# WATER RESOURCES INSTRUMENTATION

Barry A. Long

Technical Report NPS/NRWRD/NRTR-92/09

WATER RESOURCES DIVISION

National Park Service - Department of the Interior
Fort Collins - Denver - Washington

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# INTRODUCTION

This technical report provides information on the types of field instrumentation available to measure and/or sample water resource attributes. The report is designed to be a quick-reference document that provides the user with information available from several sources in a condensed format. The instrumentation lists that follow do not represent a complete list of sampling equipment for all water resource parameters. They simply are examples of instruments that have maintained a successful record of performance based upon the author's experience and that of other Water Resources Division (WRD) staff. The focus of the presentation is on sampling in freshwater environments, however, many of the instruments are utilized in marine environments. Also, please note that the WRD does not endorse any brand name products.

This report is organized in a tabular format for six categories of water resource instrumentation. These categories include: (1) flow measurement; (2) stage (level) measurement; (3) physical and chemical water quality measurement; (4) biological water quality measurement; (5) water, soil and biota samplers; and (6) data storage and management. The tables are preceded by brief explanations of instrument types in each category. The tables provide lists of instrument types, manufacturers, distributors, model and part numbers, 1991/1992 prices, and comments (e.g. product/model names, descriptions, sizes, and component parts). Spaces are left at the end of each instrument type so that users can add instruments from other vendors to their lists. The names, mailing addresses and telephone numbers of the vendors listed are included in the Appendix for the user's reference.

# BACKGROUND

Natural resource specialists, biologists, hydrologists, rangers and maintenance personnel working on lands managed by the National Park Service (NPS) frequently need to monitor water resource attributes in streams, lakes, springs, wells, wetlands, estuaries and oceans to evaluate baseline conditions or to detect changes that may be attributed to land uses or natural events. The two most frequently measured attributes are water quantity and quality, however, water-dependent habitats and fluvial geomorphic processes have been receiving increasing attention.

Water quantities commonly are measured to characterize flow regimes and ground water levels related to the water requirements of human and resource values. Also, water quantities are measured or estimated to evaluate rainfall-runoff relationships and determine the magnitude and frequency of floods that may inundate floodplain areas. Standardized methods are recommended for measuring water quantities in various natural and artificial settings (USDI 1977; Rantz et al. 1982). Often statistical parameters (minimum, maximum, median, mean) are used to describe normal baseflow levels, annual or seasonal runoff volumes for water uses, and/or peak flows. Peak flows are used in flood analyses and are important attributes in the analysis of geomorphic processes and conditions, and in the design of hydraulic structures. Magnitude and frequency of high flows commonly are evaluated using either annual or partial-duration series flood-frequency analyses (USDI 1982). Flow-duration analyses are used in assessments of flow availability for a range of flow conditions (floods, normal baseflows, droughts, etc.). Generally, they display monthly flow volumes (or daily flow rates) for selected values of flow exceedence. Water balance, or water budget, analyses occasionally are employed to measure local gains and losses between longitudinal stream reaches, or to construct a complete picture of inflows and outflows (including precipitation, streamflow, evapotranspiration losses, ground water gains and losses, water uses, etc.) for a stream, pond/lake, reservoir, wetland or entire watershed system.

Water qualities usually are measured to characterize the physical, chemical and biological condition of water resources, or to evaluate the impacts of water pollution from various sources on receiving water bodies. Pollutant sources may be defined as point sources (discharge from pipes or confined areas) or non-point sources (diffuse runoff from watersheds). Several common tests or measurements can be made in relation to the types of land use activities being evaluated (Kunkle et al. 1987; MacDonald et al. 1991). Generally, strategies are developed for the design and implementation of water quality monitoring plans. Good water quality monitoring plans focus on satisfying specific objectives, sample site selection, sample frequency, indicator parameters, instrumentation, logistics, sample analysis and data management (Ponce 1980a; Sanders et al. 1983; Kunkle et al. 1987). National Park Service guidance relating to monitoring design is contained in two recent documents

(NPS-77 1991; NPS-75, in preparation). Often water samples are collected in addition to measurement of water parameters in the field. Standardized methods for water quality measurement and sampling are available to assist those conducting water studies (USDI 1977; Kunkle and Wilson 1984). In addition, standardized procedures are recommended for quality assurance and control, sample handling (preservation, transportation, etc.), and laboratory analyses of water parameters within specific holding times (APHA 1989; Border et al. 1978; USEPA 1979a; USEPA 1979b). Water data results can be analyzed and interpreted to assess ambient conditions, impacts due to natural or human-caused sources, and/or water quality trends (UNESCO 1978; Ponce 1980b; Hem 1985). Often monitoring is conducted to determine whether particular water bodies are in compliance with state water quality standards. Federal water quality criteria provide the basis for most state standards (USEPA 1986).

Another method for assessing water quality is by sampling indicator organisms, or "biomonitoring". Although instrumentation for biomonitoring is not covered in-depth in this paper, references are provided to assist those in developing this component of a water quality monitoring program (USEPA 1985; USEPA 1989a; USEPA 1989b).

