distributer plate which channels them to their individual bottles. After each sample the pump automatically reverses itself to purge intake tube and minimize cross-contamination. Operator may manually trigger unit for individual test sample or purge at any stage of operation. The optional automatic starter allows the unit to be activated when the flow depth reaches some predetermined level.

Designation:	ISCO MODEL 1680RW
Manufacturer:	Instrumentation Specialties Co. Environmental Division P.O. Box 5347 Lincoln, Nebraska 68505 Phone (402) 464-0231
Sampler Intake:	Weighted plastic cylindrical strainer with four rows of five 0.3 cm (1/8 in.) holes evenly spaced around its periphery.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	7.9m (26 ft) maximum lift; 96% delivery at 2.4m (8 ft), 80% at 5.5m (18 ft).
Line Size:	0.64 or 0.95 cm (1/4 or 3/8 in.) I.D.
Sample Flow Rate:	Up to 0.8 m/s (2.7 fps) standard or 1.2 m/s (4 fps) superspeed, depending upon lift.
Sample Capacity:	Same as Model 1680.
Controls:	Same as Model 1680.
Power Source:	115 VAC
Sample Refrigerator:	Automatic refrigerator provides selectable temperature from 0° to 8°C.
Construction Materials:	Same as Model 1680. Refrigerated compartment is lined with rigid foamed-in-place insulation that will not support bacterial growth or retain odors.
Basic Dimensions:	62 x 65 x 108 cm (24x26x42 in.); weighs 52.6 kg (116 lbs); fixed installation.
Base Price:	$1,820. Options priced as for Model 1680.
General Comments:	This is basically a fixed installation; refrigerated version of the portable Model 1680.

Designation:	KENT MODEL SSA
Manufacturer:	Kent Cambridge Instrument Company 73 Spring Street Ossining, New York 10562 Phone (914) 941-8100
Sampler Intake:	Plastic strainer at end of 7.6m (25 ft) suction tube.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	Up to 4.9m (16 ft).
Line Size:	0.6 cm (1/4 in.) I.D.
Sample Flow Rate:	Up to 150 mℓ per minute depending upon lift.
Sample Capacity:	Collects 24 discrete samples of up to 177 (or 473) mℓ over a period of 6, 12, or 24 hours.
Controls:	Spring-driven clock triggers unit at one hour intervals; other timing mechanisms are available to allow a sample to be taken at 15 or 30 minute intervals. Sample volume is determined by forward pump run time which is adjustable to compensate for lift and flow depth.
Power Source:	12 VDC lead-acid battery, 115 VAC or 220 VAC.
Sample Refrigerator:	None.
Construction Materials:	Sampling train is all plastic; totally enclosing glass reinforced plastic case available.
Basic Dimensions:	45.7 cm (18 in.) diameter by 40.6 cm (16 in.) H; weighs 24.4 kg (54 lbs); portable.

<u>Base Price</u>:	$1,240.
<u>General Comments</u>:	On signal, pump starts and runs in reverse to clear tubing of fluid, then runs forward for a pre-set time to deliver sample to container, after which it again reverses to purge pump and tubing of fluid. A complete cycle takes from 2 to 5 minutes depending upon lift and the quantity of sample desired.

Designation:	KENT MODEL SSB
Manufacturer:	Kent Cambridge Instrument Company 73 Spring Street Ossining, New York 10562 Phone (914) 941-8100
Sampler Intake:	Fine gauze filter at end of suction tube.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	Up to 4m (13 ft).
Line Size:	0.6 cm (1/4 in.) I.D.
Sample Flow Rate:	Less than 200 mℓ per minute depending upon lift.
Sample Capacity:	Collects aliquots of pre-set size and either composites them hourly (standard, 30 and 15 minute intervals optional) in one of 24 discrete 500 mℓ containers or in a single 20ℓ bottle.
Controls:	Rheostat on continuously running pump motor controls speed which, together with lift and a 0-60 second diverter timer, determines aliquot size. In the 24 bottle version, the bottles are mounted on a rotating turntable that indexes hourly (standard, 30, or 15 minute intervals optional). Aliquot interval is either controlled by an external flowmeter (rate or totalized signal) or by an adjustable interval timer.
Power Source:	115 VAC; 240 VAC.
Sample Refrigerator:	None.
Construction Materials:	Sampling train is plastic except for diverter which may be stainless steel; cabinet is sheet metal.

Basic Dimensions: 38 x 38 x 87 cm (15x15x34 in.); weighs 30 kg (66 lbs); designed for fixed installation.

Base Price: $2,354.

General Comments: Unit is not recommended for flows that are high in suspended solids. In operation, the discharge from the continuously running pump is directed to a tippler mechanism that normally returns the flow to waste downstream from the intake. On signal the tippler mechanism diverts the flow to the sample discharge line for a predetermined time period. Manufacturer recommends changing pump tubing every two weeks and "regular" cleaning of the tippler mechanism.

Designation:	KENT MODEL SSC
Manufacturer:	Kent Cambridge Instrument Company 73 Spring Street Ossining, New York 10562 Phone (914) 941-8100
Sample Intake:	Fine strainer at end of suction tube which must be immersed at least 5 cm (2 in.) below the surface of the liquid to prevent pump from drawing air.
Gathering Method:	Suction lift from progressive cavity screw-type pump.
Sample Lift:	Up to 5m (16.4 ft).
Line Size:	2.5 cm (1 in.) I.D.
Sample Flow Rate:	Up to 33 ℓpm depending upon lift.
Sample Capacity:	Collects either 24 discrete 280 mℓ samples or a 20ℓ composite sample.
Controls:	Sample interval is either controlled by external flowmeter or fixed at 15, 30, or 60 minutes by interval timer. A 0-300 second delay timer is used to control pump running time to assure that a full 280 mℓ aliquot is taken.
Power Source:	115 VAC; 240 VAC.
Sample Refrigerator:	None.
Construction Materials:	Sampling train is rubber, plastic, and stainless steel.
Basic Dimensions:	76 x 125 x 81 cm (30x49x32 in.); weighs 80 kg (176 lbs); designed for fixed installation.
Base Price:	$2,354.

General Comments:

On signal, the pump starts and its discharge is directed to a tipping bucket, the force of the jet being sufficient to hold the tippler in an upright position so that its overflow discharges back into the flow stream. After a preset time the pump stops and the weight of the sample in the tippler causes it to overbalance and discharge its contents into the sample container. In the 24 bottle version, the turntable carrying the bottles then rotates to present a fresh container for the next sample. The unit must be mounted adjacent to the channel from which the samples are to be taken with the tippler overflow directed back into the channel. The pump must be primed with water upon installation or at any time when it does not contain residual effluence. Manufacturer states that tippler mechanism must be cleaned regularly.

Designation:	KROFTA MODELS PN AND PF
Manufacturer:	Krofta Engineering Corporation 58 Yokun Avenue Lenox, Massachusetts 01240 Phone (413) 637-0740
Sampler Intake:	End of rigid metal metering chamber.
Gathering Method:	Forced flow due to pneumatic ejection.
Sample Lift:	Depends upon pressure, but in excess of 9m (30 ft)
Line Size:	Appears to be at least 1 cm (3/8 in.).
Sample Flow Rate:	Depends upon pressure and lift.
Sample Capacity:	Aliquots of volume proportional to flow rate are composited in a user-supplied container.
Controls:	Sampler is equipped with a 24 minute repeat cycle timer and five removable cams that can be used to provide either 4, 6, 8, 12, or 24 minutes between aliquots.
Power Source:	115 VAC plus compressed air (15 psi min, 80 psi max).
Sample Refrigerator:	None.
Construction Materials:	Sampling train is stainless steel and rubber.
Basic Dimensions:	Depends upon model but all chamber assemblies are under 96 cm (38 in.) long and 15 cm (6 in.) in diameter; control box is 15 x 15 x 10 cm (6x 6x4 in.).
Base Price:	Model PN-2 for use with rectangular weirs is $945; Model PF-2 for use with Parshall flumes is $1,060.

General Comments:

Sampler must be used with appropriate primary flow measuring device. The repeat cycle timer and cam operate a microswitch, which controls the compressed air supply solenoid valve. During each sampling interval, the cam allows the microswitch to open, deenergizing the solenoid valve, which relieves the air pressure, allowing the cylinder spring return to raise the sampling inlet valve. The sample will enter and rise in the sample chamber to the height of water on the weir or flume. At the end of three minutes, the cam will close the microswitch and air will enter the operating cylinder, closing the inlet valve. As the cylinder piston moves down, a hole in the cylinder wall is exposed, allowing air to pass through a tubing, connecting the pressure side of the cylinder with the sampling chamber. A removable orifice is placed at the lower end of the tube, restricting the air flow, to maintain sufficient line pressure to hold the valve closed, yet allow pressure to build up in the sample chamber, to evacuate the sample through the hollow valve seat and valve stem to a user-supplied collection barrel.

Designation:	KROFTA MODEL CO
Manufacturer:	Krofta Engineering Corporation 58 Yokun Avenue Lenox, Massachusetts 01240 Phone (413) 637-0740
Sampler Intake:	End of rigid metal metering chamber.
Gathering Method:	Forced flow due to pneumatic ejection.
Sample Lift:	Depends upon pressure, but in excess of 9m (30 ft).
Line Size:	Appears to be at least 1 cm (3/8 in.).
Sample Flow Rate:	Depends upon pressure and lift.
Sample Capacity:	Aliquots of volume proportional to flow rate are composited in a user-supplied container.
Controls:	Sampler has a 3 minute repeat cycle timer.
Power Source:	115 VAC plus compressed air (15 psi min, 80 psi max).
Sample Refrigerator:	None.
Construction Materials:	Sampling train is bronze, stainless steel, and rubber.
Basic Dimensions:	13 x 20 x 33 cm (5x8x13 in.).
Base Price:	$635.
General Comments:	Sampling period is one minute during which time the bottom valve is open, the compressed air valve is closed and the three-way valve is open to atmosphere for bleed off. Discharge period is two minutes during which time, the bottom valve is closed, the compressed air valve is open and the bleed off is closed.

The sample collected is forced by compressed air through a hose to the collection drum. The Sampler's inlet is cleaned by escaping air, when the bottom valve opens.

Designation:	KROFTA PORTABLE SAMPLER
Manufacturer:	Krofta Engineering Corporation 58 Yokun Avenue Lenox, Massachusetts 01240 Phone (413) 637-0740
Sampler Intake:	Weighted metal mesh strainer.
Gathering Method:	Suction lift from self-priming positive displacement pump.
Sample Lift:	7.6m (25 ft) maximum.
Line Size:	0.64 cm (1/4 in.) I.D.
Sample Flow Rate:	Unknown.
Sample Capacity:	Adjustable size aliquots up to 300 $m\ell$ are composited in a 13.2ℓ (3-1/2 gal) container.
Controls:	Aliquot volume is controlled by pump running time. Sampling interval is either 15 or 30 minutes depending upon cam selection.
Power Source:	12 VDC, 115 VAC or both.
Sample Refrigerator:	None.
Construction Materials:	Sampling train is plastic, stainless steel, and rubber.
Basic Dimensions:	Case is 36 x 20 x 36 cm (14x8x 14 in.); battery pack is separate; portable.
Base Price:	$1,110 complete with battery pack, charger, and collection tank; $720 for AC version.
General Comments:	During the time between sampling, the pump is off and a solenoid vent valve is open, allowing intake line to drain. When pump starts, the vent valve closes and sample is taken.

Designation:	LAKESIDE TREBLER MODEL T-2
Manufacturer:	Lakeside Equipment Corporation 1022 East Devon Avenue Bartlett, Illinois 60103 Phone (312) 837-5640
Sampler Intake:	Specially designed scoop.
Gathering Method:	Mechanical; rotating scoop traverses entire depth of flow; as scoop is rotated out of flow the sample drains by gravity through the hub and into a composite sample jar.
Sample Lift:	Unit must be in flow stream.
Line Size:	1.3 cm (1/2 in.) diameter pipe connects hub to sample container.
Sample Flow Rate:	Not applicable.
Sample Capacity:	Scoop is shaped to gather a volume of sample that is proportional to the channel flow; can vary typically from 300 to 600 mℓ when installed in a Parshall flume.
Controls:	Timer can be used to trigger sampling cycle at any desired interval of a 1 hour period.
Power Source:	115 VAC electricity.
Sample Refrigerator:	Automatic refrigerator available which maintains sample temperature at approximately 4°C.
Construction Materials:	Cast aluminum frame, steel sprockets and chain drive, plexiglass or cast aluminum scoop, plastic pipe, polyethylene sample bottle.
Basic Dimensions:	Approximately 0.6-0.9m (2-3 ft) of head room above flume is required. Other dimensions depend upon size of flume. Refrigerator case is 76 x 61 x 91 cm (30 x 24 x 36 in.). Fixed installation.

Base Price:	\$688 with plexiglass scoop. \$962 with timer. Add \$615 for refrigerator.
General Comments:	Without timer the unit takes 30 samples per hour. For accurate sampling the unit must operate in conjunction with a Parshall flume or weir. For raw sewage or industrial wastes with high settleable solids count a Parshall flume is recommended. Daily inspection and weekly cleaning is recommended.

Designation:	MANNING MODEL S-3000
Manufacturer:	Manning Environmental Corporation 120 DuBois Street P.O. Box 1356 Santa Cruz, California 95061 Phone (408) 427-0230
Sampler Intake:	Weighted intake strainer at end of 6.7m (22 ft) sampling tube.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	Up to 7m (23 ft).
Line Size:	0.95 cm (3/8 in.) I.D.
Sample Flow Rate:	Up to 1.8 m/s (6 fps) depending upon lift.
Sample Capacity:	Adjustable size aliquots (between 25 and 500 mℓ) are composited in either a 11.4 or 18.9ℓ (3 or 5 gal) container.
Controls:	Unit may be paced by the contact closure output of an external flow-meter or by an optional internal quartz crystal timer whose interval can be continuously adjusted between 3 minutes to 4 hours. Sample size is adjustable by positioning end of inlet tube in metering chamber.
Power Source:	12 VDC non-spillable wet-cell battery; 115 VAC optional.
Sample Refrigerator:	An ice compartment is provided in the base to facilitate sample cooling.
Construction Materials:	Sampling train is all plastic; case is molded plastic with stainless steel hardware.
Basic Dimensions:	50 cm (20 in.) diameter x 74 cm (28.9 in.) H; weighs 13.2 kg (29 lbs); portable.

<u>Base Price</u>:	$895; add $105 for quartz cycle timer.
<u>General Comments</u>:	Sampler may be manually started or actuated by an external device such as a liquid level or rain gage. Cycle begins with compressor purging metering chamber and intake line with air for 15 seconds. A solenoid valve then inverts the compressor lines to create a vacuum in the metering chamber, and liquid is drawn up until it is full as detected by an electronic sensor. The solenoid valve then reverses and the metering chamber is again pressurized, forcing the excess sample back out the intake hose. A pinch valve opens, permitting the premeasured sample remaining to be forced into the sample bottle, and then closes, permitting purge to continue for 10 seconds. Unit automatically recycles through purge twice, if required.

Designation:	MANNING MODEL S-4040
Manufacturer:	Manning Environmental Corporation 120 DuBois Street P.O. Box 1356 Santa Cruz, California 95061 Phone (408) 427-0230
Sampler Intake:	Weighted intake at end of 6.7m (22 ft) sampling tube.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	Up to 7m (23 ft).
Line Size:	0.95 cm (3/8 in.) I.D.
Sample Flow Rate:	Up to 1.8 m/s (6 fps) depending upon lift.
Sample Capacity:	Standard unit takes 24 discrete samples adjustable in size between 25 and 500 mℓ. Options allow for collecting sequential composite samples made up of up to 10 aliquots each or for filling up to 10 bottles in immediate succession.
Controls:	Unit may be paced by the contact closure output of an external flowmeter or by an optional internal quartz crystal timer whose interval can be set at 3.75, 7.5, 15, or 30 minutes or 1, 2, 4, 6, 12 or 24 hours. Sample size is adjustable by positioning end of inlet tube in metering chamber. Optional features allow sampler to be switch selectable to take multiple samples in one bottle or the same sample in multiple bottles. There are manual controls for bottle advance and for one complete test cycle.
Power Source:	12 VDC non-spillable wet-cell battery; 115 VAC optional.
Sample Refrigerator:	An ice compartment is provided in the base to facilitate sample cooling.

Construction Materials:	Sampling train is all plastic; case is molded plastic with stainless steel hardware.
Basic Dimensions:	48 cm (19 in.) diameter x 57 cm (22.5 in.) H; weighs 16 kg (35 lbs); portable.
Base Price:	$1,290; add $105 for quartz cycle timer, $150 for multiplexer.
General Comments:	Sampler may be manually started or actuated by an external device such as a liquid level or rain gage. Cycle begins with compressor purging metering chamber and intake line with air for 15 seconds. A solenoid valve then inverts the compressor lines to create a vacuum in the metering chamber, and liquid is drawn up until it is full as detected by an electronic sensor. The solenoid valve then reverses and the metering chamber is again pressurized, forcing the excess sample back out the intake hose. A pinch valve opens, permitting the premeasured sample remaining to be forced into the sample bottle, and then closes, permitting purge to continue for 10 seconds. Unit automatically recycles through purge twice, if required.

Designation:	MANNING MODEL S-5000
Manufacturer:	Manning Environmental Corporation 120 DuBois Street P. O. Box 1356 Santa Cruz, California 95061 Phone (408) 427-0230
Sampler Intake:	Weighted intake at end of 6.7m (22 ft) sampling tube.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	Up to 6m (20 ft).
Line Size:	1.6 cm (5/8 in.) I.D.
Sample Flow Rate:	Up to 0.9 m/s (3 fps) depending upon lift.
Sample Capacity:	Adjustable size aliquots (between 50 and 1000 mℓ) are composited in either a 7.8, 11.4, or 18.9ℓ (2, 3, or 5 gal) container.
Controls:	Unit may be paced by the contact closure output of an external flow-meter or by an optional internal quartz crystal timer whose interval can be set at 3.75, 7.5, 15, or 30 minutes or 1, 2, 4, 6, 12 or 24 hours. Sample size is adjustable by positioning end of inlet tube in metering chamber.
Power Source:	115 VAC.
Sample Refrigerator:	Automatic refrigerator to maintain sample compartment between 4°-10°C is available.
Construction Materials:	Sampling train is all plastic; case is painted steel.
Basic Dimensions:	61 x 44 x 68 cm (24x18x26 in.) wall mounted; 61 x 64 x 148 cm (24x25x 58 in.) floor mounted; weights are 42 kg (95 lbs) wall mounted, 51 kg (113 lbs) floor mounted, 80 kg (175 lbs) refrigerated; fixed installation.

Base Price:	$2,150 for floor mounted refrigerated model; add $120 for quartz crystal timer; deduct $600 for wall mounted or $400 for floor mounted, nonrefrigerated models.
General Comments:	Sampler may be manually started or actuated by an external device such as a liquid level or rain gage. Cycle begins with compressor purging metering chamber and intake line with air for 15 seconds. A solenoid valve then inverts the compressor lines to create a vacuum in the metering chamber, and liquid is drawn up until it is full as detected by an electronic sensor. The solenoid valve then reverses and the metering chamber is again pressurized, forcing the excess sample back out the intake hose. A pinch valve opens, permitting the premeasured sample remaining to be forced into the sample bottle, and then closes, permitting purge to continue for 10 seconds. Unit automatically recycles through purge twice, if required.

Designation:	MANNING MODEL S-6000
Manufacturer:	Manning Environmental Corporation 120 DuBois Street P.O. Box 1356 Santa Cruz, California 95061 Phone (408) 427-0230
Sampler Intake:	Weighted intake at end of 6.7m (22 ft) sampling tube.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	Up to 6m (20 ft).
Line Size:	1.6 cm (5/8 in.) I.D.
Sample Flow Rate:	Up to 0.9 m/s (3 fps) depending upon lift.
Sample Capacity:	Standard unit takes 24 discrete samples adjustable in size between 50 and 1000 mℓ. Options allow for collecting sequential composite samples made up of up to 20 aliquots each or alternately taking 1 to 8 immediately consecutive samples in consecutive bottles.
Controls:	Unit may be paced by the contact closure output of an external flowmeter or by an optional internal quartz crystal timer whose interval can be set at 3.75, 7.5, 15, or 30 minutes or 1, 2, 4, 6, 12 or 24 hours. Sample size is adjustable by positioning end of inlet tube in metering chamber. Optional features allow sampler to be switch selectable to take multiple samples in one bottle or the same sample in multiple bottles. There are manual controls for bottle advance and for one complete test cycle.
Power Source:	115 VAC.

