

explicit manner, a water sample will yield unique color traits, dependent on the concentrations of nutrients in the sample.

Colorimeters range from simple to extraordinarily sophisticated instruments. In situations that require analyses of a large number of samples in a limited amount of time, it is advantageous to use an autoanalyzer. An autoanalyzer is simply a colorimeter that has most of its functions automated, including the addition of the chemicals necessary to produce the measurable color.

Autoanalyzers are capable of analyzing an extremely large number of samples while eliminating much of the potential for human error. The instruments are, however, subject to the usual maintenance problems associated with electronic and computerized equipment operating in "wet chemistry" environments.

The analytical procedures used to measure nitrogen and phosphorus are detailed in APHA (1985). The procedures can be automated using high-capacity autoanalyzers manufactured by Technicon\* or ALPKEM\*, or comparable instruments. For laboratories with limited sample loads, the less sophisticated, but still computerized (if desired), Technicon AA-I\*, AA-II\*, or comparable machines will suffice.

Prices for these instruments range from approximately \$2,000 to \$70,000, depending on the daily sample capacity desired and the number of nutrient parameters that can be analyzed simultaneously. These figures do not include the cost of maintenance for the instrument, nor the chemicals and replacement parts necessary for day-to-day operation. They do include the computer hardware and software for the more sophisticated units.

## Field Test Kits

Many field test kits are available for analyzing water samples for nitrogen and phosphorus concentrations. Accuracy, range, and detection limits vary among kits. Specifications of a sampling of these kits are listed in Table 2.

Field test kit data are useful as indicators of nutrient concentrations, with the general consensus being that the resulting concentrations will be "ball park" figures.

Because of the limited sensitivities and/or detection limits of the kits, the resulting data will have limited usefulness in matters concerning south Florida, where arguments occur over concentrations below 0.03 ppm (mg/L). The user must also be extremely careful regarding what nutrient species are actually being measured. For example, a kit measuring "total phosphorus," with no digestion procedure involved, is probably only measuring total soluble inorganic phosphorus. Acid reagents used in these kits will account for some, but not all, of the particulate organic and inorganic compounds.

Hach and LaMotte Chemical Companies\* (Hach Company, 1990; LaMotte Chemical Company, 1991) are two of many suppliers of test kits for nitrogen and phosphorus analyses. Prices range from about \$50 to \$500, depending upon the method or chemistry used. The test kits are reliable as long as the user is aware of their inherent limitations. Field test kits should not be looked upon as inexpensive substitutes for laboratory analyses.

## Quality Assurance/Quality Control (QA/QC)

Quality assurance is attained by employing adequately trained and experienced personnel, having good physical facilities and equipment, using certified reagents and standards, frequently servicing and calibrating instruments, and using replicate and known-addition sample analysis.

It is desirable that QA/QC programs are approved by the Department of Environmental Regulation. A good analytical quality control program consists of an organized plan for sampling procedures, sample custody, analytical procedures, calibration procedures and frequency, routine maintenance of equipment, quality control checks (matrix spikes, method blanks, standard calibration, check samples, laboratory duplicates, field quality controls, precision, accuracy), data reduction, data validation, and reporting.

Quality assurance/control is important to make sure each organization or laboratory involved with sample collection or analysis has the responsibility of implementing procedures that assure that the precision, accuracy, and comparability of the data submitted is of a known and documented level of quality.