# INSTRUMENTATION

## Flow Measurement

Flow (streamflow, discharge, etc.) is the basic property of water transport in streams, rivers, springs and pipes. Flow or discharge is defined as a unit volume of water moving past a point in a unit period of time. In a stream, flow is calculated by multiplying the width of the stream times the average depth times the average velocity of the moving water. The units of flow are most often in cubic feet per second (cfs), cubic meters per second (cms), gallons per minute (gpm) or acre-feet per day, month, or year.

Rotating-cup current meters, such as the Price and Pygmy Type meters, mounted on wading rods are the most common instruments used to determine flow. They measure flow velocity in cross-sectional cells that are delineated by a tape or tagline across a stream. Summation of the products of length, depth and velocity from the individual cells results in the total flow. Electromagnetic flow meters measure the voltage generated by current movement past a sensor unit containing two electrodes. That voltage is directly proportional to velocity. Fluorometers measure flow movement (time-of-travel), flow discharge, and flow/pollutant dispersion and diffusion using fluorescent dye tracers. Parshall flumes and weirs measure flow height changes through contracted openings which are calibrated to represent flow discharge. Ultrasonic velocity/flow recorders are recent modifications of ultrasonic level technology where sound waves are transported through water and bounced of reflector plates. By positioning the plates in a certain way, time of travel or velocity and discharge of the flowing water can be calculated. Examples of the above mentioned instruments are presented in Table 1. Many of these instruments can be adapted to monitor flow in water or sewage delivery systems.

| Table 1. Flow Measurement | | | | | |
|---|---|---|---|---|---|
| Type | Manufacturer | Distributor | Model/Part No. | Price | Comments |
| Price Type "AA" Current Meters | U.S. Geological Survey | Hydrologic Instrum. Facil. | 1101001 | 864.00 | |
| | Teledyne Gurley | Teledyne Gurley | 622AA | 1,097.00 | add $1,295 for digital flow indicator (Model 1100) |
| | " " | " " | 622D | 1,333.00 | w/ earphone, case |
| | " " | Forestry Suppliers | 94982 | 2,940.00 | w/ wading rod, digital flow indicator |
| | Scientific Instruments | Scientific Instruments | 1210 | 770.00 | |
| | | | | | |
| Pygmy Type Current Meters | U.S. Geological Survey | Hydrologic Instrum. Facil. | 1103001 | 516.00 | |
| | Teledyne Gurley | Teledyne Gurley | 625AA | 682.00 | add $1,295 for digital flow indicator (Model 1100) |
| | " " | " " | 625D | 782.00 | w/ earphone, case |
| | " " | Forestry Suppliers | 94992 | 1,320.00 | w/ wading rod |
| | Scientific Instruments | Scientific Instruments | 1205 | 618.00 | |
| | | | | | |
| Electomagnetic Current Meters | Marsh McBirney | Marsh McBirney | 201 | 2,150.00 | GSA contract |
| | " " | " " | 2000 | 2,995.00 | |
| | | | | | |
| Fluorometers | Turner Designs | Turner Designs | Model 10-AU-005 | 7,240.00 | add $395.00 for rhodamine optical kit (#10-041) |
| | | | | | |
| Top-Setting Wading Rods | U.S. Geological Survey | Hydrologic Instrum. Facil. | 2101001 | 330.00 | |
| | Teledyne Gurley | Teledyne Gurley | 299-309 | 525.00 | |
| | Scientific Instruments | Scientific Instruments | 1246 | 380.00 | |
| | Marsh McBirney | Marsh McBirney | 75013 | 525.00 | GSA contract |
| | | | | | |
| Taglines | U.S. Geological Survey | Hydrologic Instrum. Facil. | 1301001 | 182.40 | reel w/ 300 feet, 1/32 inch stainless steel cable |
| | Scientific Instruments | Scientific Instruments | 1100 | 555.00 | reel w/ 300 feet, 0.04 inch stainless steel cable |
| | " " | " " | 1105 | 555.00 | reel w/ 100 meter, 0.1 cm stainless steel cable |
| | | | | | |
| Weirs | | | | | |
| Flumes | U.S. Geological Survey | Hydrologic Instrum. Facil. | 1211001 | 360.00 | Parshall w/ 3-inch throat (0.002 - 0.70 cfs) |
| | T.N./Manning Products | T.N. Technologies | PF-3 | 390.00 | Parshall w/ max. free flow discharge = 1.2 cfs |
| | " " " | " " | PF-18 | 1,590.00 | Parshall w/ max. free flow discharge = 15.9 cfs |
| | Baski, Incorporated | Baski, Incorporated | CTF-1 | 228.00 | Cutthroat w/ interchang. wing walls, throat plates |
| | " " | " " | CTF-2 | 234.00 | " " " " " " |
| | " " | " " | CTF-4 | 244.00 | " " " " " " |
| | " " | " " | CTF-8 | 263.00 | " " " " " " |
| | | | | | |
| Ultrasonic Velocity Recorders | Stork Acoustical | Stork Acoustical | Surflow Mark 1 | 12,000.00 | |
| | ORE International | ORE International | Accusonic 7300 | 8,500.00 | w/ 2 transducers, add $7,000 for responder |
| | | | | | |