Sample Refrigerator:	Automatic refrigerator to maintain sample compartment between 4°-10°C is standard.
Construction Materials:	Sampling train is all plastic; case is painted steel.
Basic Dimensions:	61 x 64 x 148 cm (24x25x58 in.); weighs 86 kg (190 lbs); fixed installation.
Base Price:	$2,930; add $120 for quartz cycle timer, $200 for multiplexer.
General Comments:	Sampler may be manually started or actuated by an external device such as a liquid level or rain gage. Cycle begins with compressor purging metering chamber and intake line with air for 15 seconds. A solenoid valve then inverts the compressor lines to create a vacuum in the metering chamber, and liquid is drawn up until it is full as detected by an electronic sensor. The solenoid valve then reverses and the metering chamber is again pressurized, forcing the excess sample back out the intake hose. A pinch valve opens, permitting the premeasured sample remaining to be forced into the sample bottle, and then closes, permitting purge to continue for 15 seconds. Unit automatically recycles through purge twice, if required. Option allows first 12 bottles to be taken at one time interval while the second twelve are taken at a different time interval.

Designation:	MARKLAND MODEL 1301
Manufacturer:	Markland Specialty Engineering Ltd. Box 145 Etobicoke, Ontario (Canada) Phone (416) 625-0930
Sampler Intake:	Small gravity filled sample chamber equipped with patented non-clogging "duckbill" inlet control.
Gathering Method:	Forced flow due to pneumatic ejection.
Sample Lift:	18.3m (60 ft) standard.
Line Size:	0.64 cm (1/4 in.) I.D.
Sample Flow Rate:	Varies with pressure and lift.
Sample Capacity:	Composites 75-mℓ aliquots into a 7.6ℓ (2 gal) bottle.
Controls:	Solid state clock allows selecting intervals between aliquots of 15 to 60 minutes. Optional controller allows pacing from external flowmeter.
Power Source:	Compressed air bottle plus two 6-volt, dry-cell lantern batteries.
Sample Refrigerator:	None
Construction Materials:	Standard intake housing is aluminum alloy; stainless steel and PVC are available as alternates. Standard "duckbill" is EPT; Buna-N and Viton are available. Tygon tubing, stainless steel or plastic fittings, polyethylene sample bottle, fiberglass case.
Basic Dimensions:	Sample intake is 7.3 cm (2.875 in.) diameter x 12.7 cm (5 in.) H; case is 43 x 30 x 71 cm (17x12x 28 in.); weighs 27.2 kg (60 lbs); portable.

Base Price: $1095; add $135 for stainless steel or PVC intake, $20 for Viton "duckbill", $100 for flow proportional adapter; all prices include air freight and duty.

General Comments: The heart of the sampler is the patented rubber "duckbill" in the sample intake housing. It is round on the bottom and flattens out to a flaired top where the opening is simply a slit. When the intake is vented to atmosphere, the hydrostatic liquid head forces a sample up through the vertical inlet and through the "duckbill" slit, which acts like a screen (the lips can only open a limited amount), until the pressure is equalized. When air pressure is applied to raise the sample the "duckbill" lips close (acting as a check valve), and the squeezing-shut progresses downwards toward the bottom inlet expelling ahead (in a sort of milking action) any contained solids which fall back into the stream due to gravity.

Designation:	MARKLAND MODEL 101
Manufacturer:	Markland Specialty Engineering Ltd. Box 145 Etobicoke, Ontario (Canada) Phone (416) 625-0930
Sampler Intake:	Small gravity filled sample chamber equipped with patented non-clogging "duckbill" inlet control.
Gathering Method:	Forced flow due to pneumatic ejection.
Sample Lift:	18.3m (60 ft) standard.
Line Size:	0.64 cm (1/4 in.) I.D.
Sample Flow Rate:	Varies with pressure and lift.
Sample Capacity:	Composites 75-mℓ aliquots into a 7.6ℓ (2 gal) bottle.
Controls:	A cycle timer with field adjustable cams allows taking an aliquot every 10, 15, 20, 30, or 60 minutes.
Power Source:	Plant air for Model 101; Model 2101 includes air compressor and motor; 110 VAC.
Sample Refrigerator:	0.17 cu m (6 cu ft) automatic refrigerator to hold either a 7.6 or 18.9ℓ (2 or 5 gal) bottle available.
Construction Materials:	Standard intake housing is aluminum alloy; stainless steel and PVC are available as alternates. Standard "duckbill" is EPT; Buna-N and Viton are available. Tygon tubing, stainless steel or plastic fittings, polyethylene sample bottle.

Basic Dimensions:	Sample intake is 7.3 cm (2.875 in.) diameter x 12.7 cm (5 in.) H; wall-mounted control box is 15 x 10 x 15 cm (6x4x6 in.); fixed installation.
Base Price:	$594 for Model 101 including control box, remote sampling intake, air filter, regulator and pressure gauge, 100 feet of tubing, and 2 gallon sample collection bottle; $634 for Model 2101 including control box, remote sampling intake, air compressor and motor, 100 feet of tubing, and 2 gallon sample collection bottle; add $135 for stainless steel or PVC intake, $20 for Viton "duckbill", $335 for refrigerator, $11 for 5 gallon sample container; all prices include air freight and duty. Model 300 discrete 24 bottle attachment is $795.
General Comments:	The heart of the sampler is the patented rubber "duckbill" in the sample intake housing. It is round on the bottom and flattens out to a flaired top where the opening is simply a slit. When the intake is vented to atmosphere, the hydrostatic liquid head forces a sample up through the "duckbill" slit, which acts like a screen (the lips can only open a limited amount), until the pressure is equalized. When air pressure is applied to raise the sample, the "duckbill" lips close (acting as a check valve), and the squeezing-shut progresses downwards toward the bottom inlet expelling ahead (in a sort of milking action) any contained solids which fall back into the stream due to gravity.

Designation:	MARKLAND MODEL 102
Manufacturer:	Markland Specialty Engineering Ltd. Box 145 Etobicoke, Ontario (Canada) Phone (416) 625-0930
Sampler Intake:	Small gravity filled sample chamber equipped with patented non-clogging "duckbill" inlet control.
Gathering Method:	Forced flow due to pneumatic ejection.
Sample Lift:	18.3m (60 ft) standard.
Line Size:	0.64 cm (1/4 in.) I.D.
Sample Flow Rate:	Varies with pressure and lift.
Sample Capacity:	Composites 75-mℓ aliquots into a 7.6ℓ (2 gal) bottle.
Controls:	A cycle timer with field adjustable cams allows taking an aliquot every 10, 15, 20, 30, or 60 minutes.
Power Source:	Plant air plus 110 VAC.
Sample Refrigerator:	0.17 cu m (6 cu ft) automatic refrigerator to hold either a 7.6 or 18.9ℓ (2 or 5 gal) bottle available.
Construction Materials:	Standard intake housing is aluminum alloy; stainless steel and PVC are available as alternates. Standard "duckbill" is EPT; Buna-N and Viton are available. Tygon tubing, stainless steel or plastic fittings, polyethylene sample bottle, fiberglass case.
Basic Dimensions:	Sample intake is 7.3 cm (2.875 in.) diameter x 12.7 cm (5 in.) H; wall-mounted control box is 25 x 13 x 30 cm (10x5x12 in.); fixed installation.

Base Price:	$894. Includes control box, remote sampling intake, air filter, regulator and pressure gauge, 100 feet of tubing, and 2 gallon sample collection bottle. Add $135 for stainless steel or PVC intake, $20 for Viton "duckbill", $325 for refrigerator, $10 for 5 gallon sample container. All prices include air freight and duty. Model 300 discrete 24 bottle attachment is $795.
General Comments:	The heart of the sampler is the patented rubber "duckbill" in the sample intake housing. It is round on the bottom and flattens out to a flaired top where the opening is simply a slit. When the intake is vented to atmosphere, the hydrostatic liquid head forces a sample up through the vertical inlet and through the "duckbill" slit, which acts like a screen (the lips can only open a limited amount), until the pressure is equalized. When air pressure is applied to raise the sample the "duckbill" lips close (acting as a check valve), and the squeezing-shut progresses downwards toward the bottom inlet expelling ahead (in a sort of milking action) any contained solids which fall back into the stream due to gravity. The control box has a pinch valve on the sample line which squeezes it closed and keeps the sample intake housing filled with pressurized air between aliquot ejections. This feature is useful when sampling liquids with high solids content which would tend to settle out in the intake while waiting to be ejected. Also, the air pressurization provides a reverse air

purge back through the "duckbill" thereby providing a sort of self cleaning action should any solids build up in the "duckbill" inlet. The manufacturer recommends this model in particular for raw sewage or liquids with solids content over 200 PPM.

Designation:	MARKLAND MODEL 104T
Manufacturer:	Markland Specialty Engineering Ltd. Box 145 Etobicoke, Ontario (Canada) Phone (416) 625-0930
Sampler Intake:	Small gravity filled sample chamber equipped with patented non-clogging "duckbill" inlet control.
Gathering Method:	Forced flow due to pneumatic ejection.
Sample Lift:	18.3m (60 ft) standard.
Line Size:	0.64 cm (1/4 in.) I.D.
Sample Flow Rate:	Varies with pressure and lift.
Sample Capacity:	Composites 75-mℓ aliquots into a 7.6ℓ (2 gal) bottle.
Controls:	Solid state predetermining digital counter accepts signals from an external flowmeter to gather samples proportional to flow. Optional solid state clock allows sampling at predetermined time intervals.
Power Source:	Plant air for Model 104T; Model 2104T includes air compressor and motor; 110 VAC.
Sample Refrigerator:	0.17 cu m (16 cu ft) automatic refrigerator to hold either a 7.6 or 18.9ℓ (2 or 5 gal) bottle available.
Construction Materials:	Standard intake housing is aluminum alloy; stainless steel and PVC are available as alternates. Standard "duckbill" is EPT; Buna-N and Viton are available. Tygon tubing, stainless steel or plastic fittings, polyethylene sample bottle, fiberglass case.

Basic Dimensions: Sample intake is 7.3 cm (2.875 in.) diameter x 12.7 cm (5 in.) H; fixed installation.

Base Price: $1094 for Model 104T including control box, remote sampling intake, air filter, regulator and pressure gauge, 100 feet of tubing, and 2 gallon sample collection bottle; $1134 for Model 2104T including control box, remote sampling intake, air compressor and motor, 100 feet of tubing, and 2 gallon sample collection bottle. Add $135 for stainless steel or PVC intake, $20 for Viton "duckbill", $335 for refrigerator, $10 for 5-gallon sample container, and $215 for plug-in solid state clock module. All prices include air freight and duty. Model 300 discrete 24 bottle attachment is $795.

General Comments: The heart of the sampler is the patented rubber "duckbill" in the sample intake housing. It is round on the bottom and flattens out to a flaired top where the opening is simply a slit. When the intake is vented to atmosphere, the hydrostatic liquid head forces a sample up through the vertical inlet and through the "duckbill" slit, which acts like a screen (the lips can only open a limited amount) until the pressure is equalized. When air pressure is applied to raise the sample, the "duckbill" lips close (acting as a check valve), and the squeezing-shut progresses downwards toward the bottom inlet expelling ahead (in a sort of milking action) any contained solids which fall back into the stream due to gravity. The two digit counter, when connected to an external flowmeter providing dry contact pulsing closed momentarily with frequency proportional to flow, counts down from the preset point to zero. When zero is reached, the sampling circuit latches in and extracts an aliquot while simultaneously resetting the counter back to the reset point. Pulses received while the aliquot is being ejected are counted without loss.

Designation:	NALCO MODEL S-100
Manufacturer:	Nalco Chemical Company 180 N. Michigan Avenue Chicago, Illinois 60601 Phone (312) 887-7500
Sampler Intake:	End of 1.3 cm (1/2 in.) standard garden hose.
Gathering Method:	Forced flow from submersible pump.
Sample Lift:	Up to 7.6m (25 ft).
Line Size:	1.3 cm (1/2 in.) garden hose.
Sample Flow Rate:	28.4 ℓpm (7.5 gpm) at 6m (20 ft).
Sample Capacity:	Aliquot volume between 50 to 900 mℓ is a function of the preset diversion time (from 0.6 to 6.0 seconds); composited in user-supplied container.
Controls:	Can be used for either automatic or manual collection of samples. May be operated from a relay tripped by an external flowmeter or level switch contact or by a built-in interval timer that can be set from 3 minutes to 150 minutes.
Power Source:	115 VAC
Sample Refrigerator:	None.
Construction Materials:	Plastic or rubber hose lines; cases are plastic.
Basic Dimensions:	Control box is 29 x 22 x 25 cm (11.5x8.5x10 in.) and weighs 4.5 kg (10 lbs); carrying case is 52 x 20 x 41 cm (20.5x8x16 in.) and weighs 12.2 kg (27 lbs); portable.

Base Price: Not available at time of writing.

General Comments: Can be used portably or installed permanently in one location. Inlet connection to the pump is a standard female garden hose fitting; outlet connection is a standard male garden hose fitting. Sample container must be provided by user. Unit has a pre-flush before each sample diversion to help assure representative flow, and drainage after each sample interval helps keep system clean and free of cross-contamination.

Designation:	NAPPE PORTA-POSITER SAMPLER
Manufacturer:	Nappe Corporation Croton Falls Industrial Complex Route 22 Croton Falls, New York 10519 Phone (914) 277-3085
Sampler Intake:	Provided by user; sampler has 0.64cm (1/4 in.) NPT male hose fitting.
Gathering Method:	Suction lift from self-priming positive displacement pump with flexible impeller.
Sample Lift:	1.8m (6 ft) maximum.
Line Size:	Line from petcock to sample container appears to be about 0.64 cm (1/4 in.) I.D.
Sample Flow Rate:	Pump delivers up to 11.4 ℓpm (3 gpm). Flow through by-pass to sample container depends upon petcock setting.
Sample Capacity:	Adjustable size aliquots (20 to 240 mℓ) are composited in a 3.8ℓ (1 gal) container.
Controls:	The pump is operated once every 15 minutes for a period of 20 seconds. A cycle progress indicator informs the operator of the time to next sample. There is also a manual advance to the next sample.
Power Source:	Model PPAC is 115 VAC; Model PPD is 12 VDC and Model PPU is 115 VAC or 12 VDC. The 12 VDC power must be supplied by the user and is usually a wet-cell battery.
Sample Refrigator:	None.

Construction Materials:	Sample train is bronze, brass, Buna-N, and polyethylene. Casing is 16 gauge steel with baked enamel finish.
Basic Dimensions:	Basic unit is 24 x 22 x 34 cm (9.5x8.5x13.5 in.); Models PPAC and PPD weigh 10.4 kg (23 lbs); Model PPU weighs 11.8 kg (26 lbs); portable.
Base Price:	PPAC-4 $225. PPD-4 $245. PPU-4 $285.
General Comments:	At the end of each sampling cycle, both inlet and exhaust are gravity drained. This drainage provides a sort of backwashing to help prevent clogging. Model PPU is provided with two interchangeable power cords; models PPAC and PPD have permanent power cords. A sample intake strainer is available as an option at $12.50, and a mounting base is available at $10.00. 1.3 cm (1/2 in.) I.D. polyethylene hose is available at $1.50 per foot.

Designation:	NAPPE SERIES 46 LIQUID SAMPLER
Manufacturer:	Nappe Corporation Croton Falls Industrial Complex Route 22 Croton Falls, New York 10519 Phone (914) 277-3085
Sampler Intake:	Provided by user; sampler has 0.95 cm (3/8 in.) NPT female pipe inlet.
Gathering Method:	Suction lift from self-priming pump with flexible impeller.
Sample Lift:	To 4.6m (15 ft) suction; to 6m (20 ft) discharge.
Line Size:	0.95 cm (3/8 in.) I.D.
Sampler Flow Rate:	Pump delivers up to 13.2 ℓpm (3.5 gpm).
Sample Capacity:	Adjustable size aliquots are composited in a 11.4ℓ (3 gal) sample container.
Controls:	Sampler can be triggered by an adjustable timer which sets the frequency between samples or by an external flowmeter for flow-proportional sampling. Pump is programmed for one of three cycles depending upon sample requirements.
Power Source:	115 VAC.
Sample Refrigerator:	Refrigeration is available and consists of a chilling coil immersed in the sample container. The compressor is housed in a compartment on top of the main sample cabinet. Temperature control is by an expansion valve that is factory set at 7°C (45°F).

Construction Materials: Pump is stainless steel with neoprene impeller. Solenoid is stainless steel and neoprene. Sample container is polyethylene. Hoses are reinforced neoprene. Sampler cabinet is primed aluminum finished in baked enamel. Hinges are stainless steel; lock is brass.

Basic Dimensions: Non-refrigerated - 39 x 34 x 102 cm (15.4x13.5x40.1 in.); Refrigerated - 39 x 34 x 130 cm (15.4x13.5x51.1 in.); Shipping weight is 91 kg (200 lbs); designed for fixed installation.

Base Price: \$1100 to \$1800 depending upon options.

General Comments: The pump is programmed for one of three cycles. For lifts up to 3m (10 ft), the pump operates for 30 seconds prior to and during the sample diversion; for lifts from 3 to 4.6m (10 to 15 ft), the pump runs continuously and is protected by a pressure sensor; and for lifts over 4.6m (15 ft), the pump is located outside the cabinet, alongside the sampling point and runs continuously. The electrical programmer is housed on the cabinet door and is hinged to permit access. Sealed disconnect couplings are used on the refrigeration lines to permit cleaning of coils. For situations where the sampling point is not accessible to the sampler, an optional submersible pump is available.

Designation:	N-CON SURVEYOR II MODEL
Manufacturer:	N-Con Systems Company, Inc. 308 Main Street New Rochelle, New York 10801 Phone (914) 235-1020
Sampler Intake:	End of 1.3 cm (1/2 in.) sampling tube installed to suit by user.
Gathering Method:	Suction lift by self-priming flexible impeller pump.
Sample Lift:	1.8m (6 ft) maximum.
Line Size:	0.64 cm (1/4 in.) I.D. line connects diverter to sample container.
Sample Flow Rate:	20 ℓpm (5 gpm).
Sample Capacity:	Aliquot size adjustable from approximately 150 mℓ to 5000 mℓ; composited in user supplied container, 7.6ℓ (2 gal) jug to 208ℓ (55 gal) drum.
Controls:	Timer may be set to collect from 3 to 20 samples per hour; may also be paced by either pulse duration or totalizer signals from external flowmeter.
Power Source:	115 VAC.
Sample Refrigerator:	115 VAC/12 VDC refrigerator which can hold either one 7.6ℓ (2 gal) or two 3.8ℓ (1 gal) bottles available.
Construction Materials:	Sampling train is PVC, nylon, epoxy resin, and Buna-N.
Basic Dimensions:	28 x 20 x 25 cm (11 x 8 x 10 in); weighs 6.8 kg (15 lbs); portable.
Base Price:	$290; add $280 for refrigerator, $20 for flow proportional hook-up.
General Comments:	When sample is to be collected, the self-priming pump operates for a preset period of time which determines the volume of the sample.

Approximately 15% of the pump's throughput is diverted to the sample receiver by a fluidic diverter. When the pump stops the fall of liquid level in the exhaust line backwashes to help prevent clogging. User must supply reinforced garden hose lines for sample intake and return and sample container.