## Stage (Level) Measurement

Stage, or water level, is a similar category to flow in that it is a characterization of how much water is present in streams, rivers, lakes, reservoirs, wells, or on the level surface with respect to snow. Commonly, water stages in streams and rivers are converted to flows by ratings of stage versus discharge based on periodic field measurements. Ratings are curvelinear functions that are plotted on graph paper. They represent relationships between stage and discharge for particular stream cross-sections at specific points in time. Ratings change periodically due to changes in channel bed elevations and shapes. Water levels in wells are measured to assess ground water gradients, movement, drawdown, recharge, and aquifer capacities. Occasionally, tide levels are measured using stage recording devices.

For surface waters, stage in feet or meters is measured by using either staff gage observations, float-type water level recorders, ultrasonic water level recorders, bubbler manometers or pressure transducers. A staff gage is simply a calibrated ruler that is inverted and placed in a stream or lake. A float-type recorder consists of a chart recorder connected to a float that is housed in a stilling well. An ultrasonic recorder is an instrument placed above a water body that bounces a sound signal off the water surface which is in turn collected and recorded back at the unit. A bubbler manometer forces a gas bubble from an orifice beneath the water's surface. The pressure required to force the gas bubble from the orifice is related to the weight or height of water over the orifice. A pressure transducer measures the pressure on the sensor due to the weight of water over it. All these instruments can be equipped with chart mechanisms or dataloggers to record and store the stage data.

Ground water levels usually are measured by lowering electronic cables or calibrated steel tapes into wells. The electronic cables complete an electrical circuit when they contact the water. Ground water levels also can be measured using float-type recorders, pressure transducers and potentiometers. The snow tube is a standard instrument used to collect snow depth and water equivalent data. Examples of these instruments are included in Table 2.

## Table 2. Stage (Level) Measurement

| Type | Manufacturer | Distributor | Model/Part No. | Price | Comments |
|---|---|---|---|---|---|
| Float Type Water Level Recorders | Leupold & Stevens | Leupold & Stevens | 7001 | 2,395.00 | w/ timer, float tape and 5 in. float (metric #7002) |
| | " " | " " | Type A-71 | 2,888.00 | w/ Chelsea clock, pulley, line, 10 in. float |
| | " " | " " | Type F | 1,243.00 | w/ QMT clock, pulley, line, 5 in. float (eng./met.) |
| | " " | Forestry Suppliers | Type F/90800 | 1,145.00 | english (metric #90801) |
| | Belfort | " " | 5-FW/90880 | 1,795.00 | |
| | Solinst | " " | 301/90900 | 2,985.00 | add $150.00 for well casing connector (#90901) |
| | | | | | |
| Ultrasonic Water Level Recorders | T.N./Manning Products | T.N. Technologies | UL-1100 | 3,150.00 | |
| | " " " | " " | UF-1100 | 3,715.00 | level to flow conversion |
| | " " " | " " | UD-1100 | 4,100.00 | level to flow conversion w/ datalogger; add $2,160 for IBM interface kit |
| | Isco Environ. Division | Isco Environ. Division | 68-3210-001 | 2,493.00 | w/ datalogger; add $995.00 for Flowlink. GSA |
| | | | | | |
| Bubbler Manometers | U.S. Geological Survey | Hydrologic Instrum. Facil. | 1213100 | 3,000.00 | PS2 w/ SDI-12 interface |
| | Scientific Instruments | Scientific Instruments | 7735 | 3,889.00 | STACOM |
| | Isco Environ. Division | Isco Environ. Division | 68-3230-001 | 2,863.00 | w/ datalogger; add $995.00 for Flowlink. GSA |
| | | | | | |
| Pressure Transducers | Leupold & Stevens | Leupold & Stevens | SDT-II 10 /45553 | 610.00 | 10 feet range w/ 30 feet cable |
| | Druck | Druck | PDCR 830 | 485.00 | 5 psi sensor |
| | Isco Environ. Division | Isco Environ. Division | 68-3220-001 | 2,678.00 | w/ datalogger; add $995.00 for Flowlink. GSA |
| | | | | | |
| Staff Gages | U.S. Geological Survey | Hydrologic Instrum. Facil. | 1201001 | 10.80 | 0 - 3.33 feet |
| | Leupold & Stevens | Leupold & Stevens | Style A/15415 | 37.00 | " " " |
| | " " | " " | Style C/15405 | 27.00 | " " " |
| | Scientific Instruments | Scientific Instruments | Style A/6100 | 63.00 | " " " |
| | " " | " " | Style C/6300 | 47.00 | " " " |
| | Forestry Suppliers | Forestry Suppliers | Style A/39725 | 37.50 | " " " |
| | " " | " " | Style C/39732 | 27.25 | " " " |
| | | | | | |
| Groundwater Level Meters (Electronic) | Leupold & Stevens | Leupold & Stevens | Type L/43704 | 475.00 | 100 meters/328 feet |
| | Solinst | Forestry Suppliers | 90792 | 640.00 | 300 feet |
| | Fisher | " " | WLS/90780 | 244.00 | 300 feet |
| | Soiltest, Incorporated | Soiltest, Incorporated | 446-020 | 935.00 | 300 feet |
| | | | | | |
| Steel Tapes (Black Neubin) | U.S. Geological Survey | Hydrologic Instrum. Facil. | 1309003 | 648.00 | 300 feet |
| | | | | | |
| Snow Tubes | Carpenter Machine Works | Carpenter Machine Works | standard | 1,474.00 | w/ cutter, 3 30-inch aluminum sections, scale, drive wrench, spaners, thread protector, case |
| | | | | | |