Designation:	N-CON SCOUT II MODEL
Manufacturer:	N-Con Systems Company, Inc. 308 Main Street New Rochelle, New York 10801 Phone (914) 235-1020
Sampler Intake:	Plastic strainer approximately 5 cm (2 in.) diameter x 20 cm (8 in.) long and perforated with 0.3 cm (1/8 in.) holes.
Gathering Method:	Suction lift by peristaltic pump.
Sample Lift:	Up to 5.5 m (18 ft).
Line Size:	0.64 cm (1/4 in.) I.D.
Sample Flow Rate:	150 mℓ per minute.
Sample Capacity:	Aliquot size is adjustable via a solid state timer to suit hydraulics of installation and sampling programs; composited in a 3.8ℓ (1 gal) container.
Controls:	All solid state controller in moisture-proof enclosure has function switch for test, reset and set, and purge selection (before, after, or both before and after sample collection), sample volume setting knob, on/off switch, and samples per hour switch (1, 2, 4, or 8 per hour or one sample every 1, 2, or 3 hours). Float switch automatically shuts unit off when sample container is full. Unit may also be paced by any flow totalizer providing a momentary contact closure every preset number of gallons.
Power Source:	115 VAC or internal 12 VDC solid-gel battery.
Sample Refrigerator:	115 VAC/12 VDC refrigerator which can hold either one 7.6ℓ (2 gal) or two 3.8ℓ (1 gal) bottles available.

Construction Materials: Sampling train PVC, silicone rubber, polyethylene; case is compression molded fiberglass, stainless steel hardware.

Basic Dimensions: 36 x 15 x 43 cm (14x6x17 in.); weighs 10 kg (22 lbs); portable.

Base Price: $575; solid-gel battery is $42, charger is $38, automatic refrigerator is $280.

General Comments: Optional refrigerator is absorption-type, measures 43 x 43 x 38 cm (17x17x15 in.), and weighs 9.5 kg (21 lbs). Case is weatherproof.

Designation:	N-CON SENTRY 500 MODEL
Manufacturer:	N-Con Systems Company, Inc. 308 Main Street New Rochelle, New York 10801 Phone (914) 235-1020
Sampler Intake:	Plastic strainer approximately 5 cm (2 in.) diameter x 20 cm (8 in.) long and perforated with 0.3 cm (1/8 in.) holes.
Gathering Method:	Suction lift by peristaltic pump.
Sample Lift:	Up to 5.5m (18 ft).
Line Size:	0.64 cm (1/4 in.) I.D.
Sample Flow Rate:	150 mℓ per minute.
Sample Capacity:	Collects 24 sequential composite 500 mℓ samples made up of from 2, 4, or 8 individual aliquots over a period of 3 to 72 hours.
Controls:	Same as Scout II Model plus bottles per hour switch adjustable from 8 bottles per hour to 1 bottle in 3 hours.
Power Source:	115 VAC or internal 12 VDC solid-gel battery.
Sample Refrigerator:	Available as option.
Construction Materials:	Same as Scout II, but glass sample jars (clear styrene optional) and aluminum case with baked-on synthetic enamel finish.
Basic Dimensions:	37 x 37 x 56 cm (14.5 x 14.5 x 22 in.); weighs 17.7 kg (39 lbs) portable.
Base Price:	$1,125; solid-gel battery is $42, charger is $38.

General Comments:

Similar in operation to the Scout Model except for capability to collect discrete samples. Sampler automatically shuts off after 24th bottle is filled. Twin doors provide easy access at both front and rear of case. Sample distribution tray slides out for easy cleaning without disturbing other components. A second pump head may be easily field installed, providing the ability to collect a single as well as sequential composite sample simultaneously or to sample at different levels in the flow or from two different sources simultaneously.

Designation:	N-CON SENTINEL MODEL
Manufacturer:	N-Con Systems Company, Inc. 308 Main Street New Rochelle, New York 10801 Phone (914) 235-1020
Sampler Intake:	Provided by user; sampler has standard 5 cm (2 in.) pipe inlet.
Gathering Method:	External head to provide flow through a sampling chamber from which an oscillating dipper (after McGuire and Stormgaard) extracts a sample aliquot and transfers it to a funnel where it is gravity fed to a composite bottle.
Sample Lift:	Not applicable.
Line Size:	Smallest line in sampling train is the one connecting the funnel to the sample bottle; it appears to be about 2.5 cm (1 in.).
Sample Flow Rate:	38 to 189 ℓpm (10 to 50 gpm).
Sample Capacity:	Sampling dipper collects a 25 mℓ aliquot; a 7.6ℓ (2 gal) composite container is provided.
Controls:	Constant rate sampling (between 3 and 20 samples per hour) is controlled by built-in timer; flow proportional composites are collected by connecting to the electrical output of a pulse duration or integrating external flowmeter.
Power Source:	115 VAC electricity
Sample Refrigerator:	Automatic refrigerator to maintain sample at 4° to 10°C is available.
Construction Materials:	PVC and polyethylene.
Basic Dimensions:	56 x 71 x 147 cm (22 x 28 x 58 in.). Designed for fixed installation. Weighs 83.9 kg (185 lbs).

Base Price:	Around $2,600 with refrigerator.
General Comments:	Manufacturer claims representative samples assured due to design of sample chamber which causes thorough mixing of liquid before it flows over adjustable weir.

Designation:	N-CON TREBLER MODEL
Manufacturer:	N-Con Systems Company, Inc. 308 Main Street New Rochelle, New York 10801 Phone (914) 235-1020
Sampler Intake:	Specially designed scoop.
Gathering Method:	Mechanical; oscillating scoop is lowered into the channel traversing entire depth of flow, then returned to its raised position, draining the collected sample by gravity through a swivel fitting coaxial with the hub into a sample container.
Sample Lift:	Unit must be in flow stream.
Line Size:	1.3 cm (1/2 in.) diameter pipe connects hub to sample container.
Sample Flow Rate:	Not applicable.
Sample Capacity:	Scoop is shaped to gather a volume of liquid that is proportional to the channel flow; can vary typically from 200 to 600 mℓ when installed in a Parshall flume.
Controls:	Electric timer may be set to take from 3 to 20 samples per hour.
Power Source:	115 VAC electricity
Sample Refrigerator:	Automatic refrigerator available which provides 4° to 10°C sample storage.
Construction Materials:	Cast aluminum frame and cover; PVC scoop, plastic pipe.
Basic Dimensions:	Approximately 0.6 to 0.9m (2 to 3 ft) of headroom is required. Other dimensions depend upon size of flume or weir. Refrigerator case is 61 x 66 x 76 cm (24 x 26 x 30 in.). Designed for fixed installation.

Base Price: $1,050; add $300 for refrigerator.

General Comments: Drive mechanism and control programmer are totally enclosed and weatherproof, with no exposed chains or sprockets. Oscillating action of scoop permits installation in smaller weir boxes and manholes and lessens the chances of fouling with rags, etc., or being damaged by floating debris. Must operate in conjunction with a weir or Parshall flume.

Designation:	NOASCONO AUTOMATIC SHIFT SAMPLER
Manufacturer:	Paul Noascono Company 805 Illinois Avenue Collinsville, Illinois 62234 Phone (618) 344-3706
Sampler Intake:	End of 0.48 cm (3/16 in.) I.D. suction tube installed to suit by user.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	Up to 9m (30 ft).
Line Size:	0.48 cm (3/16 in.) I.D.
Sample Flow Rate:	Up to 8 mℓ per minute.
Sample Capacity:	Ten user-supplied wide mouth, 3.8ℓ (1 gal) jars are sequentially filled from continuously running pump; one jar requires 8 hours to fill.
Controls:	On/off switch. Speed regulation is accomplished by a variable pump pulley and with a two-step motor pulley.
Power Source:	110 VAC.
Sample Refrigerator:	None.
Construction Materials:	Sampler box is "Benelex", plywood, and stainless steel. Sampling train is Mayon, teflon, and Tygon. Other parts are bronze and plastic.
Basic Dimensions:	41 x 122 x 56 cm (16x48x22 in.); weighs 39 kg (87 lbs); portable.
Base Price:	$360.

General Comments:

Manufacturer claims that construction of box will ensure corrosion-free operation and will enable sampler to operate at sub-zero temperatures with the addition of user-supplied heater. Box cover is insulated with styrofoam blanket. Box is designed to hold 10 wide-mouth 3.7ℓ (1 gal) sample jars which must be supplied by the user. A threaded stainless steel driving shaft and plastic trough are used to deliver sample to jars sequentially. Manufacturer notes that samples will not be representative as regards solids content.

Designation:	PERI PUMP MODEL 704
Manufacturer:	The Peri Pump Company Ltd. 951 Killarney Drive Pittsburg, Pennsylvania 15234 Phone (613) 392-6048
Sampler Intake:	Weighted screen at end of 1.8m (6 ft) long suction tube installed to suit by user.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	Designed to operate between 1.2 and 1.8m (4 and 6 ft); Manufacturer claims, however, that pump is capable of lifting over 7.6m (25 ft) although at reduced output.
Line Size:	Appears to be about 0.64 cm (1/4 in.) I.D.
Sample Flow Rate:	Approximately 160 mℓ per minute.
Sample Capacity:	Fixed size (approx. 40 mℓ) aliquots are taken every 15 minutes and composited in a 3.8ℓ (1 gal) container.
Controls:	On/off switch.
Power Source:	Two 12 VDC dry-cell batteries.
Sample Refrigerator:	None
Construction Materials:	Sample train is PVC and silicon. Case is aluminum with rubber sealed door and epoxy-sealed controls and is painted with an acrylic lacquer.
Basic Dimensions:	49 x 37 x 30 cm (16x12x10 in.); weighs 11.3 kg (25 lbs); portable.
Base Price:	Not available at time of writing.

General Comments: An overflow tube is connected to the container in case the unit is left longer than 24 hours. Aliquot size is a function of lift.

Designation:	PHILIPS AUTOMATIC SAMPLER
Manufacturer:	Philips Electronic Instruments, Inc. 750 South Fulton Avenue Mount Vernon, New York 10550 Phone (914) 664-4500
Sampler Intake:	Wire mesh guarded plastic cylinder 50 cm (20 in.) in diameter in which floating pump maintains intake at a constant but adjustable depth; 50 cm (20 in.) recommended.
Gathering Method:	Forced flow from submersible pump.
Sample Lift:	15m (49 ft) minimum.
Line Size:	Appears to be at least 1.3 cm (1/2 in.).
Sample Flow Rate:	Between 1 and 2 m/s (3.3 and 6.6 fps); pump capacity is approximately 1 ℓ/s (16 gpm).
Sample Capacity:	Twelve 2-liter containers.
Controls:	Sample container filling rate can be controlled in proportion to liquid level or flow, a constant filling rate can be used, or bottles can be filled almost instantly with a fixed time interval between samples.
Power Source:	115 VAC.
Sample Refrigerator:	Automatic refrigerator to maintain sample compartment at 3°-4°C; typically a 2ℓ sample will cool from 30° to 5°C in one hour.
Construction Materials:	Appears to be all plastic.
Basic Dimensions:	Large unit suitable for fixed installation.
Base Price:	Not available at time of writing.
General Comments:	Flow from the pump is directed to a surge tank external to the main cabinet. For regular sampling a

motor driven, rotating dosing ring, normally with 3-10 mℓ chambers, is mounted over the distributor ring. The motor speed is controlled in proportion to either flow or level of the waterway. Alternatively a fixed time or filling rate can be used. A separately driven distributor ring directs the samples to any one of the twelve 2 litre containers, via individual hose connections. This is programmed to move to the next container as required. An intermediate position closes all connections to containers after sample deliveries, so minimizing exposure to air. Contamination is minimized by the fast intake of 3-4 ℓ/min and the use of 10 mℓ dosing chambers. Cleaning ports are provided in both dosing and distribution rings for routine cleaning if required.

Designation:	PHIPPS AND BIRD DIPPER-TYPE
Manufacturer:	Phipps and Bird, Inc. P.O. Box 27324 Richmond, Virginia 23261 Phone (804) 264-2858
Sampler Intake:	Dipping bucket.
Gathering Method:	Mechanical; dipper on sprocket-chain drive.
Sample Lift:	Up to 3m (10 ft) standard, longer on special order.
Line Size:	Not applicable.
Sample Flow Rate:	Not applicable.
Sample Capacity:	Dipping bucket holds ~200 mℓ; user supplies sample composite container to suit.
Controls:	Sampling cycle can either be started at fixed, selected intervals from a built-in timer (15 minutes) or in response to signals from an external integrating flowmeter. Test switch.
Power Source:	115 VAC or 12 VDC electricity.
Sample Refrigerator:	Optional refrigerator, with wide mouth sample intake (to match sampler discharge trough) leading to custom sampler container, will maintain sample between 4-10°C.
Construction Materials:	Dipper and funnel are stainless steel; sprockets and chain are steel (stainless available), supports are angle iron.
Basic Dimensions:	Lower portion of unit will pass through a 30.5 cm (12 in.) diameter opening; base is 41 x 61 cm (16 x 24 in.) and entire unit will pass through a 76 cm (30 in.) diameter opening; unit extends 0.9m (3 ft) above base. Fixed installation.

Base Price: $725; $1,145 in stainless steel; $1,980 for explosion proof version; $2,450 for explosion proof version in stainless steel; refrigerator is $325.

General Comments: Manufacturer states unit was designed to sample trash laden streams where it is not possible to operate a pump. A circuit breaker prevents damage if unit becomes jammed.

Designation:	PROTECH MODEL CG-110
Manufacturer:	Protech, Inc. Roberts Lane Malvern, Pennsylvania 19355 Phone (215) 644-4420
Sampler Intake:	Plastic sampling chamber (about 5 cm diameter) with two rows of 0.3 cm (1/8 in.) diameter ports around the circumference. Weighted bottom caps are available to keep the intake screen off the bottom.
Gathering Method:	Forced flow due to pneumatic ejection.
Sample Lift:	Standard maximum is 9.1m (30 ft).
Line Size:	0.32 cm (1/8 in.) I.D.
Sample Flow Rate:	Less than 1 ℓpm; depends upon pressure setting and lift.
Sample Capacity:	Sample chamber volumes of 25, 50, 75, or 100 mℓ; composited in user supplied container.
Controls:	Sampling frequency is determined by a built-in ratemeter and fluidic accumulator timing circuit. Sampling interval adjustable from 2 to 60 minutes. On-off valve for control of external pressure source. Standard 50 mℓ sample chamber has removable 25 mℓ plug.
Power Source:	Requires external pressure source such as refrigerant type of propellant, nitrogen or compressed air.
Sample Refrigerator:	Available as an option.

Construction Materials:	All components in sampling train are TFE resins, PVC, and nylon. Case is heavy duty aluminum with baked vinyl finish.
Basic Dimensions:	33 x 23 x 30 cm (13x9x12 in.); weighs 7.3 kg (16 lbs); portable.
Base Price:	$485.
General Comments:	Model is explosion proof. No battery or electrical lines needed. Propellant consumption is approximately equivalent to 150-170 samples per 0.45 kg (1 lb) of R-12 refrigerant. Optionally available are TFE sample chamber and tubing for sampling oily or sticky liquids, puncturing valve for propellant in sealed refrigerant cans, short unweighted bottom cap for sample chamber, and a portable refrigerator.

Designation:	PROTECH MODEL CG-125
Manufacturer:	Protech, Inc. Roberts Lane Malvern, Pennsylvania 19355 Phone (215) 644-4420
Sampler Intake:	Plastic sampling chamber (about 5 cm diameter) with two rows of 0.3 cm (1/8 in.) diameter ports around the circumference. Weighted bottom caps are available to keep the intake screen off the bottom.
Gathering Method:	Forced flow due to pneumatic ejection.
Sample Lift:	Standard maximum is 9.1m (30 ft).
Line Size:	0.32 cm (1/8 in.) I.D.
Sample Flow Rate:	Less than 1 ℓpm (1/4 gpm); depends upon pressure setting and lift.
Sample Capacity:	Sample chamber volumes from 25 to 250 mℓ available; sample composited in suitable container, 5.8ℓ (1.5 gal) jug available.
Controls:	Sampling frequency is determined by metering gas pressure (via a rotometer with a vernier needle valve and two float balls) into a surge tank until a preset pressure, normally 1 kg/sq cm (15 psi), is reached, whereupon a pressure controller releases the gas, a 0.14 kg/sq cm (2 psi) differential, to the sample chamber forcing the sample up to the sample bottle and blowing the lines clear. The higher the gas flow rate the higher the sampling frequency. Sampling frequency is adjustable from two minutes to one hour.
Power Source:	Three 0.45 kg (1 lb) cans of refrigerant on a common manifold inside the case is standard; compressed air or nitrogen can also be used.

Sample Refrigerator:	Portable refrigerator (110 VAC or 12 VDC) with capacity for one 5.8ℓ (1.5 gal) or two 3.8ℓ (1 gal) sample containers available.
Construction Materials:	All components in sampling train are TFE resins, PVC, and nylon. Case is aluminum, gas valves and fittings are of brass and copper.
Basic Dimensions:	33 x 25 x 43 cm (13 x 10 x 17 in.) standard; deep case large enough to hold a 5.8ℓ (1.5 gal) sample container and winterizing kit is available. Standard unit weighs 14 kg (31 lbs) total; portable.
Base Price:	$695 for basic unit including 50 mℓ sample chamber, 6 cans of refrigerant, and two 9m (30 ft) lengths of tubing. Add $75 for deep case; $140 for winterizing kit; $20 for 100 mℓ or $80 for 250 mℓ sample chamber; $275 for refrigerator. Two high-lift, to 91m (300 ft), models are available; CG-170 at $870 offers continuously adjustable lift, while CG-190 at $890 has convertible high/low lift.
General Comments:	Standard model is explosion proof, no battery or electrical power is required. Manufacturer claims unit will sample up to 1/8" diameter solids. Check valve in sample chamber is self-cleaning. Self-cleaning feature is accomplished by the two-way flushing action which occurs during each filling and pressurizing cycle. A flow splitter provides 1 to 2, 1 to 1, or 2 to 1 ratio of sample flow to waste return flow. Three cans of refrigerant allow taking up to 250 aliquots. Winterizing is accomplished using strip heaters operated by an automatic temperature control.

Designation: PROTECH MODEL CG-125FP

Manufacturer: Protech, Inc.
Roberts Lane
Malvern, Pennsylvania 19355
Phone (215) 644-4420

Sampler Intake: Plastic sampling chamber (about 5 cm diameter) with two rows of 0.3 cm (1/8 in.) diameter ports around the circumference. Weighted bottom caps are available to keep the intake screen off the bottom.

Gathering Method: Forced flow due to pneumatic ejection.

Sample Lift: Standard maximum is 9.1m (30 ft).

Line Size: 0.32 cm (1/8 in.) I.D.

Sample Flow Rate: Less than 1 ℓpm (1/4 gpm); depends upon pressure setting and lift.

Sample Capacity: Sample chamber volumes from 25 to 250 mℓ available; sample composited in suitable container, 5.8ℓ (1.5 gal) jug available.

Controls: Can take samples at preset time intervals in same way as Model CG-125. For flow proportional sampling a normally closed, solenoid operated valve in the gas inlet opens momentarily on receiving an impulse from an external flow registering device. The sampling frequency is determined by the frequency and duration of these impulses and the rotometer setting. Thus the intermittent flow signal impulses are translated into fluidic impulses that are accumulated in the surge tank which serves as a totalizer. If the flow proportional signal is supplied by a totalizer and it is desired to take one sample per impulse, a solid state timer is available

	which will hold the solenoid open long enough to accumulate the necessary pressure.
Power Source:	115 VAC or 6 VDC; three 0.45 kg (1 lb) cans of refrigerant on a common manifold inside the case is standard; compressed air or nitrogen can also be used.
Sample Refrigerator:	Optional as with CG-125.
Construction Materials:	All components in sampling train are TFE resins, PVC, and nylon. Case is aluminum, gas valves and fittings are of brass and copper.
Basic Dimensions:	Same as Model CG-125.
Basic Price:	$925 for basic unit; add $250 for solid state timer, other accessories priced as for Model CG-125.
General Comments:	Basically a flow proportional version of Model CG-125. Completely portable in battery version. Control solenoid is certified by UL for use in hazardous areas.

Designation: PROTECH MODEL CEG 200

Manufacturer: Protech, Inc.
Roberts Lane
Malvern, Pennsylvania 19355
Phone (215) 644-4420

Sampler Intake: Plastic 250 mℓ sampling chamber with 4 removable 50 mℓ plugs.

Gathering Method: Forced-flow due to pneumatic ejection.

Sample Lift: Standard maximum is 16.8m (55 ft).

Line Size: Smallest line is 0.32 cm (1/8 in.) I.D.

Sample Flow Rate: Less than 1 ℓpm (1/4 gpm); depends upon pressure setting and lift.

Sample Capacity: Aliquots taken by 250 mℓ sample chamber with 4 removable 50 mℓ plugs are composited in a 5.8ℓ (1.5 gal) sample container.

Controls: Sampling interval and duration are controlled individually (6 seconds to 60 hours) from panel with visible countdown. Samples can be taken by propellant from an external pressure source, or by internal air compressor for continuous use or standby. Accepts signals by preset timer or from external flowmeter signal. Purging time is controllable via sample duration timer. Higher lift than standard is available by resetting internal pressure regulator.

Power Source: 115 VAC and propellant from an external pressure source such as nitrogen, compressed air, or refrigerant.

Sample Refrigerator:	Noiseless absorption type available as an option with capacity for one 5.8ℓ (1.5 gal) or two 3.8ℓ (1 gal) sample containers. An aluminum stand is also available to support the refrigerator on a shelf below the sampler. Stationary models accommodate the refrigerator within cabinet.
Construction Materials:	All components in sampling train are TFE resins, PVC, and nylon. Case is aluminum.
Basic Dimensions:	Portable - 33 x 48 x 43 cm (13x19x17 in.), weighs 18 kg (40 lbs) total; Stationary indoor- 69 x 66 x 127 cm (27x26x50 in.), weighs 107 kg (235 lbs) total; Stationary outdoor - 76 x 66 x 152 cm (30x26x60 in.), weighs 118 kg (260 lbs) total.
Base Price:	$1,345 (portable), $1,990 (stationary indoor), and $2445 (stationary outdoor); all include 250 mℓ sample chamber, 15.2m (50 ft) each of 0.64 cm (1/4 in.) O.D. and 1.3 cm (1/2 in.) O.D. tubing, and 5.8ℓ (1.5 gal) sample container. For portable model add $275 for refrigerator, $140 for winterizing kit, and $75 for aluminum stand to hold sampler above container or refrigerator.
General Comments:	Manufacturer claims unit has high-solids capability for sampling industrial and sewage wastes. Sample lines are purged of liquid after each sample is taken. A seven-day programming clock for stationary models programs operation in selected 15-minute increments; available at $195.

Designation:	PROTECH MODEL CEL-300
Manufacturer:	Protech, Inc. Roberts Lane Malvern, Pennsylvania 19355 Phone (215) 644-3854
Sampler Intake:	Plastic cylindrical (about 10 cm diameter x 20 cm long) screen perforated with over 500-0.5 cm (3/16 in.) diameter ports over pump inlet.
Gathering Method:	Forced flow from submersible pump.
Sample Lift:	Standard maximum is 9.1m (30 ft.)
Line Size:	1.3 cm (1/2 in.) I.D. inlet hose.
Sample Flow Rate:	3.8 to 7.6 ℓpm (1 to 2 gpm) recommended.
Sample Capacity:	Aliquot volume (2 to 65 mℓ) is a function of the preset diversion time; 5.8ℓ (1.5 gal) composite container is standard.
Controls:	Unit operates on continuous-flow principle, returning the uncollected sample to waste. Sample is pumped through a non-clogging flow-diverter type chamber. Upon receiving a signal from either an external flow registering device or the built-in timer, the unit diverts the flow for a preset period of time (adjustable from 0.06 to 1.0 second) to the sample container. When operating in the timed sampling mode, the sampling frequency can be set for 1, 2, or 5 minutes. When operating in the flow-proportional mode the sampler may accept either a timed pulse signal which can be accumulated (totalized) by the built-in timer, or a single totalized signal whereupon the sampler will be fired directly.

Power Source:	115 VAC.
Sample Refrigerator:	Available as an option in portable model. Stationary models have automatic refrigerated sample compartment.
Construction Materials:	Sampling train; PVC, nylon, stainless steel, and TFE resins; case is aluminum with baked vinyl finish.
Basic Dimensions:	Portable - 33 x 48 x 43 cm (13 x 19 x 17 in.), weighs 31.8 kg (70 lbs) total; Stationary indoor - 69 x 66 x 127 cm (27 x 26 x 50 in.), weighs 113 kg (250 lbs) total; Stationary outdoor - 76 x 66 x 152 cm (30 x 26 x 60 in.), weighs 125 kg (275 lbs) total.
Base Price:	$1,495 portable, $2,205 stationary indoor, $2,750 stationary outdoor; all include 11m (36 ft) of 1.3 cm (1/2 in.) I.D. inlet hose, 6.1m (20 ft) of 2.5 cm (1 in.) waste return hose, clamps, submersible magnetic-drive pump, motor, and sample container. Alternative pumps are direct-drive submersible (add $10), flexible-impeller positive-displacement (add $25), progressive-cavity positive-displacement (add $185), open-impeller centrifugal (add $145), and closed-impeller centrifugal (add $175).
General Comments:	Model DEL-400S is essentially similar except that it takes up to 24 discrete samples in separate 500 mℓ containers. It is housed in a stationary outdoor cabinet measuring 76 x 81 x 183 cm (30 x 32 x 72 in.) and total weight is 154 kg (340 lbs). Aluminum cabinet version weighs 93 kg (205 lbs). Standard model costs $3,995 and aluminum version is $4,765.

Designation:	QCEC MODEL CVE
Manufacturer:	Quality Control Equipment Company P.O. Box 2706 Des Moines, Iowa 50315 Phone (515) 285-3091
Sampler Intake:	End of suction line installed to suit by user.
Gathering Method:	Suction lift from vacuum pump.
Sample Lift:	6m (20 ft.) maximum.
Line Size:	0.64 cm (1/4 in.) I.D.
Sample Flow Rate:	Adjustable; up to 3 ℓ/m (0.8 gpm) depending upon lift.
Sample Capacity:	Adjustable aliquots of from 20 to 50 mℓ are composited in a 1.9ℓ (1/2 gal) jug (standard) or 3.8ℓ (1 gal) jug (optional).
Controls:	Sampling cycles can either be started at fixed, selected intervals by a built-in timer or in response to signals from an external flowmeter.
Power Source:	115 VAC standard; 12 VDC optional.
Sample Refrigerator:	Standard model has insulated case with built-in ice chamber; automatic refrigeration is available as an option.
Construction Materials:	Sampling train is tygon, polypropylene, polyethylene, and glass; case is fiberglass.
Basic Dimensions:	38 x 38 x 61 cm (15 x 15 x 24 in.) portable.
Base Price:	$570 for base unit with timer only. Add $175 for control to allow pacing by external flowmeter, $250 for mechanical refrigeration, $35 for electric heater.

General Comments: Unit was developed by Dow Chemical and is manufactured under license. It uses a patented vacuum system which delivers a volumetrically controlled sample on signal. Liquid is lifted through suction tube into a sample chamber (which is connected to the sample container) with a float check valve. When the chamber is filled to the desired level it is automatically closed to vacuum, the pump shuts off, and the sample is forcibly drawn into the sample container. The suction line drains by gravity to the source. An option provides a 5.6 kg/sq cm (80 psi) blow-down of the sampling train just prior to sampling assuring that no old material remains in the submerged lower end of the suction tube, helps clean the lines of any accumulations which might clog or plug, and provides a fresh air purge of the entire system.

Designation:	QCEC MODEL CVE-76
Manufacturer:	Quality Control Equipment Company P.O. Box 2706 Des Moines, Iowa 50315 Phone (515) 285-3091
Sampler Intake:	End of suction line installed to suit by user.
Gathering Method:	Suction lift from vacuum pump.
Sample Lift:	6m (20 ft) maximum.
Line Size:	0.64 or 0.95 cm (1/4 or 3/8 in.) I.D.
Sample Flow Rate:	Adjustable; up to 3 ℓ/m (0.8 gpm) depending upon lift.
Sample Capacity:	Adjustable aliquots of from 20 to 50 mℓ are composited in a 3.8ℓ (1 gal) jug, sizes to 11.4ℓ (3 gal) optional. In sequential mode collects 24-500 mℓ samples.
Controls:	New all solid state control system with interval timing module will accept signals from external flowmeters and perform its own integration to provide flow proportional sampling. It will also accept external time pulse signals, or signals from sampling switches, or operate on a straight timed (1 to 99 min) interval basis. Sample flow rate is also adjustable.
Power Source:	115 VAC or 12 VDC, including internal gel-cell battery.
Sample Refrigerator:	Standard model has insulated case with built-in ice chamber; automatic refrigeration is available as an option.
Construction Materials:	Sampling train is tygon, polypropylene, polyethylene, and glass; case is fiberglass.

Basic Dimensions:	46 cm (18 in.) diameter x 81 cm (32 in.) high; weighs 22.7 kg (50 lbs) with battery; portable.
Base Price:	Approximately $1,000 for basic unit.
General Comments:	This unit is essentially an improved version of the older CVE. Its internal battery will last up to 4 days on a single charge. Up to two weeks operation is possible with automotive type batteries. Unit has built-in charger. The new solid state control system allows the double blow-down feature to operate in all control modes. The sample container is easily removable from the top.

Designation:	QCEC MODEL E
Manufacturer:	Quality Control Equipment Company P.O. Box 2706 Des Moines, Iowa 50315 Phone (515) 285-3091
Sampler Intake:	Dipping bucket.
Gathering Method:	Mechanical; dipper on sprocket-chain drive.
Sample Lift:	To suit; manufacturer claims no reasonable limit to working depth.
Line Size:	Not applicable.
Sample Flow Rate:	Not applicable.
Sample Capacity:	Dipping bucket holds 60 mℓ; user supplies sample composite container to suit.
Controls:	Sampling cycles can either be started at fixed, selected intervals by a built-in timer or in response to signals from an external flowmeter.
Power Source:	115 VAC Electricity
Sample Refrigerator:	None
Construction Materials:	Dipper is stainless steel; sprockets and chain are corrosion-resistant cast iron (stainless available), supports are provided by user.
Basic Dimensions:	Upper unit is 20 x 39 x 36 cm (8 x 15.5 x 14 in.); lower unit is 7.6 x 11.4 cm (3 x 4.5 in.).
Base Price:	$965 plus $25 per foot beyond 6'; add $400 for stainless steel sprockets and chain plus $45 per foot beyond 6', $175 for control to allow pacing by external flowmeter.

General Comments: Manufacturer states that unit was designed as a permanently installed sampler for the most difficult applications such as packing houses, steel mills, pulp mills, and municipal applications. Unit must be custom installed by user. Minimum water depth required is 10 cm (4 in.).

Designation:	RICE BARTON EFFLUENT SAMPLER
Manufacturer:	Rice Barton Corporation P.O. Box 1086 Worcester, Massachusetts 01601 Phone (617) 752-2821
Sampler Intake:	Open end of rigid pipe extending from below expected low water level to above sample container.
Gathering Method:	Suction lift from vacuum pump.
Sample Lift:	Around 3.7m (12 ft) maximum.
Line Size:	Smallest line appears to be about 2.5 cm (1 in.)
Sample Flow Rate:	Will vary with lift.
Sample Capacity:	Adjustable size aliquots of from 200 to 500 mℓ are composited in a user-supplied container.
Controls:	Panel offers selection of manual, timed sequence, or automatic remote modes. Timing cycles can be varied from one to ten minutes, or longer if necessary.
Power Source:	110 VAC.
Sample Refrigerator:	None.
Construction Materials:	Sampling train has all non-corrosive effluent contact surfaces.
Basic Dimensions:	Draw pipe, sample discharge tube and valve unit are sample lift plus about 0.9m (3 ft) long; motor, pump, and control unit appear to be about 0.6 x 0.1 x 0.9m (2x1x3 ft); appears best suited for fixed installations.
Base Price:	Not available at time of writing.

General Comments: Large diameter sample draw pipe is normally pressurized with zero effluent level. On signal, an air control valve is shifted to vacuum and the effluent rises in the draw pipe until the sample discharge pipe is full. A liquid probe contact signal shifts the air control valve to pressure, leaving sample discharge pipe full. Timer signal opens sample discharge valve and sample is discharged to container. Valve closes and unit is ready for next cycle. Unit was designed for sampling of effluents with high solids content.

Designation:	SEIN MODEL APAE 241
Manufacturer:	S.E.I.N. Ecologie 171 rue Veron 94140 Alfortville, France Phone 893.08.31
Sampler Intake:	Provided by user.
Gathering Method:	External head to provide flow to a constant head sampling chamber where a rotating dipper extracts aliquots and transfers them to a rotating funnel from which they flow by gravity to one of 24 containers.
Sample Lift:	Not applicable.
Line Size:	0.8 cm (5/16 in.) I.D.
Sample Flow Rate:	Sampler requires approximately 6.7 ℓ/m (1.8 gpm).
Sample Capacity:	Unit collects 24-2ℓ sequential composite samples made up of 5, 10, 20, or 40 mℓ aliquots.
Controls:	Aliquot size determined by scoop selected. Unit may be paced by external flowmeter or by internal crystal timer that allows taking a sample every 4.5, 9, 18, 36, 72, 144, or 288 seconds. Thus, depending upon aliquot size selected, the complete cycle may range from 1.5 hours to 32 days.
Power Source:	220 VAC or 12 VDC.
Sample Refrigerator:	Automatic refrigerator preset to 4°C available.
Construction Materials:	Sampling train is all plastic; fiberglass case.
Basic Dimensions:	65 x 95 x 77 cm (26x37x30 in.) weighs 46 kg (101 lbs), portable. Refrigerated model weighs 61 kg (134 lbs).

Base Price: Not available at time of writing.

General Comments: Options include a heater for winter operation and 24-one liter glass sample containers.

Designation:	SERCO MODEL NW-3
Manufacturer:	Sonford Products Corporation 100 East Broadway, Box B St. Paul Park, Minn. 55071 Phone (612) 459-6065
Sampler Intake:	24-0.64 cm (1/4 in.) I.D. vinyl sampling lines are connected to individual ports in a stainless steel sampling head (approx 10 cm dia) and protected by a stainless steel shroud.
Gathering Method:	Suction lift from vacuum in evacuated sample bottles.
Sample Lift:	0.9m (3 ft) standard; sample size reduced as lift increases; about 3m (10 ft) appears practical upper limit.
Line Size:	0.64 cm (1/4 in.) inside diameter.
Sample Flow Rate:	Varies with filling time, atmospheric pressure, bottle vacuum, sample lift, etc.
Sample Capacity:	24-473 mℓ French square glass bottles are provided. Sample sizes up to 350 mℓ can be obtained depending upon lift, bottle vacuum and atmospheric pressure; 200 mℓ is typical.
Controls:	A spring driven clock via a changeable gearhead rotates an arm which trips line switches at a predetermined time interval triggering sample collection. Sampling intervals of 2, 3, or 8 hours and 5, 10 or 30 minutes are available in addition to the standard one hour interval.
Power Source:	Spring driven clock.
Sample Refrigerator:	Has ice cavity for cooling:

Construction Materials:	Aluminum case with rigid polystyrene insulation; aluminum bottle rack; glass bottles with rubber stoppers and rubber lines through switch plate, plastic connectors and vinyl lines to stainless steel sampling head.
Basic Dimensions:	39 x 39 x 68 cm (15.5x15.5x26.8 in.) empty weight is 25 kg (55 lbs); portable.
Base Price:	$1,195 with lines for up to 8 foot lift; add $17 per foot for additional lift, $75 for additional spring driven clocks to obtain other than one-hour sampling intervals. $1,695 for battery-powered electric unit.
General Comments:	Optionally available with a battery or 115 VAC electrically timed actuator that will also accept contact closure input from an external flowmeter.

Designation:	SERCO MODEL TC-2
Manufacturer:	Sonford Products Corporation 100 East Broadway, Box B St. Paul Park, Minn. 55071 Phone (612) 459-6065
Sampler Intake:	Provided by user; sampler has standard 5 cm (2 in.) pipe inlet.
Gathering Method:	External head to provide flow through a sample reservoir from which a mechanical arm actuated by an air cylinder with a dipper cup extracts a sample aliquot and transfers it to a funnel where it is gravity fed to a composite bottle.
Sample Lift:	Not applicable.
Line Size:	2 cm (3/4 in.) I.D.
Sample Flow Rate:	Recommended flow rate through sampler is 45 to 76 ℓ/m (12 to 20 gpm). Reservoir is designed so that sufficient velocity and turbulence will prevent settling or separation.
Sample Capacity:	Sampling dippers are available in either 10 or 20 mℓ capacity; a two gallon sample composite container is provided.
Controls:	Takes samples either on signal from a preset timer (to 999.9 sec in 0.1 sec steps) or from signals originating from an external flowmeter.
Power Source:	115 VAC electrical plus low pressure plant air.
Sample Refrigerator:	Automatic refrigeration unit thermostatically controlled to maintain sample temperature at 4° to 10°C.

Construction Materials: Sampling arm is all brass and stainless steel; dipper cup is plastic; cabinet is stainless steel with zinc plated framing and procelain interior.

Basic Dimensions: 96 x 60 x 86 cm (38x22x34 in.) plus sampling arm which extends up 64 cm (25 in.) and back 51 cm (20 in.). Designed for fixed installation.

Base Price: Around $2,600.

General Comments: A permanent installation for continuous composite sampling. The actual sampling device is simply an open cup which is large enough to permit sampling all sizes of suspended solids normally encountered in wastewater flows. Because the cup is emptied by turning it over completely, the entire sample is removed and there is little likelihood of solids being retained in the cup.

Designation:	SIGMAMOTOR MODEL WA-2
Manufacturer:	Sigmamotor, Inc. 14 Elizabeth Street Middleport, New York 14105 Phone (716) 735-3616
Sampler Intake:	End of 7.6m (25 ft) long suction tube installed to suit by user.
Gathering Method:	Suction lift from nutating-type peristaltic pump.
Sample Lift:	6.7m (22 ft) maximum lift.
Line Size:	0.3 cm (1/8 in.) I.D.
Sample Flow Rate:	60 mℓ per minute.
Sample Capacity:	Adjustable, fixed size aliquots are composited in a 9.5ℓ (2.5 gal) sample container.
Controls:	Built-in adjustable timer allows sampling interval to be set from 5 minutes to 15 hours. Aliquot size is determined by adjustable sampling time; 1 to 30 minutes for Model WA-2 and 2 to 30 minutes for Model WD-2.
Power Source:	115 VAC. Model WD-2 comes with a NiCad battery pack and charger.
Sample Refrigerator:	None. Model WA-2R has an automatic refrigeration unit for cooling sample compartment.
Construction Materials:	Sample train is tygon and polyethylene; case is ABS plastic.
Basic Dimensions:	WA-2 and WD-2 - 34 x 25 x 37 cm (13.5 x 10 x 14.5 in.) WA-2R - 53 x 61 x 86 cm (21 x 24 x 34 in.); weights are WA-2 8.6 kg (19 lbs), WD-2 11.3 kg (25 lbs), WA-2R 34.9 kg (77 lbs); all portable.
Base Price:	$530 WA-2; $750 WD-2; $1,030 WA-2R

General Comments:	Charge time for battery operated models is 16 hours. Battery can fill sample container once per charge. On model WA-2R the pump automatically purges the tubing at the end of each sampling cycle to help prevent bacterial growth in the line. Purge time is adjustable from 1 to 15 minutes.

Designation:	SIGMAMOTOR MODEL WAP-2
Manufacturer:	Sigmamotor, Inc. 14 Elizabeth Street Middleport, New York 14105 Phone (716) 735-3616
Sampler Intake:	End of 7.6m (25 ft) long suction tube installed to suit by user.
Gathering Method:	Suction lift from nutating-type peristaltic pump.
Sample Lift:	6.7m (22 ft) maximum lift
Line Size:	0.3 cm (1/8 in.) I.D.
Sample Flow Rate:	60 mℓ per minute
Sample Capacity:	Unit takes adjustable, fixed size aliquots and composites them in a 5.8ℓ (2.5 gal) container.
Controls:	Aliquot size is determined by adjusting sampling time (2 to 30 minutes). Models WAP-2, WAP-2R and WDP-2 vary the sampling interval in response to a varying signal from a user-supplied flow transmitter. Models WAP-2, WAPP-2R and WAPP-2 respond to a switch closure from an external flowmeter. All models can also operate from an adjustable built-in timer with sampling intervals from 5 minutes to 15 hours.
Power Source:	Models WAP-2, WAP-2R, WAPP-2 and WAPP-2R operate on 115 VAC. Models WDPP-2 and WDP-2 operate on 115 VAC or 12 VDC and are supplied with a NiCad battery pack and charger.
Sample Refrigerator:	None. Models WAP-2R and WAPP-2R have an automatic refrigeration unit for cooling sample compartment.
Construction Materials:	Sample train is tygon and polyethylene. Case is ABS plastic.