## Physical and Chemical Water Quality Measurement

The category of physical and chemical water quality measurement represents instrumentation used to measure physical and chemical parameters in the field, and apparatus used to prepare water samples for chemical laboratory analyses. In general, the basic physical parameters that are measured during field investigations of water quality include flow, air and water temperature, specific electrical conductance (EC), salinity, hydrogen-ion activity (pH), dissolved oxygen (DO), redox potential (Eh or ORP), depth and turbidity. Single parameter and multiparameter sensors are readily available from numerous vendors to measure these physical constituents in water. A selection from this group is presented in Table 3. The user is encouraged to revise or update this list to suit their purposes. Chemical standards and buffers are included for calibration of pH and conductivity meters. In addition to the sensors listed, specific chemical electrodes are available from some vendors that measure nitrate, ammonia, chloride and several other chemical parameters.

The portable laboratory is an example of a water quality kit that contains a spectrophotometer, reagents, digital titrator, pH meter and conductivity meter. Spectrophotometers measure light absorbencies and resultant chemical concentrations by passing specific wavelengths of light through samples to a detector. Fluorometers measure the natural fluorescence of chlorophyll and aromatic hydrocarbons, and light scattering properties related to water clarity.

Water samples commonly are collected in the field and transported to certified laboratories for analysis of specific suites of inorganic and organic chemical parameters. These parameters may include: cations, anions, nutrients, sediments, heavy metals, radionuclides, pesticides, volatile and semi-volatile hydrocarbons, etc. Peristaltic pumps, filters and filter holders are included because often water samples must be filtered in the field for dissolved constituent analysis in the laboratory, especially for nutrients and heavy metals.

| Table 3. Physical and Chemical Water Quality Measurement | | | | | |
|---|---|---|---|---|---|
| Type | Manufacturer | Distributor | Model/Part No. | Price | Comments |
| Portable Laboratories | HACH Company | HACH Company | DREL/2000 45250-05 | 3,195.00 | w/ spectrophotometer, digital titrator, reagents, pH and conductivity meters |
| | | | | | |
| Multiparameter Meters | HYDROLAB Corporation | HYDROLAB Corporation | H20 | 3,690.00 | transmitter w/ EC, salinity, temperature, pH, DO sensors, stirrer, 5 meter cable, interface and case |
| | " " | " " | Scout 2 | 4,985.00 | w/ same as above, plus display unit |
| | " " | " " | Surveyer 3 | 6,640.00 | w/ same as above, plus datalogger and internal battery |
| | " " | " " | Datasonde 3 | 7,045.00 | w/ same as above, plus redox (ORP), depth sensors, and 25 meter cable |
| | Yellow Springs/Grant | Yellow Springs Instrum. | 3800 | 5,995.00 | transmitter w/ EC, salinity, temperature, pH, DO sensors; add $2,175.00 for ORP, depth, turbidity and ammonium sensors |
| | " " " | Forestry Suppliers | 3800/76900 | 5,995.00 | same as above |
| | | | | | |
| Conductivity and Salinity Meters | Yellow Springs Instrum. | Yellow Springs Instrum. | 33 S-C-T | 615.00 | w/out probe |
| | " " " | Forestry Suppliers | 33 S-C-T/76178 | 625.00 | add $165.00 for probe (# 76179) |
| | " " " | VWR Scientific | " /66121-254 | 615.00 | add $156.00 for probe (#66121-276) |
| | Orion Research | Orion Research | 122 | 655.00 | w/ probe |
| | " " | VWR Scientific | 122/23197-939 | 655.00 | w/ probe |
| | Beckman/Rosemount | " " | RC16D/23195-125 | 905.00 | add $100.00 for probe (#23196-659) |
| | | | | | |
| pH Meters | HACH Company | HACH Company | Hach One/43800 | 495.00 | w/ probe |
| | Orion Research | Orion Research | 0250A0 | 625.00 | w/ ATC probe |
| | " " | " " | 0250A3 | 715.00 | w/ ATC probe, standards and case |
| | " " | VWR Scientific | 250A/34104-120 | 625.00 | w/ ATC probe |
| | | | | | |
| Dissolved Oxygen Meters | Yellow Springs Instrum. | Yellow Springs Instrum. | 50 B | 965.00 | w/out probe |
| | " " " | VWR Scientific | 50 B/52456-121 | 965.00 | add $317.00 for probe (#52457-010) and cable assembly (#52457-155) |
| | " " " | Forestry Suppliers | 50 B/76190 | 965.00 | add $345.00 for probe (#76168) and cable assembly (#76169) |
| | Orion Research | Orion Research | 820 | 995.00 | w/ probe |
| | " " | VWR Scientific | 820/52458-050 | 995.00 | w/ probe |
| | | | | | |
| Turbidimeters | HACH Company | HACH Company | 2100 P | 895.00 | |
| | | | | | |
| Fluorometers | Turner Designs | Turner Designs | Model 10-AU-005 | 7,240.00 | add $399.00 for chlorophyll optical kit (#10-040) |
| | | | | | |
| Thermographs | Ryan | Forestry Suppliers | "J"/89357 | 650.00 | w/ range 0 - 30 degrees Centigrade |
| | " | " " | TempMento/89381 | 712.00 | |
| | | | | | |