Basic Dimensions:

Models WAP-2, WAPP-2, WDP-2 and WDPP-2 are 34 x 30 x 37 cm (13.5x10x14.5 in.); Models WAP-2R and WAPP-2R are 51 x 61 x 86 cm (20x24x34 in.); weights are

WAP-2 and WAPP-2	8.6 kg (19 lbs),
WAP-2R and WAPP-2R	34.9 kg (77 lbs),
WDP-2 and WDPP-2	11.3 kg (25 lbs);

portable.

Base Price:

WAP-2	\$750	WAP-2R	\$1,190
WAPP-2	\$600	WAPP-2R	\$1,040
WDP-2	\$970	WDPP-2	\$ 800

General Comments:

Charge time for battery operated models is 16 hours. Battery can fill sample container once per charge. A winterizing kit is available at \$95 to allow effective operation at temperatures to -23°C (-10°F). A stainless steel strainer anchor intake is available, at \$15, to prevent plugging of sampling tubes. In refrigerated models the pump automatically reverses for a preset (1 to 15 minute) time period to purge the tubing after each aliquot is taken.

Designation:	SIGMAMOTOR MODEL WM-3-24
Manufacturer:	Sigmamotor, Inc. 14 Elizabeth Street Middleport, New York 14105 Phone (716) 735-3616
Sampler Intake:	End of 7.6m (25 ft) ling suction tube installed to suit by user.
Gathering Method:	Suction lift from nutating-type peristaltic pump.
Sample Lift:	6.7m (22 ft) maximum lift.
Line Size:	0.3 cm (1/8 in.) I.D.
Sample Flow Rate:	60 mℓ per minute
Sample Capacity:	Unit takes 24 discrete samples of up to 500 mℓ each.
Controls:	Sampling frequency adjustable from one every 5 minutes to one every 15 hours. Sample size adjustable by varying sampling time (2 to 30 minutes).
Power Source:	115 VAC for models WM-2-24, WM-3-24 and WM-1-24R; 12 VDC or 115 VAC for Model WM-4-24, which comes with a wet-type lead-acid battery (35 amp hours capacity) and charger.
Sample Refrigerator:	None. Model WM-1-24R has an automatic refrigerated case for entire sampler and collection unit.
Construction Materials:	Sample train is tygon and polyethylene; tygon and glass for Model WM-2-24.
Basic Dimensions:	WM-3-24 and WM-4-24 are 38 x 37 x 78 cm (15x14.5x30.5 in.); WM-1-24R is 51 x 61 x 127 cm (20x24x50 in.). Weights are WM-3-24, 16.3 kg (36 lbs); WM-4-24, 26.3 kg (58 lbs); and WM-1-24R, 49.9 kg (110 lbs). Portable.

Base Price:	WM-3-24	$1,050	WM-4-74	$1,190
			WM-1-24R	$1,600

General Comments: At the end of each sampling cycle, the pump automatically reverses for 1 to 15 minutes purging the sample line and tending to make each sample completely discrete. The sample line feeds into a funnel attached to a rotating nozzle which is automatically positioned to fill the next sample container. A one-piece deep-drawn plastic distribution plate is used to route the sample from the nozzle to the containers, which are in a rectangular array. Model WM-4-24 is supplied with a 6 amp automatic battery charger which adjusts charging rate to battery condition. This may be left connected for trickle charge. Charge time is 7 hours. Battery can fill 200 (500 mℓ) bottles per charge. A winterizing kit for Models WM-3-24 and WM-4-24 is available, at $95, for effective operation to temperatures of -23°C (-10°F). A strainer-anchor is available for $15 to prevent plugging of sampling tubes.

Designation:	SIGMAMOTOR MODEL WA-5
Manufacturer:	Sigmamotor, Inc. 14 Elizabeth Street Middleport, New York 14105 Phone (716) 735-3616
Sampler Intake:	End of 7.6m (25 ft) long suction tube installed to suit by user.
Gathering Method:	Suction lift from finger-type peristaltic pump.
Sample Lift:	5.5m (18 ft) maximum lift with 0.64 cm (1/4 in.) tubing; 3m (10 ft) with 0.95 cm (3/8 in.) tubing; 1.5m (5 ft) with 1.3 cm (1/2 in.) tubing.
Line Size:	0.64 cm (1/4 in.) I.D. standard. Also available in 0.95 cm (3/8 in.) and 1.3 cm (1/2 in.) I.D.
Sample Flow Rate:	80 mℓ per minute; other flows depend on tubing size.
Sample Capacity:	Adjustable, fixed size aliquots are composited in a 19ℓ (5 gal) sample container.
Controls:	Adjustable timer allows sampling interval to be set from 5 minutes to 15 hours.
Power Source:	115 VAC for Models WA-5 and WA-5R; 115 VAC or 12 VDC for Model WD-5. WD-5 comes with a wet type lead-acid battery (35 amp-hours capacity) and charger.
Sample Refrigerator:	None. Model WA-5R has an automatic refrigeration unit for cooling sample compartment.
Construction Materials:	Sample train is tygon and polyethylene; case is fiberglass.

<u>Basic Dimensions</u>: Models WA-5 and WD-5 are 38 x 37 x 78 cm (15x14.5x30.5 in.); Model WA-5R is 51 x 61 x 127 cm (20x24x50 in.); weights are WA-5 19.1 kg (42 lbs), WD-5 28.1 kg (62 lbs), WA-5R 52.2 kg (115 lbs); all portable.

<u>Base Price</u>:

$ 970 WA-5
$1,200 WD-5
$1,370 WA-5R

<u>General Comments</u>: A 6-amp automatic battery charger is included with Model WD-5. Unit adjusts charging rate to battery condition. Charge time is 7 hours; may be connected for trickle charge. Battery can fill sample container four times per charge. A winterizing kit is available for Models WA-5 and WD-5, at $95, for effective operation to temperatures of -23°C (-10°F). A stainless steel strainer-anchor intake is available for $15 to prevent plugging of sampling tubes.

Designation:	SIGMAMOTOR MODEL WAP-5
Manufacturer:	Sigmamotor, Inc. 14 Elizabeth Street Middleport, New York 14105 Phone (716) 735-3616
Sampler Intake:	End of 7.6m (25 ft) long suction tube installed to suit by user
Gathering Method:	Suction lift from finger-type peristaltic pump.
Sample Lift:	5.5m (18 ft) maximum lift with 0.64cm (1/4 in.) tubing; 3m (10 ft) with 0.95 cm (3/8 in.) tubing; 1.5m (5 ft) with 1.3 cm (1/2 in.) tubing.
Line Size:	0.64 cm (1/4 in.) I.D. standard. Also available in 0.95 cm (3/8 in.) and 1.3 cm (1/2 in.) I.D.
Sample Flow Rate:	80 mℓ per minute; other flows depend on tubing size.
Sample Capacity:	Adjustable, fixed size aliquots are composited in a 19ℓ (5 gal) sample container.
Controls:	Aliquot size is determined by adjusting sampling time (2 to 30 minutes). Models WAP-5, WAP-5R, and WDP-5 vary the sampling interval in response to a varying signal from a user supplied transmitter. Models WAPP-5, WAPP-5R, and WDPP-5 respond to a switch closure from an external flowmeter. All models can also operate from an adjustable built-in timer with sampling intervals from 5 minutes to 15 hours.
Power Source:	Models WAP-5, WAP-5R, WAPP-5, and WAPP-5R operate on 115 VAC. Models WDP-5 and WDPP-5 operate on 115 VAC or 12 VDC and are equipped with a wet type lead-acid battery (35 amp-hours capacity) and charger.

Sample Refrigerator:	None. Models WAP-5R and WAPP-5R have an automatic refrigeration unit for cooling sample compartment.
Construction Materials:	Sample train is tygon and polyethylene. Case is fiberglass.
Basic Dimensions:	Models WAP-5, WAPP-5, WDP-5, and WDPP-5 are 38 x 37 x 78 cm (15x14.5x30.5 in.); Models WAP-5R and WAPP-5R are 51 x 61 x 127 cm (20x24x50 in.) Weights are WAP-5 and WAPP-5 19.1 kg (42 lbs), WDP-5 and WDPP-5 28.1 kg (62 lbs), WAP-5R, WAPP-5R, and WAC-5R 52.2 kg (115 lbs); all portable.
Base Price:	WAP-5 $1,150 WAP-5R $1,590 WAPP-5 $1,020 WAPP-5R $1,420 WDP-5 $1,200 WDPP-5 $1,250
General Comments:	Charge time for battery-operated models is 7 hours. Battery can fill sample container four times per charge. A winterizing kit is available for Models WAP-5, WAPP-5, WDP-5 and WDPP-5 at $95 for effective operation to temperatures of -23°C (-10°F). A stainless steel strainer-anchor intake is available at $15 to prevent plugging of sampling tubes.

Designation:	SIGMAMOTOR MODEL WM-5-24
Manufacturer:	Sigmamotor, Inc. 14 Elizabeth Street Middleport, New York 14105 Phone (716) 735-3616
Sampler Intake:	End of 7.6m (25 ft) long suction tube installed to suit by user.
Gathering Method:	Suction lift from finger-type peristaltic pump.
Sample Lift:	5.5m (18 ft) maximum lift with 0.64 cm (1/4 in.) tubing; 3m (10 ft) lift with 0.95 cm (3/8 in.) tubing; and 1.5m (5 ft) lift with 1.3 cm (1/2 in.) tubing.
Line Size:	0.64 cm (1/4 in.) I.D. standard. Also available in 0.95 cm (3/8 in.) and 1.3 cm (1/2 in.) I.D.
Sample Flow Rate:	80 mℓ per minute; other flows depend on tubing size.
Sample Capacity:	Unit takes 24 discrete samples of up to 500 mℓ each.
Controls:	Sampling frequency adjustable from one every 5 minutes to one every 15 hours. Sample size adjustable by varying sampling time (2 to 30 minutes.)
Power Source:	115 VAC for Model WM-5-24 and WM-5-24R; 12 VDC or 115 VAC for Model WM-6-24, which comes with a wet-type lead acid battery (35 amp hours capacity) and charger.
Sample Refrigerator:	None. Model WM-5-24R has an automatic refrigeration unit for cooling sample compartment.
Construction Materials:	Sample train is tygon and polyethylene; case is fiberglass.

Basic Dimensions:	Models WM-5-24 and WM-6-24 are 38 x 37 x 78 cm (15x14.5x30.5 in.); Model WM-5-24R is 51 x 61 x 127 cm (20x24x50 in.). Weights are: WM-5-24 20.0 kg (44 lbs), WM-6-24 29.0 kg (64 lbs), WM-5-24R 56.7 kg (125 lbs); portable.
Basic Price:	WM-5-24 $1,400 WM-6-24 $1,500 WM-5-24R $1,975
General Comments:	At the end of each cycle, the pump automatically reverses, purging the sample line and tending to make each sample completely discrete. Sample line feeds into a funnel attached to a rotating nozzle which is automatically positioned to fill the next sample container. A one-piece deep-drawn plastic distribution plate is used to route the sample from the nozzle to the containers, which are in a rectangular array. Model WM-6-24 comes with a 6-amp automatic battery charger which adjusts to battery condition automatically. This may be left connected for trickle charge. Charge time is 7 hours. Battery can fill 200 (500 mℓ) bottles per charge. A winterizing kit is available for Models WM-5-24 and WM-6-24 at $95 for effective operation to temperatures of -10°F. A stainless steel strainer-anchor intake is available at $15 to prevent plugging of sampling tubes.

Designation:	SIGMAMOTOR MODEL 7034
Manufacturer:	Sigmamotor, Inc. 14 Elizabeth Street Middleport, New York 14105 Phone (716) 735-3616
Sampler Intake:	End of 7.6m (25 ft) long suction tube installed to suit by user.
Gathering Method:	Suction lift from finger-type peristaltic pump.
Sample Lift:	5.5m (18 ft) maximum lift.
Line Size:	0.64 cm (1/4 in.) I.D.
Sample Flow Rate:	Adjustable from 30 to 1750 mℓ per minute.
Sample Capacity:	Adjustable, fixed size aliquots are composited in a 9.5 ℓ (2.5 gal) sample container.
Controls:	Sampling time (hence aliquot size) and frequency are adjustable from 0.01 to 99.99 minutes in 0.01 minute steps. Pacing by external flowmeter is optional.
Power Source:	115 VAC and plant air.
Sample Refrigerator:	Automatic refrigeration unit is standard.
Construction Materials:	Sample train is tygon and polyethylene; case is painted steel.
Basic Dimensions:	71 x 130 x 142 cm (28x51x56 in.); weighs 113 kg (250 lbs); fixed installation.
Base Price:	$2,980
General Comments:	Timer activated valve automatically introduces a compressed air purge at the end of each pumping cycle. Winterizing kits, all-weather enclosures, and explosion-proof construction are options.

Designation:	SIGMAMOTOR MODEL 7042
Manufacturer:	Sigmamotor, Inc. 14 Elizabeth Street Middleport, New York 14105 Phone (716) 735-3616
Sampler Intake:	End of 7.6m (25 ft) long suction tube installed to suit by user.
Gathering Method:	Suction lift from finger-type peristaltic pump.
Sample Lift:	5.5m (18 ft) maximum lift.
Line Size:	0.64 cm (1/4 in.) I.O.
Sample Flow Rate:	Adjustable from 30 to 1750 mℓ per minute.
Sample Capacity:	Unit takes 24 discrete samples of up to 500 mℓ each.
Controls:	Sampling time (hence aliquot size) and frequency are adjustable from 0.01 to 99.99 minutes in 0.01 minute steps. Pacing by external flowmeter is optional.
Power Source:	115 VAC and plant air.
Sample Refrigerator:	Automatic refrigeration unit is standard.
Construction Materials:	Sample train is tygon and polyethylene; case is painted steel.
Basic Dimensions:	71 x 130 x 142 cm (28 x 51 x 56 in.); weighs 113 kg (250 lbs); fixed installation.
Base Price:	$3,280
General Comments:	Sample line feeds into a funnel attached to a rotating nozzle which is automatically positioned to fill the next sample container. A one-piece deep-drawn plastic distribution

plate is used to route the sample from the nozzle to the containers, which are in a rectangular array. Timer activated valve automatically introduces a compressed air purge at the end of each pumping cycle. Winterizing kits, all-weather enclosures, and explosion-proof construction are options.

Designation:	SIGMAMOTOR MODEL 7080
Manufacturer:	Sigmamotor, Inc. 14 Elizabeth Street Middleport, New York 14105 Phone (716) 735-3616
Sampler Intake:	Provided by user; sampler has standard 3.8 cm (1.5 in.) pipe inlet.
Gathering Method:	External head provided by user or optional submersible pump flows continuously through the unit. On signal, the unit diverts sample from the line into the sample container.
Sample Lift:	Not applicable.
Line Size:	0.95 cm (3/8 in.) I.D.
Sample Flow Rate:	38 to 530 ℓ/m (10 to 140 gpm).
Sample Capacity:	Adjustable, fixed size aliquots are composited in a 9.5ℓ (2.5 gal) sample container.
Controls:	Diversion time (hence aliquot size) and sampling frequency are adjustable from 0.01 to 99.99 minutes in 0.01 minute steps. Pacing by external flowmeter is optional.
Power Source:	115 VAC.
Sample Refrigerator:	None. Automatic refrigerator is optional.
Construction Materials:	Sample train is tygon and polyethylene; case is painted steel.
Basic Dimensions:	51 x 20 x 41 cm (20x8x16 in.); weighs 18.1 kg (40 lbs); fixed installation.
Base Price:	$800; submersible pump is $400.
General Comments:	Sample bottles are not housed within enclosure. Winterizing kits, all-weather enclosures, and explosion-proof construction are options.

Designation:	SIGMAMOTOR MODEL HV-1A
Manufacturer:	Sigmamotor, Inc. 14 Elizabeth Street Middleport, New York 14105 Phone (716) 735-3616
Sampler Intake:	End of 7.6m (25 ft) long suction tube installed to suit by user.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	Up to 5.5m (18 ft).
Line Size:	0.95 cm (3/8 in.) I.D.
Sample Flow Rate:	Up to 1.8 m/s (6 fps) depending upon lift.
Sample Capacity:	Adjustable size aliquots (between 10 and 500 mℓ) are composited in a 9.4ℓ (2.5 gal) container.
Controls:	Sampling frequency adjustable from 5 minutes to 15 hours. Aliquot size is adjustable by positioning end of inlet tube in metering chamber.
Power Source:	115 VAC. Model HV-1 comes with a 12 volt lead acid battery and charger.
Sample Refrigerator:	None. Model HV-1R has an automatic refrigeration unit for cooling sample compartment.
Construction Materials:	Sampling train is tygon, glass, and polyethylene; case is fiberglass.
Basic Dimensions:	HV-1 and HV-1A are 38 x 37 x 78 cm (15x14.5x30.5 in.); HV-1R is 51 x 61 x 127 cm (20x24x50 in.); weights are HV-1A 18.1 kg (40 lbs), HV-1 27.2 kg (60 lbs), HV-1R 52.2 kg (115 lbs); all portable.
Base Price:	HV-1A $1,295 HV-1 $1,380 HV-1R $1,695

General Comments:

Cycle begins with vacuum being drawn on metering chamber. Liquid is drawn in until sensor detects that chamber is full. Metering chamber is then vented, causing excess sample to syphon back out the intake hose. Remaining aliquot is then discharged into sample container and compressor is reversed, purging entire system. Battery charging time is 3-1/2 to 5 hours.

Designation:	SIGMAMOTOR MODEL HVP-1A
Manufacturer:	Sigmamotor, Inc. 14 Elizabeth Street Middleport, New York 14105 Phone (716) 735-3616
Sampler Intake:	End of 7.6m (25 ft) long suction tube installed to suit by user.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	Up to 5.5m (18 ft).
Line Size:	0.95 cm (3/8 in.) I.D.
Sample Flow Rate:	Up to 1.8 m/s (6 fps) depending upon lift.
Sample Capacity:	Adjustable size aliquots (between 10 and 500 mℓ) are composited in a 9.4ℓ (2.5 gal) container.
Controls:	Aliquot size is adjustable by positioning end of inlet tube in metering chamber. Models HVP-1A, HVP-1, and HVP-1AR vary the interval in response to a varying signal from a user-supplied flow transmitter. Models HVPP-1A, HVPP-1, and HVPP-1AR respond to a switch closure from an external flowmeter. All models can also operate from an adjustable built-in timer with sampling intervals from 5 minutes to 15 hours.
Power Source:	115 VAC. Models HVP-1 and HVPP-1 come with a 12 volt lead acid battery and charger.
Sample Refrigerator:	None. Models HVP-1AR and HVPP-1AR have an automatic refrigeration unit for cooling sample compartment.
Construction Materials:	Sampling train is tygon, glass, and polyethylene; case is fiberglass.

Basic Dimensions: HVP-1A, HVP-1, HVPP-1A, and HVPP-1 are 38 x 37 x 78 cm (15x14.5x30.5 in); HVP-1AR and HVPP-1AR are 51 x 61 x 127 cm (20x24x50 in.); weights are HVP-1A and HVPP-1A 18.1 kg (40 lbs), HVP-1 and HVPP-1 27.2 kg (60 lbs), HVP-1AR and HVPP-1AR 52.2 kg (115 lbs); all portable.

Base Price:

HVP-1A	$1,385	HVPP-1A	$1,345
HVP-1	$1,480	HVPP-1	$1,420
HVP-1AR	$1,785	HVPP-1AR	$1,745

General Comments: Cycle begins with vacuum being drawn on metering chamber. Liquid is drawn in until sensor detects that chamber is full. Metering chamber is then vented, causing excess sample to syphon back out the intake hose. Remaining aliquot is then discharged into sample container and compressor is reversed, purging entire system. Battery charging time is 3-1/2 to 5 hours.

Designation:	SIGMAMOTOR MODEL HV-24A
Manufacturer:	Sigmamotor, Inc. 14 Elizabeth Street Middleport, New York 14105 Phone (716) 735-3616
Sampler Intake:	End of 7.6m (25 ft) long suction tube installed to suit by user.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	Up to 5.5m (18 ft).
Line Size:	0.95 cm (3/8 in.) I.D.
Sample Flow Rate:	Up to 1.8 m/s (6 fps) depending upon lift.
Sample Capacity:	Unit takes 24 discrete samples of up to 500 mℓ each.
Controls:	Sampling frequency adjustable from 5 minutes to 15 hours. Aliquot size is adjustable by positioning end of inlet tube in metering chamber.
Power Source:	115 VAC. Model HV-24 comes with a 12 volt lead acid battery and charger.
Sample Refrigerator:	None. Model HV-24AR has an automatic refrigeration unit for cooling sample compartment.
Construction Materials:	Sampling train is tygon, glass, and polyethylene; case is fiberglass.
Basic Dimensions:	HV-24 and HV-24A are 38 x 37 x 78 cm (15x14.5x30.5 in.); HV-24AR is 51 x 61 x 127 cm (20x24x50 in.); weights are HV-24A 20.0 kg (44 lbs), HV-24 29.0 kg (64 lbs), HV-24AR 56.7 kg (125 lbs); all portable.
Base Price:	HV-24A $1,575 HV-24 $1,650 HV-24AR $1,975

General Comments:

Cycle begins with vacuum being drawn on metering chamber. Liquid is drawn in until sensor detects that chamber is full. Metering chamber is then vented, causing excess sample to syphon back out the intake hose. Remaining aliquot is then discharged into sample container and compressor is reversed, purging entire system. Sample line feeds into a funnel attached to a rotating nozzle which is automatically positioned to fill the next sample container. A one-piece deep-drawn plastic distribution plate is used to route the sample from the nozzle to the containers, which are in a rectangular array. Model HV-24 comes with a 6-amp automatic battery charger which adjusts to battery condition automatically. This may be left connected for trickle charge. Charge time is 3-1/2 to 5 hours.

Designation:	SIRCO SERIES B/ST-VS
Manufacturer:	Sirco Controls Company 8815 Selkirk Street Vancouver, B.C. Phone (604) 261-9321
Sampler Intake:	Weighted end of 7.6m (25 ft) sampling tube. May also sample from 2 or 3 different points.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	Up to 6.7m (22 ft) vertical and 30.5m (100 ft) horizontal.
Line Size:	0.95 cm (3/8 in.) I.D. standard, larger sizes available.
Sample Flow Rate:	Up to 12 ℓ/s (3.2 gpm) depending upon lift.
Sample Capacity:	Sample volume is adjustable between 10 to 1000 mℓ (repeatable to within ±0.5 mℓ); either composited in 7.6, 11.4, or 18.9ℓ (2, 3, or 5 gal) jars or sequential or discrete in either 12 or 24 jars of either 1/2 or 1 liter capacity.
Controls:	"Metermatic" chamber (adjustable) controls sample volume. Available with built-in timer for preset time interval (3 min to 45 hr) sampling or for connection to external flowmeter for flow proportional sampling or both. Purge timer, automatic jar full shut-off.
Power Source:	Either 110 VAC or 12 VDC lead zinc or nickel cadmium battery or combination.
Sample Refrigerator:	Available with thermostatically controlled refrigerated sample compartment.

Construction Materials:	PVC sampling tube, weatherproof steel enclosure standard; all stainless steel construction available.
Basic Dimensions:	Sampler only - 41 x 36 x 81 cm (16 x 14 x 32 in.), weighs 45 kg (100 lbs); Sampler with container - 41 x 36 x 163 cm (16 x 14 x 64 in.) weighs 68 kg (150 lbs); Refrigerated model - 58 x 71 x 152 cm (23 x 28 x 60 in.), weighs 91 kg (200 lbs); designed for fixed installation.
Base Price:	Varies, depending upon what combination of features are desired, from under $1,900 to over $3,000.
General Comments:	Signal from flowmeter or timer starts vacuum/compressor pump as well as purge timer. Compressor side of pump purges sample pick-up tube until purge timer times out. Sequence changes and vacuum side of pump evacuates metering chamber and draws sample in to the desired capacity. After obtaining the desired amount of sample, the compressor side of pump is used to forcibly discharge sample from metering chamber into sample collector. Should plugging of the sample pick-up tube occur, an automatic timer switch uses the compressor side to blow out the tube. This sequence repeats itself as often as needed to obtain the exact amount of sample required. Purging also takes place before and after each sample is taken. Manufacturer states this unit is especially designed to sample untreated raw sewage or high consistency industrial waste as it is capable of taking solids up to 3/8" in diameter including rags, fibers, and similar. The only wetted parts are the sample tubing and volume control chamber.

Designation:	SIRCO PIONEER
Manufacturer:	Sirco Controls Company 8815 Selkirk Street Vancouver, B.C. Phone (604) 261-9321
Sampler Intake:	Weighted end of 7.6m (25 ft) sampling tube.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	Up to 6.7m (22 ft) vertical and 30.5m (100 ft) horizontal.
Line Size:	0.95 cm (3/8 in.) I.D. standard, larger sizes available.
Sample Flow Rate:	Up to 12 ℓ/s (3.2 gpm) depending upon lift.
Sample Capacity:	Sample volume is adjustable between 10 to 1000 mℓ (repeatable to within ±0.5 mℓ); and deposited in either 12 or 24 jars of either 1/2 or 1 liter capacity.
Controls:	"Metermatic" chamber (adjustable) controls sample volume. Available with built-in timer for preset time interval (3 min to 45 hr) sampling or for connection to external flowmeter for flow proportional sampling or both.
Power Source:	115 VAC.
Sample Refrigerator:	Available with thermostatically controlled refrigerated sample compartment.
Construction Materials:	PVC sampling tube, weatherproof steel enclosure standard; all stainless steel construction available.
Basic Dimensions:	Sampler only - 41 x 36 x 81 cm (16 x 14 x 32 in.), weighs 45 kg (100 lbs); sampler with container - 41 x 36 x 163 cm (16x14x64 in.) weighs 68 kg (150 lbs); refrigerated

model - 58 x 71 x 152 cm (23x28x60 in.), weighs 91 kg (200 lbs); designed for fixed installation.

Base Price: Not available at time of writing.

General Comments: This sampler was designed to provide the user with a continuous non-terminating sampling system. It is based on the B/ST-VS unit. Here, however, the 24 bottle sampler takes samples continuously until manually stopped. At that time the samples in the bottles are the last (24) samples taken, regardless of how long the unit has been taking samples. Operating from a built-in timer or proportional to flow, the sampler fills all available sample bottles at (say) one hour intervals. When the last (No. 24) sample bottle is filled the bottle No. 1, previously filled, is automatically emptied and flushed to receive the new sample and so forth around the clock. This filling - emptying - flushing - filling cycle continues until the sampler is manually stopped, at which time the samples in the bottles represent the last (24) collected. The unit is available with 12, 24 or 48 sample collector bottles. It can be supplied with a remote or on-site tampering alarm device.

Designation:	SIRCO SERIES B/IE-VS
Manufacturer:	Sirco Controls Company 8815 Selkirk Street Vancouver, B.C. Phone (604) 261-9321
Sampler Intake:	5 cm (2 in.) I.D. guide pipe for sampling cup with perforations in lower end to maximum flow level.
Gathering Method:	Mechanical; a weighted sampling cup is lowered through a guide pipe into the effluent by a hoist mechanism powered by a reversing gear motor. At the upper travel stop the cup empties sample into a sample container by gravity.
Sample Lift:	Up to 61m (200 ft).
Line Size:	Smallest line in sampling train appears to be about 0.95 cm (3/8 in.) tube connecting collection funnel to sample reservoir.
Sample Flow Rate:	Not applicable.
Sample Capacity:	Sample cup has 100 mℓ capacity; either composited in 7.6, 11.4 or 18.9ℓ (2, 3, or 5 gal) jars or sequential in either 12 or 24 jars of either 1/2 or 1 liter capacity.
Controls:	Available with built-in timer for pre-set time interval sampling or for connection to external flowmeter for flow proportional sampling or both.
Power Source:	Either 110 VAC or 12 VDC lead zinc or nickel cadmium battery or combination.
Sample Refrigerator:	Available with thermostatically controlled refrigerated sample compartment.

Construction Materials:	PVC sampling cup and guide tube, weatherproof steel enclosure standard; all stainless steel construction available.
Basic Dimensions:	About 0.6 x 0.6 x 1.5m (2x2x5 ft); designed for fixed installation.
Base Price:	Varies from under $1,500 to around $3,000 depending upon features desired.
General Comments:	This unit was designed for high lift applications. According to the manufacturer it is not recommended for high consistency industrial effluent or raw sewage where large pieces of fiber, rags, papers, etc. are present.

Designation:	SIRCO SERIES B/DP-VS
Manufacturer:	Sirco Controls Company 8815 Selkirk Street Vancouver, B.C. Phone (604) 261-9321
Sampler Intake:	Provided by user. Sampler has 5 cm (2 in.) inlet pipe.
Gathering Method:	External head to provide flow through sampler and back to sewer. On signal a liquid diverter mechanism is energized and sample is drawn into a metering chamber. After the desired amount of sample is obtained, a solenoid pinch valve at the bottom of the metering chamber is actuated and the sample is discharged by gravity into the sample jar.
Sample Lift:	Not applicable.
Line Size:	Smallest line size appears to be about 0.95 cm (3/8 in.) tube leading to sample jar.
Sample Flow Rate:	Depends upon user's installation; no recommended minimum.
Sample Capacity:	Sample metering chamber adjustable from 50 to 500 mℓ (500 to 1000 mℓ optional); either composited in 7.6, 11.4, or 18.9ℓ (2, 3, or 5 gal, jars or sequential in either 12 or 24 jars of either 1/2 or 1 liter capacity.
Controls:	Available with built-in timer for pre-set time interval (3 min to 45 hrs) sampling or for connection to external flowmeter for flow proportional sampling or both. Automatic jar full shut-off.
Power Source:	Either 110 VAC or 12 VDC lead zinc or nickel cadmium battery or combination.

<u>Sample Refrigerator</u>:	Available with thermostatically controlled refrigerated sample component.
<u>Construction Materials</u>:	Sampling train is stainless steel and plastic; weatherproof steel enclosure standard; all stainless steel construction available.
<u>Basic Dimensions</u>:	Same as B/ST-VS.
<u>Base Price</u>:	Varies from under $1,600 to around $3,000 depending upon features desired.
<u>General Comments</u>:	This unit was designed for installations where the sampler must be some distance, say more than 100 feet, from the sample pick-up point. It is recommended by the manufacturer for treated sewage or final effluent.

Designation:	SIRCO MODEL MK-VS
Manufacturer:	Sirco Controls Company 8815 Selkirk Street Vancouver, B.C. Phone (604) 261-9321
Sampler Intake:	Weighted end of sampling tube installed to suit by user.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	Up to 6.7m (22 ft).
Line Size:	0.95 cm (3/8 in.) I.D.
Sample Flow Rate:	Up to 6 ℓps (1.6 gpm) depending upon lift.
Sample Capacity:	Sample volume adjustable between 25 to 500 mℓ (repeatable to within ±0.5 mℓ); composited in 15.1ℓ (4 gal) container or sequential or discrete in 24 500 mℓ containers.
Controls:	Adjustable chamber slide electrode controls sample volume. Built-in timer allows adjusting sample cycle from 3 minutes to 45 hours. Option allows pacing by external flowmeter. Automatic shut-off.
Power Source:	110 VAC or 12 VDC lead-acid or nickel cadmium battery.
Sample Refrigerator:	Ice compartment allows some sample cooling. Automatic refrigerator available.
Construction Materials:	Sample train is PVC, plexiglass, and stainless steel. Case is weatherproof aluminum.
Basic Dimensions:	41 x 41 x 56 cm (16 x 16 x 22 in.); weighs 16.8 kg (37 lbs) without battery. Portable.
Base Price:	Around $1,300 and up depending upon features desired.

General Comments:

Signal from timer starts vacuum/compressor pump. Compressor side of pump purges sample intake tube, sequence changes and vacuum side of pump evacuates metering chamber and draws desired amount of sample. Compressor side of pump then discharges sample into sample container. Should plugging of the sampling tube occur, the pump is switched to the compressor side to blow out the tube. This sequence is repeated until the desired amount of sample is collected. Purging also takes place before and after each sample is taken.

Manufacturer states that the unit is especially designed to sample untreated raw sewage or high consistency industrial waste containing rags, fibers, etc.

A low cost Model MK-5, which collects up to 150 adjustable size (25 to 150 mℓ) aliquots and composites them in a 3.8ℓ (1 gal) jug, is also available. It does not have power-purge but uses similar controls as MK-VS units. Measuring 43 x 25 x 56 cm (17x10x22 in.) and weighing 19 kg (42 lbs), the unit can lift up to 6m (20 ft) through its 0.64 cm (1/4 in.) I.D. intake tube.

Designation:	SONFORD MODEL HG-4
Manufacturer:	Sonford Products Corporation 100 East Broadway, Box B St. Paul Park, Minn. 55071 Phone (612) 459-6065
Sampler Intake:	Parabolic port in a 1.9 cm (3/4 in.) I.D. rigid tube.
Gathering Method:	Mechanical; sampling tube is rotated down into the flow where it fills through the port by gravity; an electric motor rotates the tube up and the sample flows by gravity into the container.
Sample Lift:	Telescoping sampling tubes may be adjusted to reach down to 53 cm (21 in.) from the bottom of sampler.
Line Size:	1.9 cm (3/4 in.) I.D.
Sample Flow Rate:	Varies with tube angle.
Sample Capacity:	Varied aliquot sizes of 10, 20 or 30 mℓ are composited in a single 3.8ℓ (1 gal) container.
Controls:	Sampling cycle may be triggered at preset time intervals from built-in electrical timer or on signal from external flowmeter.
Power Source:	110 VAC standard; battery optional.
Sample Refrigerator:	Has ice cavity for cooling.
Construction Materials:	Aluminum outer case with rigid insulation.
Basic Dimensions:	33 x 31 x 33 cm (13 x 12 x 13 in.) plus clearance for oscillating sampling tube which varies depending upon telescoping adjustment. Portable.
Base Price:	\$325 electric; \$495 with battery.

Designation:	STREAMGUARD MODEL FTV-503
Manufacturer:	Fluid Kinetics, Inc. 4859 Production Drive Fairfield, Ohio 45014 Phone (513) 863-6667
Sampler Intake:	End of suction tube.
Gathering Method:	Suction Lift by vacuum pump.
Sample Lift:	Probably up to around 6m (20 ft).
Line Size:	0.95 cm (3/8 in.) I.D.
Sample Flow Rate:	Probably around 12 ℓ/s (3 gpm) or less depending upon lift.
Sample Capacity:	Composites adjustable size aliquots, from 50 to 1000 mℓ, in a 9.5ℓ (2-1/2 gal.) container.
Controls:	Unit may be paced by an internal crystal controlled timer adjustable from 1 to 99 minutes or by an external flowmeter providing a pulse for each 100 or 1000 gallons of flow, in which case the sampling interval is adjustable from 100 to 9,900 or 1000 to 99,000 gallons in 100 or 1000 gallon steps. The purge duration can be set from 1 to 30 seconds in 1 second steps. Sample size is adjustable by positioning end of sensor in metering chamber.
Power Source:	115 VAC or 12 VDC or both.
Sample Refrigerator:	Automatic refrigerator to maintain sample at 4°C is available.
Construction Materials:	Sampling train is all plastic, glass, and stainless steel; NEMA 12 cabinet with epoxy paint finish.
Basic Dimensions:	53 x 66 x 165 cm (21x26x65 in.).

Base Price:

General Comments:

The sample cycle, initiated by an internally generated time signal, external flow signal, or manual switch, starts the compressor and closes the pinch valve. Pressure/vacuum valve is actuated, pressurizing the chamber and inlet tubing for the pre-set purge cycle time. The valve then shifts to vacuum, and the sample is drawn into the chamber. As the sample reaches the pre-set volume a pinch valve opens, the pressure/vacuum valve shifts to pressure, and the sample is pressure discharged from the chamber into the sample container. If the sample chamber fails to fill in a given time interval determined by the controller's logic circuits, the system will automatically sequence through a series of three sample cycles with progressively increasing cycle time in an attempt to clear the sample intake line. If the line has not cleared after these cycles are complete (total of eight minutes), the control will switch to alarm mode. With the selector switch set to "MANUAL," the alarm output will remove power from the sampling control and provide a relay contact output for external alarm purposes. With the selector switch set to "AUTO RESET," the unit will provide a relay contact closure for external alarm purposes, but after a ten second "off" period automatically turns power back "on" and resets the system's logic for continued operation. Sample container stopper contains a conductive probe to sense full condition. Counter indicates number of samples taken. Systems can be provided with weatherproofed cabinets, with battery operated compressors for portable use, discrete sample storage, etc.

Designation:	STREAMGUARD MODEL CSO-242
Manufacturer:	Fluid Kinetics, Inc. 4859 Production Drive Fairfield, Ohio 45014 Phone (513) 863-6667
Sampler Intake:	End of suction tube.
Gathering Method:	Suction lift by peristaltic pump.
Sample Lift:	9m (30 ft) maximum.
Line Size:	0.64 cm (1/4 in.) I.D.
Sample Flow Rate:	Up to 380 mℓ per minute, depending upon lift.
Sample Capacity:	Composites adjustable size aliquots, based on pump running time, in a 9.5ℓ (2-1/2 gal.) container.
Controls:	Unit may be paced by an internal crystal controlled timer adjustable from 1 to 99 minutes or by an external flowmeter providing a pulse for each 100 or 1000 gallons of flow, in which case the sampling interval is adjustable from 100 to 9,900 or 1000 to 99,000 gallons in 100 or 1000 gallon steps. The backflush is continuously adjustable up to 120 seconds.
Power Source:	115 VAC.
Sample Refrigerator:	Automatic refrigerator to maintain sample at 4°C is available.
Construction Materials:	Sampling train is all plastic, silicon rubber, and stainless steel; NEMA 12 and 4 steel enclosures with epoxy paint finish.
Basic Dimensions:	Controllers and pump are housed in three separate cases that are installed in a cabinet sized to suit user requirements.
Base Price:	$1,450

General Comments: This sampler incorporates the StreamGuard Model FTS-200 and PR-200 controller. Different line sizes and pump heads are available as options.

Designation:	STREAMGUARD MODEL PP-60
Manufacturer:	Fluid Kinetics, Inc. 4859 Production Drive Fairfield, Ohio 45014 Phone (513) 863-6667
Sampler Intake:	End of suction tube.
Gathering Method:	Suction lift by peristaltic pump.
Sample Lift:	9m (30 ft) maximum.
Line Size:	0.8 cm (5/16 in.) or 0.64 cm (1/4 in.) I.D.
Sample Flow Rate:	To 200 or 378 mℓ per minute, depending upon lift.
Sample Capacity:	Composites adjustable size aliquots, based on pump running time, in a user supplied container.
Controls:	Unit is paced by a user-supplied signal. Flushing time is adjustable up to 180 seconds.
Power Source:	115 VAC or 12 VDC or both.
Sample Refrigerator:	None
Construction Materials:	Sampling train is all plastic and silicon rubber; 14 gage steel cabinets with epoxy paint finish.
Basic Dimensions:	Pump and controller are housed in separate cases measuring 20 x 43 x 25 cm (8x17x10 in.) and 25 x 20 x 15 cm (10x8x6 in.); weighs approximately 10 kg (22 lbs); portable.
Base Price:	
General Comments:	These units are actually sample gathering subsystems rather than complete samples. Model PP-80 is a high capacity unit with a 1 cm (3/8 in.) I.D. line and 840 mℓ per minute flow rate.