| Table 3. Physical and Chemical Water Quality Measurement | | | | | |
|---|---|---|---|---|---|
| Type | Manufacturer | Distributor | Model/Part No. | Price | Comments |
| Standards and Buffers | Banco | VWR Scientific | AL51340-4 | 15.90 | KCl conductance standard, 0.01 M, 32 oz. |
| | VWR Scientific | " " | 34180-617 | 13.55 | pH 4.00 (red) buffer, 0.5 liters |
| | " " | " " | 34180-640 | 13.55 | pH 7.00 (yellow) buffer, 0.5 liters |
| | " " | " " | 34180-672 | 13.55 | pH 10.00 (blue) buffer, 0.5 liters |
| | | | | | |
| Peristaltic Pumps | Geotech Environ. Equip. | Geotech Environ. Equip. | Geopump 1/0740 | 567.00 | 12 volt DC/115 volt AC |
| | | | | | |
| Filter Holders | Geotech Environ. Equip. | Geotech Environ. Equip. | 0805 | 256.50 | 142 mm diameter, acrylic, GSA contract |
| | " " " | " " " | 0815 | 540.00 | 90 mm diameter, stainless steel, GSA contract |
| | " " " | " " " | 0820 | 382.50 | 47 mm diameter, stainless steel, GSA contract |
| | " " " | " " " | 0920 | 18.00 | 47 mm diameter, poly-carbonate, GSA contract |
| | | | | | |
| Filters (cellulose acetate) | Geotech Environ. Equip. | Geotech Environ. Equip. | GA045142 | 122.00/50 | 142 mm diameter, 0.45 um pore size |
| | " " " | " " " | GA045090 | 169.00/100 | 90 mm diameter, 0.45 um pore size |
| | " " " | " " " | GA045047 | 52.00/100 | 47 mm diameter, 0.45 um pore size |
| | | | | | |

## Biological Water Quality Measurement

The category of biological water quality measurement represents the instrumentation used for analysis of five common groups of indicator bacteria in water samples. Instrumentation used in analyses for other biological microorganisms in water, such as protozoa (giardia, cryptosporidium, etc.) and viruses, that cause human health problems are not included due to the specific nature of their use. Most of those organisms are collected by high volume filters and are identified by visual plate count.

The five groups of indicator bacteria are: total coliform, fecal coliform, *Escherichia coli*, fecal streptococci, and enterococci. Most of the bacteria are analyzed by membrane filtration or most probable number methods. In general, none of the indicator bacteria are intestinal pathogens, but their lifespans and living requirements are similar to bacteria that cause disease in animals and humans. Analyses of total coliform bacteria are required by state and federal law to evaluate drinking water quality. Fecal coliform and fecal streptococci bacteria commonly are analyzed to measure water contamination from human and animal wastes, respectively. In marine waters, total coliform and fecal coliform bacteria are analyzed in shellfish harvest areas. Recently, the U.S. Environmental Protection Agency (USEPA) recommended that states adopt *E. coli* and enterococci standards for freshwater bathing (USEPA 1986). *E. coli* is a serological subgroup species of fecal coliform bacteria. Enterococci is a group of bacterial species within the Lancefield's Group D streptococci, a serological subgroup of fecal streptococci. Instrumentation used to collect water samples, filter the samples, and culture the bacterial colonies are included in Table 4.