Designation:	STREAMGUARD DISCRETE SAMPLE ATTACHMENT MODEL DA-24S1
Manufacturer:	Fluid Kinetics, Inc. 4859 Production Drive Fairfield, Ohio 45014 Phone (513) 863-6667
Sampler Intake:	Not applicable.
Gathering Method:	Pump or liquid composite sampler provided by user.
Sample Lift:	Not applicable.
Line Size:	0.6 cm (1/4 in.) I.D.
Sample Flow Rate:	Not applicable.
Sample Capacity:	Twenty-seven, 473-mℓ bottles are sequentially filled at hourly intervals.
Controls:	None.
Power Source:	Spring driven clock.
Sample Refrigerator:	Refrigerated sample storage optional.
Construction Materials:	Sampling train is all plastic, mostly PVC; case is aluminum with epoxy paint finish.
Basic Dimensions:	48 x 30 x 50 cm (18x12x20 in.); portable.
Base Price:	$775.
General Comments:	This unit is actually a sample delivery subsystem rather than a complete sampler. The sample container tray slides easily out of the cabinet and the tray cover, which has a carrying handle, seals the containers when snapped into position. Since the tray is provided with segmented dividers,

individual bottles may be removed during the sampling period without disturbing the sequence of the other containers. Manufacturer claims unit will handle solids up to 0.5 cm (3/16 in.) without clogging. Options include positive indexing, different time intervals from minutes to 31 days, etc.

Designation:	STREAMGUARD DISCRETE SAMPLE ATTACHMENT MODEL DA-VTE1
Manufacturer:	Fluid Kinetics, Inc. 4859 Production Drive Fairfield, Ohio 45014 Phone (513) 863-6667
Sampler Intake:	Not applicable.
Gathering Method:	Pump or liquid composite sampler provided by user.
Sample Lift:	Not applicable.
Line Size:	0.95 cm (3/8 in.) I.D.
Sample Flow Rate:	Not applicable.
Sample Capacity:	Twenty-seven, 473-mℓ bottles are sequentially filled at preset time intervals.
Controls:	Crystal controlled timer adjustable from 1 to 99 minutes in 1 minute steps; manual indexing.
Power Source:	115 VAC; 12 VDC optional.
Sample Refrigerator:	Refrigerated sample storage optional.
Construction Materials:	Sampling train is all plastic, mostly PVC; case is aluminum with epoxy paint finish.
Basic Dimensions:	51 x 30 x 61 cm (20x12x24 in.); portable.
Base Price:	
General Comments:	This unit is actually a sample delivery subsystem rather than a complete sampler. The sample container tray slides easily out of the cabinet and the tray cover, which has a carrying handle, seals the containers when snapped into position. Since the tray is provided with segmented dividers, individual bottles may be removed during the

sampling period without disturbing the sequence of the other containers. Position 28 is external overflow that can be tube connected to waste or an external sample container. Manufacturer claims unit will handle solids up to 0.6 cm (1/4 in.) without clogging. Electronics is all solid state CMOS with transistor drive output. Options include special time intervals up to 31 days, distribution tray to handle larger solids without clogging, etc.

Designation:	TMI FLUID STREAM SAMPLER
Manufacturer:	Testing Machines, Inc. 400 Bayview Avenue Amityville, New York 11701 Phone (516) 842-5400
Sample Intake:	Stainless steel hollow cylindrical body with a 2.5 cm (1 in.) inlet and mounted submerged in the stream either on four legs mounted to a bottom plate or suspended from above if in a weir or flume.
Gathering Method:	Forced flow due to pneumatic ejection.
Sample Lift:	Over 7.6m (25 ft); depends upon air pressure.
Line Size:	1.3 cm (1/2 in.) O.D.
Sample Flow Rate:	Depends upon air pressure and lift.
Sample Capacity:	Aliquots of approximately 1/2 liter are composited in a suitable container provided by user.
Controls:	User must provide air pressure regulator if plant air supply is not regulated; sampling interval timer is adjustable to allow from one minute to one month to elapse between aliquots; manual on-off switch.
Power Source:	Compressed air supply of at least 1.4 kg/sq cm (20 psi), 7 kg/sq cm (100 psi) maximum; 110 VAC.
Sample Refrigerator:	None
Construction Materials:	Stainless steel and plastic.
Basic Dimensions:	Largest element will be user supplied sample container; sampling intake 10 x 23 x 20 cm (4 x 9 x 8 in.); timing controller 30 x 18 x 38 cm (12 x 7 x 15 in.).

Base Price:	Around $800.
General Comments:	Sampler developed by International Paper Company for use in the paper industry for checking the loss of useable fiber in effluent, taking consistency samples, etc. Sampler has performed well in flows to 6,800 ℓpm (1800 gpm) and consistencies to 3.5%.

Designation:	TMI MARK 3B MODEL SAMPLER
Manufacturer:	Testing Machines, Inc. 400 Bayview Avenue Amityville, New York 11701 Phone (516) 842-5400
Sampler Intake:	Twelve 0.64 cm (1/4 in.) I.D. vinyl sampling lines are connected to individual ports in a stainless steel sampling head (approx. 10 cm dia) fitted with a stainless steel filter having approximately 930 0.3 cm (1/8 in.) diameter holes.
Gathering Method:	Suction lift from vacuum in evacuated sample bottles.
Sample Lift:	Sample size reduced as lift increases; 3m (10 ft) appears practical upper limit with 592 mℓ (20 oz) bottles.
Line Size:	0.3 cm (1/8 in.) I.D.
Sample Flow Rate:	Varies with filling time, atmospheric pressure, bottle vacuum, sample lift, etc.
Sample Capacity:	12 "Medicine Flat" glass bottles are provided. Sample sizes up to 400 mℓ can be obtained depending upon lift, bottle vacuum and atmospheric pressure; 300 mℓ is typical.
Controls:	A spring driven clock rotates an arm which trips line switches at a predetermined time interval triggering sample collection. Sampling intervals of 1/2 to 8 hours are available.
Power Source:	Spring driven clock.
Sample Refrigerator:	None.
Construction Materials:	PVC coated, light alloy case with; glass bottles with rubber stoppers and rubber lines through switch

plate, plastic connectors and vinyl lines to stainless steel sampling head.

Basic Dimensions:	37 cm (14.5 in.) diameter x 66 cm (26 in.), empty weight is 14.5 kg (32 lbs); portable.
Base Price:	$595 including vacuum pump. Mark 4B model has 24 bottles at $685 for 592 mℓ (20 oz) size and $695 for 1 liter size.
General Comments:	This unit was originally developed by the Water Pollution Research Laboratory in England and is manufactured by North Hants Engineering Co. Ltd. under license from the National Research Development Corporation.

Designation:	TRI-AID SAMPLER SERIES
Manufacturer:	Tri-Aid Sciences, Inc. 161 Norris Drive Rochester, New York 14610 Phone (716) 461-1660
Sampler Intake:	End of suction tube installed to suit by user; manufacturer recommends using a large area screen with openings approximately 0.16 cm (1/16 in.) smaller than intake tube I.D.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	Up to 7.6m (25 ft).
Line Size:	0.95 cm (3/8 in.) I.D. standard; 1.3 cm (1/2 in.), or 1.9 cm (3/4 in.) I.D. optional.
Sample Flow Rate:	500 mℓ per minute.
Sample Capacity:	Adjustable size aliquots (based upon diversion time of continuous flow from pump) are composited in a suitable container.
Controls:	Two built-in adjustable timers control sample interval (3 to 40 minutes) and diversion time (3 to 40 seconds); alternately, unit may be paced by external flowmeter.
Power Source:	115 VAC.
Sample Refrigerator:	Available as option for foot-mount models.
Construction Materials:	Sample train is tygon, silicone, PVC; case is fiberglass for portable models, weatherproof steel for wall and foot-mount models.

Basic Dimensions:	38 x 25 x 51 cm (15x10x20 in.) for basic unit without sample container; typical foot-mount outdoor model is 91 x 51 x 173 cm (36x20x68 in.); weights are 15.9 kg (35 lbs) and up.
Base Price:	$650 either portable or wall mount for use with external Tri-Aid controller; add $115 for 1.3 cm (1/2 in.) I.D. tubing, $160 for built-in timer, $60 for foot mount.
General Comments:	Units are usually sold in conjunction with flowmeters (and possibly on-line monitors) as a complete system. Diverter valve is solenoid-actuated, three-way squeeze-tube type.

Designation:	UES SERIES 8000
Manufacturer:	Universal Engineered Systems, Inc. 7071 Commerce Circle Pleasanton, California 94566 Phone (415) 462-1543
Sampler Intake:	Weighted intake strainer at end of 7.6m (25 ft) sampling tube.
Gathering Method:	Suction lift by vacuum pump.
Sample Lift:	Up to 6.7m (22 ft).
Line Size:	0.79 cm (5/16 in.) I.D.
Sample Flow Rate:	1 liter per minute or less, depending upon lift.
Sample Capacity:	Fixed size aliquots of 25, 50, 75 or 100 mℓ are composited in a 3.8ℓ (1 gal.) flexible container.
Controls:	Unit may be paced by the contact closure of an external flowmeter or by its internal crystal timer whose interval can be set from 1 to 99 minutes in 1 minute steps. May also be cycled manually.
Power Source:	115 VAC for Models 8200 and 8202; 12 VDC for Model 8201.
Sample Refrigerator:	Insulated case has space for ice packs. Automatic refrigeration is provided in Model 8202.
Construction Materials:	All plastic; fiberglass case.
Basic Dimensions:	Model 8200 30 x 30 x 33 cm (12x12x13 in.); Model 8201 36 x 30 x 33 cm (14x12x13 in.); Model 8202 56 x 56 x 152 cm (22x22x60 in.); Models 8200 and 8201 weigh approximately 16 kg (35 lbs) and are portable, Model 8202 weighs approximately 50 kg (110 lbs) and is designed for fixed installations.

Base Price: Unknown at time of writing.

General Comments: Upon initiation of sampling cycle, the pressure side of the compressor is used to purge the metering chamber and intake line for 10 seconds. Valving switches the metering chamber to vacuum, and the required sample is drawn into the chamber. The compressor lines are again reversed, a second 10 second blowdown occurs, and the sample is deposited into the storage container. The battery will collect up to 100 samples per charge. Solid state CMOS electronics are used.

Designation:	WILLIAMS OSCILLAMATIC SAMPLER
Manufacturer:	Williams Instrument Co., Inc. P.O. Box 4365, North Annex San Fernando, California 91342 Phone (213) 896-9585
Sampler Intake:	Small diameter slitted strainer installed to suit by user.
Gathering Method:	Suction lift from diaphragm pump.
Sample Lift:	Up to 3.6m (12 ft).
Line Size:	Appears to be 0.64 cm (1/4 in.) I.D. or larger.
Sample Flow Rate:	60 mℓ per minute maximum.
Sample Capacity:	Composite container must be supplied by user. Sample volume is about one mℓ per stroke.
Controls:	Sampling rate may be adjusted from one sample per second to one every 10 minutes during operation.
Power Source:	Can be operated from any air or gas supply of 1.8 kg/sq cm (25 psi) or more or from a self-contained CO_2 bottle.
Sample Refrigerator:	None.
Construction Materials:	Sampling train is PVC, viton, and stainless steel.
Basic Dimensions:	Not in a case; largest item is gas bottle.
Base Price:	$438; includes pump, mounting bracket, tubing with strainer and fittings, and 6.8 kg (15 lbs) CO_2 bottle.

General Comments: Maximum discharge head is 36.6m (120 ft). The only moving part is a viton diaphragm which is operated by a pneumatic oscillator to create variable sample frequency.

Designation:	AVCO INCLINED SEQUENTIAL SAMPLER
Project Location:	Tulsa, Oklahoma
EPA Report No.:	11034 FKL 07/70
Sampler Intake:	Inlet tube passes through an aluminum tube which is hinged at the top of the storm drainage structure and has a polyethylene float at the other end where the inlet tube terminates with a sampling probe.
Gathering Method:	Suction lift from peristaltic pump.
Sample Lift:	Not stated, but probably under 6m (20 ft.).
Line Size:	0.3 cm (1/8 in.) I.D.
Sample Flow Rate:	Not stated, but must be fairly low for inclined sequential filling scheme to be meaningful.
Sample Capacity:	Unit sequentially fills a 60 mℓ sample bottle, then a 2,000 mℓ sample bottle, and repeats this 6 times, i.e., until it has filled six 60-mℓ and six 2,000-mℓ bottles; then it collects a continuous composite sample in a 18.9ℓ (5 gal) overflow bottle.
Controls:	A limit switch on the hinged float arm starts the pump when the flow level exceeds a preset value. When the flow level subsides the pump is shut off.
Power Source:	12 VDC marine battery.
Sample Refrigerator:	None.
Construction Materials:	Polypropylene pick-up tube, tygon and polyethylene connecting tubes, polyethylene bottles; aluminum frame, wood case.

<u>Basic Dimensions</u>:	Bottle rack is 71 x 15 x 41 cm (28x6x16 in.). Both semi-stationary and portable configurations were assembled.
<u>General Comments</u>:	A pressure box in the flow and connected to a Foxboro water pressure recorder was used. Components included a Cole-Parmer Masterflex tube pump, Model No. 7015 and a Terado power inverter (Allied No. 21f4499). The sequential filling of the sample bottles is simply performed by arranging their inlet tubes in order along an inclined manifold.

Designation:	SPRINGFIELD RETENTION BASIN SAMPLER
Project Location:	Springfield, Ill.
EPA Report No.:	11023 - - - 08/70.
Sampler Intake:	End of 280m (920 ft.) long influent line suspended 15 cm (6 in.) below water surface from a float.
Gathering Method:	Suction lift from a screw rotor pump.
Sample Lift:	Less than 4.3m (14 ft.) required in this application.
Line Size:	3.8 cm (1.5 in.) diameter lagoon influent sample intake line, 10 cm (4 in.) diameter lagoon effluent sample intake line.
Sample Flow Rate:	Approximately 15 ℓpm (4 gpm).
Sample Capacity:	Intake lines diacharged into 61ℓ (16 gal) sampling tanks. A constant volume aliquot was obtained each 30 minutes and composited in a 18.9ℓ (5 gal) container.
Controls:	A Lakeside Trebler scoop sampler was used to remove aliquots from sampling tanks. See discussion of that sampler for details.
Power Source:	115 VAC.
Sample Refrigerator:	Automatic thermostatically controlled refrigerators were used to house sample containers.
Construction Materials:	ABS plastic intake lines, PVC sample bottles, sampling tank appears to be metal, pump materials not given.

<u>Basic Dimensions</u>:	Components are distributed within a general purpose equipment building; fixed installation.
<u>General Comments</u>:	Moyno pumps operating on a continuous basis were used to provide sample flow through a 61ℓ (16 gal) sampling tank. Two samplers were constructed, one for the lagoon influent and one for the effluent.

Designation:	MILK RIVER SAMPLER
Project Location:	Grosse Point Woods, Mich.
EPA Report No.:	11023 FBD 09/70
Sampler Intake:	Overflow system influent sampler intake was simply inlet of submersible pump suspended beyond the bar screens within the transition structure between sewer and wet well. Effluent sampler intake was four 2.5 cm (1 in.) vertical suction lines spaced evenly along the 64m (210 ft.) long effluent weir which drew their samples from points between the skimming baffle and weir at a depth above the bottom of the baffle and just below the outlet weir.
Gathering Method:	Forced flow from submerged pump for influent sampler; suction lift from centrifugal pump for effluent sampler.
Sample Lift:	Not stated.
Line Size:	Except for 2.5 cm (1 in.) diameter inlet lines leading to effluent sampler header, all sampling lines were 5 cm (2 in.) diameter.
Sample Flow Rate:	Not stated.
Sample Capacity:	Samplers collect adjustable grab samples from the continuously flowing 5 cm (2 in.) pipe streams, composite them for variable periods and hold them in a refrigerated compartment for periods up to about three hours.
Controls:	The size of each grab sample is controlled externally. Otherwise, the sampling program is controlled by a continuous punched paper tape

program which varies the collection time of each composite, the number of grab samples in each composite, and each of the variables from one sampling time to another.

<u>Power Source</u>:	115 VAC.
<u>Sample Refrigerator</u>:	Automatic thermostatically controlled refrigerated sample compartments.
<u>Construction Materials</u>:	Metal, plastic, and wood were used in construction; no details were given.
<u>Basic Dimensions</u>:	Indoor portion of sampler is large, perhaps 1.8x0.9x1.5m (6x3x5 ft.) or so; fixed installation.
<u>General Comments</u>:	This unit apparently functioned fairly well on the project for which it was designed.

Designation:	ENVIROGENICS BULK SAMPLER
Project Location:	San Francisco, California
EPA Report No.:	11024 FKJ 10/70
Sampler Intake:	A metal container resembling an inverted roadside mail box approximately 37 cm (14.5 in.) long and 36 cm (14 in.) deep with a 15 cm (6 in.) radius; hinged covers at each end are mechanically connected to function integrally upon activation of an air cylinder.
Gathering Method:	Mechanical; the sampler intake assembly is designed to fit a special support structure which must be installed in the manhole chosen for sampling. It is lowered to the bottom of the invert whereupon the covers are closed thereby trapping a plug of the combined sewage inside the sampler. The filled sampler was then raised by winch to the surface.
Sample Lift:	Depth of manhole in question. No real limit.
Line Size:	Not applicable.
Sample Flow Rate:	Not applicable.
Sample Capacity:	Roughly 34ℓ (9 gal) maximum.
Controls:	Manually operated.
Power Source:	Compressed air.
Sample Refrigerator:	None.
Construction Materials:	Aluminum.
Basic Dimensions:	37 x 31 x 36 cm (14.5x12x14 in.) plus brackets and supporting structure, etc.

Designation:	ROHRER AUTOMATIC SAMPLER
Project Location:	Sandusky, Ohio
EPA Report No.:	11022 ECV 09/71
Sampler Intake:	Not clearly stated but presumably the end of the suction line mounted in the overflow conduit just beyond the leaping weir.
Gathering Method:	Suction lift from diaphragm pump.
Sample Lift:	Not stated but probably good for at least 6m (20 ft.).
Line Size:	Smallest line would appear to be the one connecting the diverter head to the sample container, but size is not given.
Sample Flow Rate:	Not stated but presumably rather large.
Sample Capacity:	Unit collects 24 0.47ℓ (1 pt.) discrete samples plus a flow proportional composite of up to 18.9ℓ (5 gal).
Controls:	Sampling is automatically started when the leaping weir diverts flow into the overflow flume. Discrete samples were collected every 5 minutes paced by a built-in timer adjustable from 5 to 60 minutes. Constant volume composite aliquots are added for each 37,854ℓ (10,000 gal) of flow through the overflow flume.
Power Source:	115 VAC.
Sample Refrigerator:	None
Construction Materials:	Not stated.
Basic Dimensions:	None given but a fixed installation located in a building specially erected for the project.

General Comments: The pump produces a continuous flow of sewage through the sampling header pipe and back to the sewer. Two taps are provided to allow continuous flow through diversion nozzles for the individual and composite sample collection stations and return to sewer. When it is desired to collect a sample, a solenoid is actuated operating a linkage which mechanically rotates the diversion nozzle causing the flow to enter a chamber connected to the sample bottle rather than the sewer return. A spring assures return of the diversion nozzle to its original position after the sample is taken. The time of solenoid activation governs the size of the sample. The 24 discrete sample bottles are mounted on a turntable which indexes upon each sampling cycle to place an empty bottle under the filling spout.

Designation:	WESTON AUTOMATIC SAMPLER
Project Location:	Washington, D.C.
EPA Report No.:	11024 EXF 08/70
Sampler Intake:	Details of intake to submersible sewage pump and of sampling head to vacuum-charged sampler not stated.
Gathering Method:	Forced flow to a retention tank by a sewage pump anchored to the sewer floor, thence, by vacuum, from the retention tank to sample bottles.
Sample Lift:	Not stated.
Line Size:	Not stated.
Sample Flow Rate:	Not stated.
Sample Capacity:	Collects 24 discrete samples.
Controls:	Wastewater is pumped continuously to the retention tank. The vacuum tank is triggered by the increased back-pressure of a bubbler line resulting from the increased depth of sewer flow. The discrete interval is adjusted by an electric timer to a minimum period of 5 minutes.
Power Source:	115 VAC.
Sample Refrigerator:	Sample bottles, sampling lines, and control switches installed in a refrigerated enclosure.
Construction Materials:	Not stated.
Basic Dimensions:	The wastewater retention tank, the refrigerated sampler, and the piping are all housed in 2.1 x 1.6 x 2.0m (7x5.2x6.5 ft.) metal shed.

General Comments:	A submersible, heavy-duty manually-controlled sewage pump delivers wastewater continuously to a retention tank having a normal retention time of less than 1 minute. The pump is anchored to the sewer bottom in a metal cage. During a storm, an increase of water depth in the sewer applies back pressure to an air-bubbling system, thus activating a mercury switch and triggering the system which collects samples from the retention tank. The 24 sample bottles are vacuum charged prior to the storm by use of a portable vacuum pump. The bottles are in a fixed position in the refrigerated enclosure, and each sample is drawn into its bottle by vacuum when a control switch is released by a tripper arm operated in conjunction with a timer.

Designation:	PAVIA-BYRNE AUTOMATIC SAMPLER
Project Location:	New Orleans (Lake Pontchartrain), Louisiana
EPA Project No.:	11020 FAS. Final report should be available soon.
Sampler Intake:	Saran wrapped, galvanized sheet metal air diffuser about 76 cm (30 in.) long, placed about 20 cm (8 in.) below the water surface. Polyethylene tubing from intake to sampler.
Gathering Method:	Positive displacement, screw type, Moyno or Aberdenffer pump operated with a 0.56 KW (3/4 HP) motor.
Sample Lift:	Maximum suction lift about 6m (20 ft.).
Line Size:	Minimum 1.9 cm (3/4 in.) line from canal to sampler. Intake pipe to sampler manifold 1.9 cm (3/4 in.). Manifold to each row of sampler bottles, 1.3 cm (1/2 in.). Line from solenoid valve to sampler, 0.64 cm (1/4 in.).
Sample Flow Rate:	Under 11.4 ℓpm (3 gpm).
Sample Capacity:	Unit collects 36 discrete samples in bottles of about 1.2ℓ (40 oz) capacity each.
Controls:	Sampler operation initiated with manually operated switch. Filling of sample bottles controlled by a motor driven timer, through relays, to a solenoid valve at each sample bottle. Time interval between sample collections not stated.
Power Source:	Sample pump operates through a 220 volt, 60 Hz, external power source. Electrical control equipment is on a 120 volt, 60 Hz, power source.

<u>Sample Refrigerator</u>:	Sample bottles, solenoid valves to each bottle, and sampler manifold, are installed in a Shaefer Cooler Model MC-1600, with cooling units built in its walls.
<u>Construction Materials</u>:	Sampler piping and fittings are of PVC. Grating and supports within the cooler are aluminum.
<u>Basic Dimensions</u>:	Outside dimensions of cooler in which sampler is installed are about 79 x 155 x 89 cm (31x61x35 in.). All equipment is installed in a 1.8 x 2.4m (6x8 ft.) shed.
<u>General Comments</u>:	The pump produces a continuous flow of sewage to the sampler. When the sampler has been placed in operation, individual solenoid valves from the sampler manifold are opened one at a time to the 36 sample bottles by an electrically operated timer. A combination standpipe and overflow line is used to maintain pressure on the solenoid valves.

Designation:	REX CHAINBELT, INC. AUTOMATIC SAMPLER
Project Location:	Kenosha, Wisconsin
EPA Project No.:	11023 EKC. Final report should be available soon.
Sampler Intake:	Pipe drilled with 0.63 to 0.95 cm (1/4 to 3/8 in.) holes.
Gathering Method:	Uses a "Hushpuppy" positive pressure pump. Cost of pump about $30. Operates only during a 2-3 minute purging period and during actual filling of sample bottle.
Sample Lift:	Suction lift about 4.6m (15 ft.).
Line Size:	1.3 cm (1/2 in.) Tygon tubing and garden hose.
Sample Flow Rate:	Approximately 11.4 ℓpm (3 gpm).
Sample Capacity:	Unit collects 18 discrete samples in bottles of 1-liter capacity.
Controls:	Sampler operation started by manually operated control. Thereafter, flow to sample bottles is regulated by an electric timer and solenoid valve. Time interval between filling of bottles can be adjusted between 3 minutes and one hour.
Power Source:	Not stated.
Sample Refrigerator:	None provided.
Construction Materials:	Sampling lines are composed of Tygon tubing and garden hose; pump is plastic and Buna N.
Basic Dimensions:	Not stated.

<u>General Comments</u>:	After manual starting, the pump runs for 2 to 3 minutes to purge the sampler lines. The pump then operates only while each sample bottle is filled through a revolving solenoid valve regulated by an electric timer. Apparently, the pump operation is stopped automatically after 18 sample bottles have been filled.

Designation:	COLSTON AUTOMATIC SAMPLER
Project Location:	Durham, North Carolina
EPA Report No.:	EPA-670/2-74-096.
Sampler Intake:	Direct intake to sump pump set on piling at stream bed. Intake from sampling flume is a standard Serco Model NW-3 sampling head.
Gathering Method:	Water pumped from stream to sampling flume with an Enpo-Cornell sump pump, Model No. 150A. Pump is placed inside a 61 x 46 cm (24x18 in.) metal box, all within a woven wire frame. A standard Serco Model NW-3 vacuum sampler gathers samples from the 91 x 27 cm (36x10.5 in.) Plexiglas flume.
Sample Lift:	About 3.3m (11 ft.) from the pump to the sampling flume. No lift from the flume to the Serco sampler.
Line Size:	Line from pump to flume is 3.8 cm (1.5 in.) fire hose. Serco sampler lines are 0.63 cm (1/4 in.) inside diameter.
Sample Flow Rate:	Flow rate from pump to flume is about 189 ℓpm (50 gpm). Flow rate from flume to Serco sampler is variable.
Sample Capacity:	24-500 mℓ bottles are provided in the Serco sampler. Actual sample sizes are about 400 mℓ.
Controls:	Operation of pump starts and stops when float in an offstream stilling well reaches specified stages. For Serco Model NW-3 sampler controls, see its writeup.

Power Source:	Pump operates on 115 VAC. Serco sampler is powered with a spring driven clock.
Sample Refrigerator:	None provided.
Construction Materials:	Sampling train composed of fire hose, Plexiglas flume, stainless steel sampling head, vinyl lines, and glass bottles with rubber stoppers.
Basic Dimensions:	Not a concentrated unit. Serco sampler 39 x 39 x 68 cm (15.5x.5.5x26.7 in.).

Designation:	ROHRER AUTOMATIC SAMPLER MODEL II
Project Location:	To be used in Akron, Ohio
EPA Report No.:	None
Sampler Intake:	Not clearly stated but presumably the end of the 5 cm (2 in.) I.D. suction line mounted directly in the flow stream to be sampled.
Gathering Method:	Suction lift from diaphram pump.
Sample Lift:	Not stated but probably good for at least 6.1m (20 ft).
Line Size:	1.9 cm (3/4 in.) I.D.
Sample Flow Rate:	Depends upon lift; could exceed 76 ℓpm (20 gpm).
Sample Capacity:	Unit collects twenty-four 1.9ℓ (1/2 gal) discrete samples plus an 18.9ℓ (5 gal) composite.
Controls:	Has a provision for automatic starting. Discrete samples and composite aliquots can be collected every 5 minutes paced by a built-in timer adjustable from 5 to 60 minutes. Switches automatically stop diversion to composite bottle when it is full and shut sampler off when last discrete bottle has been filled.
Power Source:	115 VAC
Sample Refrigerator:	None
Construction Materials:	Tygon and PVC tubing; aluminum diverter, nozzle, etc.; "Nalgene" sample bottles; aluminum frame.
Basic Dimensions:	137 x 76 x 150 cm (54 x 30 x 59 in.) including mounting dolly. Can be wheeled about, but appears too heavy to lift without assistance.

General Comments: The pump produces a continuous flow of sewage through the sampler diverter and back to the sewer. Two solenoids are provided to allow diversion of flow to either the discrete or composite sample container for a preset time period. They tip a nozzle inside a diversion chamber and thus direct the flow as commanded by the timing cams. The nozzle is spring loaded to return to its null position which directs flow back to the sewer. A rotating nozzle is indexed over one of 24 funnels, each connected by a piece of 1.9 cm (3/4 in.) I.D. tygon tubing to one of the wide mouth discrete sample bottles which are in a rectangular array.

Designation:	NEAR SEWER SAMPLER
Project Location:	Tested at San Jose Water Pollution Control Plant.
EPA Report No.:	None. Not developed under EPA sponsorship.
Sampler Intake:	Small hole approximately 1.3 cm (1/2 in.) diameter in the side of a traversing pick-up tube.
Gathering Method:	Mechanical; pick-up tube with piston is lowered and fills through intake near its lower end as it traverses the stream to be sampled. Sample is ejected through a hole near the top of the tube by raising the piston inside the tube.
Sample Lift:	Will depend upon pick-up tube length; 2.4m (8 ft) would appear to be a practical maximum.
Line Size:	Smallest line (possibly 1/2") would appear to be the one connecting the sample bottle to the pick-up tube outlet.
Sample Flow Rate:	Not applicable.
Sample Capacity:	Developer simply states that either a composite sample or a number of discrete samples can be provided.
Controls:	An upper piston was added to allow varying the quantity of samples gathered during the stream depth traverse in a controlled way. It is activated by a water surface sensor located on the bottom of the pick-up tube. The water sensor provides the capability (in conjunction with a small memory and logic unit) of gathering flow-proportional samples, at least to the extent that flow is

proportional to water depth. Otherwise samples could be paced by a timer or arranged to accept signals from an external flowmeter.

<u>Power Source</u>: Basic unit could be battery powered. External controls could require alternating current.

<u>Sample Refrigerator</u>: None

<u>Construction Materials</u>: Stainless steel and plastic.

<u>Basic Dimensions</u>: Will depend upon length of pick-up tube; say approximately 0.3 x 0.3 x 2.4m (1 x 1 x 8 ft) plus a sample container rack. Unit must be mounted in manhole or otherwise near the flow stream. Basic unit would appear to weigh 13-18 kg (30-40 lbs).

<u>General Comments</u>: Sampler is out of the main flow except when taking a sample. Developer claims sampler can pick-up a representative sample of surface oil film. Both an initial model and an improved prototype have been fabricated and tested to demonstrate the basic concepts involved, but the unit has not been made commercially available as yet. A patent has been granted for the sampler and its concept. Any requests for further information should be directed to:

S. B. Spangler, Vice President
Nielsen Engineering & Research, Inc.
850 Maude Avenue
Mountain View, California 94040
Telephone (415) 968-9457

Designation: FREEMAN AUTOMATIC SAMPLER

Project Location: Columbia, Maryland

EPA Report No.: None

Sampler Intake: Provided by user.

Gathering Method: External head to provide flow to sampling equipment shed. Fluidic diverters are controlled by solenoid valves by timer signals and divert flow to discrete sample containers, the flow otherwise returning to waste.

Sample Lift: Not applicable.

Line Size: The smallest passage in the sampling train is the 0.63 x 0.63 cm (0.25 x 0.25 in.) throat of the diverter.

Sample Flow Rate: 5.7 ℓpm (1.5 gpm).

Sample Capacity: Modularized construction allows as many 0.9ℓ (1 qt) discrete sample containers to be used as desired. For this installation, 6 modules were arranged vertically in a single cascade, and two cascades were employed.

Controls: Timer-actuated solenoid valves open and close the diverter control ports causing a sample to be taken at preset time intervals. Volume of sample is adjusted by positioning the vent tube in the sample jar.

Power Source: 115 VAC

Sample Refrigerator: None

Construction Materials: PVC pipe, fluidic diverters molded from PVC, sample containers are glass Mason jars, metal and plywood frame.

Basic Dimensions:	Each 6 module cascade appears to be about 0.5 x 0.3 x 1.5m (1.5 x 1 x 5 ft). Minimum height of a module is 15.2 cm (6 in.) head required for diverter operation plus sample bottle height.
General Comments:	The complete absence of moving parts in the flow stream is a distinct advantage. With the use of a bias orifice in one control port, only one control line need be blocked to obtain diversion. The possibility of using such an arrangement with the control lines sequenced vertically in a timing jar that is fed fluid by a calibrated wick would allow a sampler with absolutely no moving parts and requiring no power other than from the fluid flow itself.

<u>Designation</u>:	<u>PS-69 PUMPING SAMPLER</u>
<u>Project Location</u>:	Columbia, Maryland
<u>EPA Report No.</u>:	None. Not developed under EPA sponsorship.
<u>Sampler Intake</u>:	Provided by user.
<u>Gathering Method</u>:	Suction lift from progressive cavity screw-type pump.
<u>Sample Lift</u>:	6.1m (20 ft) recommended maximum.
<u>Line Size</u>:	Pump will pass 0.5 cm (3/16 in.) solids.
<u>Sample Flow Rate</u>:	Approximately 26 ℓpm (7 gpm).
<u>Sample Capacity</u>:	Adjustable size discrete samples are collected in seventy-two 0.5ℓ (1 pt) glass bottles or 0.9ℓ (1 qt) plastic containers.
<u>Controls</u>:	Sample size is adjusted by potentiometer setting; under timer operation samples may be taken as often as every 2 minutes or as infrequently as one a day; may be paced by optional stage-discharge computer or external flowmeter. Has automatic starter and event marker.
<u>Power Source</u>:	36 VDC (three 12V automobile batteries of 55 amp-hr. capacity or greater) for pump motors; one standard D dry cell battery for clock.
<u>Sample Refrigerator</u>:	None.
<u>Construction Materials</u>:	Intake tubing is user-supplied; pump is Buna-N, stainless steel, carbon and ceramic; also PVC and vinyl in sampling train.

Basic Dimensions: 96 x 147 x 183 cm (38x58x72 in.); weighs 77 kg (170 lbs) without batteries or tubing; designed for fixed installation.

General Comments: This sampler was designed for sediment transport studies in rivers. A typical cycle begins with a small pump taking water from a backflush barrel and backflushing the intake, priming the line and removing any grass or trash from the intake proper. This operation continues until a bottom float in the barrel drops. When the large (sampling) pump starts, a solenoid on the backflush barrel closes the backflush pump intake and the distribution arm advances one hole. The sampling pump feeds into a solenoid operated diverter that normally feeds the backflush tank. About 20 seconds after the sampling pump starts, the diverter switches for a preset period and the sample is routed via the distributer arm and an individual plastic hose to the next sample container. The sampling pump is shut off when the top float in the backflush barrel lifts. A smaller, portable version designated PS-73 and taking 36 discrete samples is also available. Any requests for further information should be directed to:

John V. Skinner
Hydrologist-in-Charge
Federal Inter-Agency
Sedimentation Project
St. Anthony Falls Hydraulic
Laboratory
Hennepin Island and Third Ave.
S.E.
Minneapolis, Minnesota 55414

Designation:	RECOMAT SAMPLER
Project Location:	Paris, France (Department De Seine Saint-Denis)
EPA Report No.:	None. Not developed under EPA sponsorship.
Sampler Intake:	Four 120 mℓ tanks, each with an 8 cm (5/16 in.) diameter hole in the bottom and protected by a plastic bell, which can be positioned vertically anywhere within the flow stream.
Gathering Method:	Forced-flow due to pneumatic ejection.
Sample Lift:	10m (33 ft) maximum.
Line Size:	Smallest line is 0.6 mm (1/4 in.).
Sample Flow Rate:	Depends upon pressure and lift.
Sample Capacity:	Collects 24 sequential composite samples (1.6ℓ maximum) made up of an undisclosed (but fixed) number of aliquots of less than 120 mℓ per intake.
Controls:	The design is such that it takes 5 minutes to collect each sequential composite sample. The only control is an operator setting (η) that causes the sampler to fill the first η bottles one after the other (essentially continuous operation), after which the remaining 24-η bottles are filled at 10 minute time intervals. Thus, the total sampling period can range from 2 to 4 hours.
Power Source:	Electricity required for air compressor motor and refrigerator.

Sample Refrigerator:	Entire sample distribution and storage assembly is inside an automatic refrigerator set to maintain a 4°C internal temperature.
Construction Materials:	Sampling train is plastic and rubber.
Basic Dimensions:	Sample intake is 8 cm (3.1 in.) diameter x 15 cm (5.9 in.) H; control box is 60 x 30 x 80 cm (23.6x11.8x31.5 in.); refrigerator is 100 x 100 x 120 cm (39.4x39.4x47.2 in.); each compressor is 50 x 50 x 20 cm (19.7x19.7x7.9 in.); fixed installation.
General Comments:	This sampler was designed by RECOMAT to meet specifications written by Coyne and Bellier consulting engineers. Each intake is gravity filled, via its bottom hole, through an elastic rubber truncated cone inside its tank. The release of air pressure pinches the edges of the rubber hole and forces the sample up the line, through the distribution arm, and into the sample container. Due to air losses associated with the rubber cones (and piping), due in part to failure to shut off because of obstruction by heavy particles, only 500 mℓ or so of sample is typically obtained (rather than the 1.6ℓ design capacity). A separate air compressor is used to move the distribution arm.

Designation:	EG&G PROTOTYPE SEWER SAMPLER
Project Location:	Rockville, Maryland
EPA Report No.:	EPA-600/2-76-006.
Sampler Intake:	Four intakes of present configuration can be located anywhere within the flow stream. Presently consists of 4 plastic nozzles, each with three 0.5 cm (3.16 in.) diameter ports in line with the flow, mounted to a streamlined stainless steel strap around the inside periphery of the sewer pipe.
Gathering Method:	Suction lift from separate high capacity 3-rotor peristaltic pump heads for each intake, driven by a common electric motor through keyed connecting shafts.
Sample Lift:	Submersible pump box is designed to be located within 3m (10 ft) or so of the flow. Discharge heads of over 15m (50 ft) are possible.
Line Size:	Smallest line is 0.95 cm (3/8 in.) I.D.
Sample Flow Rate:	9.5 ℓ/m (2.5 gpm) through each line for 37.9 ℓ/m (10 gpm) total flow in present configuration.
Sample Capacity:	Collects 12 discrete 2ℓ (0.53 gal) samples per storage module.
Controls:	May be set to take a sample as often as every minute or as infrequently as once every 9 hours, in 200 millisecond increments when paced by internal timer; may also be paced by suitable external flowmeter; has automatic start connection; all solid state design. Backflush and blowdown

	time periods are also adjustable. Can be programmed or run manually in any fashion for test purposes.
<u>Power Source</u>:	115 VAC.
<u>Sample Refrigerator</u>:	Entire sample distribution and storage assembly can be fitted with an insulated, refrigerated cover, but none is provided at present.
<u>Construction Materials</u>:	Sampling train is PVC, tygon, silicone, plexiglass, and polyethylene.
<u>Basic Dimensions</u>:	Not an integrated unit. Largest components are a standard 55-gallon drum and distributor and storage assembly which is approximately 1.2m (4 ft) in diameter and 0.9m (3 ft) H; electronics box is 47 x 39 x 30 cm (18.5x15.5x12 in.); fixed installation.
<u>General Comments</u>:	This automatic sampler is a prototype design incorporating several previously untried features in five modular subsystems, including all solid-state electronics, a clock to allow time-of-day correlation, high sample intake and transport velocities, large high-capacity peristaltic pumps and fluidic diverters avoiding any moving parts in the sampling train, return of the first flow to waste, fresh water or chemical purge and backflush and high pressure air blowdown after each sample is taken, multilevel sample intakes with non-intrusive mounting, and large sample capacity with the quantity of each sample determined by weight. The modular subsystem

approach allows the basic design implementation to be tailored to suit a wide variety of sampling program and site requirements.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

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16. ABSTRACT

Water and wastewater sampling is discussed within the context of a water quality monitoring program. The general characteristics of the source flows are described, and the mechanics of polydisperse systems as they affect sample gathering are discussed. It is pointed out that the collection of a sample that is representative of the source in all respects is a frequently underrated task, especially insofar as suspended solids are concerned. The various types of samples are defined, compared, and their use indicated. Other practical considerations addressed include frequency of sampling, site selection, and sample quantity, preservation, and handling. Recommendations on when to use manual versus automatic sampling are given. Each of the elements of an automatic sampler is discussed from the viewpoint of design considerations in order to help the reader assess the ability of a particular unit to meet his needs. Commercially available samplers and some custom designed equipment are reviewed. Recommended field procedures for sampling are given, and a review of automatic sampler performance is provided. An appendix provides, in a common format, 102 descriptions covering over 250 models of commercially available automatic samplers and 16 descriptions of custom built devices.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Sampling, Samplers, Sewage, Wastewater, Water analysis, Water quality, Water pollution, Effluents, Overflows, Manholes, Sanitary engineering, Urban areas, Reviews, Monitoring		13B

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