| Table 4. Biological Water Quality Measurement | | | | | |
|---|---|---|---|---|---|
| Type | Manufacturer | Distributor | Model/Part No. | Price | Comments |
| Filtering Apparatus | Millipore Corporation | Millipore Corporation | XKFC 001 00 | 1,374.00 | fecal coliform field kit |
| | " " | " " | MHWG 055 00 | 72.00/50 | disposable, w/ filters; add $109.00 for flask/stopper/tubing |
| | Nalge | VWR Scientific | 28198-630 | 47.40/12 | disposable, w/ 47 mm diameter, 0.45 um pore size filters |
| | " | HACH Company | Type A/22530-00 | 46.80/12 | disposable, w/ filters; add $13.50 for holder (#22531-00) |
| | | | | | |
| Membrane Filters (mixed esters of cellulose) | Millipore Corporation | Millipore Corporation | HAWG 047 S3 | 76.20/200 | 47 mm diameter, 0.45 um pore size |
| | " " | " " | HCWG 047 S3 | 73.90/200 | 47 mm diameter, 0.7 um pore size |
| | Gelman Scientific, Inc. | VWR Scientific | GN-6/28148-926 | 68.00/200 | 47 mm diameter, 0.45 um pore size |
| | " " " | HACH Company | GN-Metricel | 92.00/200 | 47 mm diameter, 0.45 um pore size |
| | | | | | |
| Media | Millipore Corporation | Millipore Corporation | M000 000 2E | 17.10/24 | Total Coliform MF-Endo, 2 ml glass ampules |
| | " " | " " | M000 0GP 2E | 15.50/20 | Total Coliform MF-Endo, 2 ml plastic ampules |
| | " " | " " | MB00 000 0E | 33.00/110 g | Total Coliform MF-Endo, dehydrated |
| | " " | " " | M000 00P 2F | 40.40/50 | Fecal Coliform M-FC, 2 ml plastic ampules |
| | " " | " " | MB00 000 0F | 36.30/110 g | Fecal Coliform M-FC, dehydrated |
| | " " | " " | MB00 000 0S | 49.90/110 g | Fecal Streptococci KF Agar, dehydrated |
| | HACH Company | HACH Company | 23735-20 | 14.00/20 | Total Coliform m-Endo, 2 ml glass ampules |
| | " " | " " | 23732-20 | 16.50/20 | Fecal Coliform M-FC, 2 ml glass ampules |
| | " " | " " | 22811-26 | 22.15/100 g | E. Coli m-TEC Agar, dehydrated |
| | " " | " " | 22812-26 | 24.95/100 g | Enterococci m-E Agar, dehydrated |
| | " " | " " | 14853-01 | 58.60/454 g | Fecal Streptococci KF Agar, dehydrated |
| | | | | | |
| Incubators | Millipore Corporation | Millipore Corporation | XX63 004 00 | 1,936.00 | 12 volt DC/115 volt AC, 44.5 & 35 degrees C |
| | " " | " " | XX63 200 00 | 1,800.00 | 12 volt DC/115 volt AC; 44.5, 41.5, 41, 37, & 35 deg. C |
| | | | | | |
| Vacuum Pumps | Millipore Corporation | Millipore Corporation | XX55 000 00 | 575.00 | 115 volt, 60 Hz motor |
| | Nalge | HACH Company | 14283-00 | 35.30 | hand-operated |
| | Gast | " " | 14697-00 | 267.00 | 115 volt, 60 Hz motor, 1.3 cfm |
| | | | | | |
| Assessories (flasks, bottles, syringes, pipets, petri dishes, etc.) | Millipore Corporation | Millipore Corporation | PD10 047 S0 | 23.00/100 | sterilized petri dishes and pads |
| | Nasco | Hach Company | 22331-99 | 9.75/100 | sterilized Whirl-Pak bags, 0.2 liters |
| | " | " " | 20753-33 | 13.75/100 | sterilized Whirl-Pak bags w/ sodium thiosulfate, 0.2 liters |
| | Nalge | VWR Scientific | 16125-107 | 23.80/6 | wide-mouth high-density polyethylene bottles, 1 liter |
| | " | " " | 16338-017 | 56.65 | high-density polyethylene carboy w/ spigot, 9 liters |
| | " | " " | 16651-595 | 12.05/4 | wide-mouth polyethylene wash bottles, 0.5 liters |
| | VWR Scientific | " " | 53283-366 | 58.24/200 | sterile, plugged plastic pipets, individually wrapped, 10 ml |
| | Plastipak | " " | BD9663 | 37.25/30 | plastic syringes, 60 cc x 5 cc |
| | | | | | |

## Water, Sediment and Biota Samplers

Various types of equipment employed for collecting water, sediment and biota samples are included in Table 5. The DH-48 and DH-75 are hand-held suspended sediment samplers that collect depth-integrated samples of water or water and sediment mixtures in individual bottles. The Helly-Smith is a hand-held sampler that collects bedload sediment in a mesh bag. Automatic samplers collect one large water sample or several samples over chosen time periods while left unattended. Lake samplers are essentially cylindrical containers with two rubber stopper ends that are spring loaded. When the bottles are lowered to chosen depths, messengers actuate closing mechanisms to collect the water samples. Bottom dredges collect samples of lake bottom sediments in the same fashion. Well samplers are small-diameter steel bottles that function like the lake samplers or are bailers that fill through specially designed orifices. Soil water samplers collect water samples by using vacuum pressure to extract water from the surrounding soil. Lastly, the Surber sampler is the most common means to collect macroinvertebrates in streams and rivers. However, many other types of samplers can be used to collect benthic and planktonic organisms, such as drift nets, plankton nets, Hess samplers, McNeil samplers, freeze-core samplers, and artificial substrates.

| Table 5. Water, Sediment and Biota Samplers | | | | | |
|---|---|---|---|---|---|
| Type | Manufacturer | Distributor | Model/Part No. | Price | Comments |
| Suspended Sediment Samplers | U.S. Army Corps of Eng. | Federal Interagency Sedimentation Project (ISP) | DH-48 | 259.00 | add $25.00 for 3 ft. wading rod |
| | " " " " " | | DH-75 | 199.00 | add $25.00 for 3 ft. wading rod |
| | Scientific Instruments | Scientific Instruments | DH-48/5200 | 189.00 | add $47.00 for 3 ft. wading rod (# 5215) |
| | | | | | |
| Bedload Samplers | Helly-Smith | GBC, Incorporated | 3 X 3 inch | 195.00 | add $32.00 for bag |
| | | | | | |
| Automatic Samplers | T.N./Manning Products | T.N. Technologies | PSC-4900 | 2,510.00 | w/ controller, 24 bottle carriage, battery & charger |
| | " " " | " " | PSC-6900 | 3,415.00 | w/ controller, 24 bottle carriage, refrigerator |
| | Isco Environ. Division | Isco Environ. Division | 68-2900-001 | 1,895.00 | w/ 24 0.5-liter bottles; add $275.00 for battery and suction line |
| | " " " | " " " | 68-3700-001 | 2,495.00 | w/ 24 1-liter bottles; add $280.00 for battery and suction line |
| | | | | | |
| Lake Samplers | Wilco Instruments | Forestry Suppliers | 77242 | 297.00 | 2.2 liter Alpha bottle |
| | " " | " " | 77199 | 277.00 | 2.2 liter Beta Plus bottle |
| | " " | " " | 77270 | 243.00 | 1.2 liter Kemmerer bottle, stainless |
| | " " | " " | 77276 | 174.00 | 1 liter water bottle |
| | " " | " " | 77273 | 334.00 | w/ 1 liter bottle, Secchi disk, net, thermometer |
| | " " | " " | 77278 | 86.00 | Secchi disk |
| | Wilco - Ekman | " " | 77251 | 271.00 | bottom dredge |
| | Soiltest, Incorporated | Soiltest, Incorporated | 432-005 | 411.00 | 1.2 liter Kemmerer bottle, stainless |
| | " " | " " | 430-350 | 460.00 | bottom dredge |
| | | | | | |
| Well Samplers | Wilco Instruments | Forestry Suppliers | 77241 | 325.00 | 0.6 liter 2" Kemmerer bottle, stainless |
| | " " | " " | 77197 | 318.00 | 1.2 liter 4" Kemmerer bottle, stainless |
| | Norton Norwell | " " | 78274 | 199.00 | 1 liter teflon bailer w/ standard top & bottom |
| | Soiltest, Incorporated | Soiltest, Incorporated | 433-100 | 1,305.00 | portable pump kit (including Geopump 1) |
| | " " | " " | 431-033 | 150.00 | 1 liter teflon bailer w/ cap |
| | " " | " " | 432-010 | 512.00 | 0.6 liter 2" Kemmerer bottle, stainless |
| | AccuWell | Isco Environ. Division | 60-3004-060 | 695.00 | portable pump PTP-100; add $275 for battery and suction line |
| | " | " " " | 68-4600-002 | 205.00 | 1 liter bailer BLR-130 |
| | | | | | |
| Soil Water Samplers | Soiltest, Incorporated | Soiltest, Incorporated | 426-200 | 50.00 | ceramic cup |
| | " " | " " | 426-900 | 118.00 | vacuum service unit used w/ # 426-200 |
| | " " | " " | 426-000 | 104.00 | lysimeter |
| | | | | | |
| Stream Biota Samplers | Wilco Instruments | Forestry Suppliers | 77246 | 155.00 | Surber sampler |
| | | | | | |

## Data Storage and Management

Data storage and management is a category worthy of much more consideration than is presented in this report. However, examples of common hardware and software that are available are included in Table 6. Datalogger technology has considerably advanced the field of data storage and retrieval. The new dataloggers are small, compact, easy to use, and essentially are powerful microcomputers that can be attached to most recording equipment. The STORET and WATSTORE databases are national mainframe databases that can be accessed by personal computers. STORET is a USEPA database that contains water quality data. WATSTORE is a U.S. Geological Survey (USGS) database that contains daily flow, peak flow and water quality data. The EarthInfo databases are compact disk (CD-ROM) versions of the USGS WATSTORE and National Climatic Data Center databases. The U.S. Army Corps of Engineers, Hydrologic Engineering Center (USCOE/HEC) hydrology models are used to calculate surface runoff, flood routing, water surface elevations, scour and deposition, and flood-flow frequency. Most of the HEC models (HEC-1, HEC-2, HEC-6, HECWRC, etc.) are available free of charge to other federal agencies from the USCOE. The Soil Conservation Service models TR-55 and TR-20 employ curve number techniques to calculate peak flow runoff (McCuen 1982).

Table 6. Water Resources Instrumentation: Data Storage and Management

| Type | Manufacturer | Distributor | Model/Part No. | Price | Comments |
|---|---|---|---|---|---|
| Dataloggers | Leupold & Stevens | Leupold & Stevens | Type A/F | 708.00 | GSA contract |
| | " " | " " | 420 Level | 752.00 | GSA contract |
| | Campbell Scientific, Inc. | Campbell Scientific, Inc. | CR-10 | 2,170.00 | w/ datalogger, display, storage module, power supply, PC interface, software. GSA contract |
| | " " " | " " " | BDR-320 | 965.00 | w/ datalogger, enclosure, power supply, software |
| | Omnidata | Omnidata | EL-925 | 1,557.00 | Easylogger w/ 8K RAM, 64K ROM. GSA contract |
| | " | " | PC-602 | 1,183.00 | Polycorder w/ 128K memory. GSA contract |
| | | | | | |
| | | | | | |
| Databases | U.S. Environ. Pro. Agen. | U.S. Environ. Pro. Agen. | STORET | | |
| | U.S. Geological Survey | U.S. Geological Survey | WATSTORE | | |
| | EarthInfo, Incorporated | EarthInfo, Incorporated | Hydrodata | 595.00/disk | |
| | " " | " " | Climatedata | 595.00/disk | |
| | | | | | |
| | | | | | |
| Software/ Models | U.S. Army Corps of Eng. | Hydrologic Engin. Center | HEC-1 | | flood hydrograph, peak flow runoff, flood routing |
| | " " " " " | " " " | HEC-2 | | channel cross-sections, water surface profiles |
| | " " " " " | " " " | HEC-6 | | channel scour and deposition |
| | " " " " " | " " " | HECWRC | | flood flow frequency analysis (Log Pearson III) |
| | Soil Conservation Service | Soil Conservation Service | TR-55 | | peak flow runoff |
| | " " " | " " " | TR-20 | | peak flow runoff |
| | Haestad Methods | Haestad Methods | HEC-1 | 495.00 | flood hydrograph |
| | " " | " " | HEC-2 | 495.00 | water surface profiles |
| | " " | " " | HEC-PLOT | 295.00 | graphics plotting |
| | " " | " " | Friend | 495.00 | data entry |
| | " " | " " | HEC PACK | 795.00 | includes Friend, HEC-1, HEC-2, HEC-Plot |
| | " " | " " | POND-2 | 990.00 | detention pond design |
| | " " | " " | Quick TR-55 | 495.00 | peak flow runoff |
| | " " | " " | POND PACK | 995.00 | Includes Quick TR-55 and Pond 2 |
| | " " | " " | HECWRC | 495.00 | flood flow frequency |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

# SUMMARY

This report is designed to be a working reference. Tabular information is presented on water resource instrumentation, manufacturers, distributors and prices. Since the information presented here can be out-dated quickly, users are encouraged to update the tables on an annual basis by calling the vendors listed in the Appendix. Also, users are encouraged to send additional information to the WRD to assist in the development of a centralized database for periodic updates of this report. The original tables are available in WordPerfect 5.1 format by contacting the WRD.

If you have any questions regarding the content of the tables, additions to the instrument lists, or other specific needs concerning water resource instrumentation and monitoring, please contact the author at the address listed in the front of this report. The staff of the WRD are willing and able to assist in project design, instrument selection, training, and data management and interpretation.

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Logan, UT 84321
(801) 753-2342

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1024 North 36th Street
Seattle, WA 98103
(206) 632-2755

Druck Incorporated
4 Dunham Drive
New Fairfield, CT 06812
(203) 746-0400

EarthInfo, Incorporated
5541 Central Avenue
Boulder, CO 80301
(303) 938-1788
(800) 222-0920

Federal Interagency Sedimentation Project
St. Anthony Falls Hydraulic Laboratory
3rd Avenue S.E. and Hennepin Island
Minneapolis, MN 55414
(612) 370-2361

Forestry Suppliers, Incorporated
P.O. Box 8397
205 West Rankin Street
Jackson, MS 39284
(601) 354-3565
(800) 647-5368

GBC, Incorporated
190 South Union Boulevard
Lakewood, CO 80228
(303) 988-6450

Geotech Environmental Equipment, Inc.
1441 West 46th Avenue, #17
Denver, CO 80211
(303) 433-7101

HACH Company
P.O. Box 608
Loveland, CO 80539
(303) 669-3050
(800) 227-4224

Haestad Methods
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(800) 727-6555

HYDROLAB Corporation
P.O. Box 50116
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Isco Environmental Division
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Marsh McBirney, Incorporated
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