Self-Evaluation Techniques: Evaluating Water Quality

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http://waterquality.ucanr.org

This Fact Sheet is part of the **Farm Water Quality Planning (FWQP)** series, developed for a short course that provides training for growers of irrigated crops who are interested in implementing water quality protection practices. The short course teaches the basic concepts of watersheds, nonpoint source pollution (NPS), self-assessment techniques, and evaluation techniques. Management goals and practices are presented for a variety of cropping systems.

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An essential tool in determining the effectiveness of land-use and management activities on your agricultural operation is the evaluation of water quality. Central Coast growers want to know whether their efforts in installing expensive erosion controls and adjusting their land use practices have improved water quality, or whether perhaps some other confounding influence such as regional geology or a point source upstream of their operation is the source of the water quality problem they are trying to address. The self-assessment data that you provide will be an important part of your effort to document improvements in water quality that result from management practices or to identify current or potential problems.

Scientists often undervalue simple field measurements and suspect that they lack scientific validity, but properly designed and carefully executed self-assessment techniques can provide sound data. Their strength lies in the potential for taking large numbers of measurements inexpensively and with only semi-skilled assistance. Keep in mind that water quality assessment is not a one-time event. You may need to accumulate months' or years' worth of data before you can distinguish confounding temporal and weather influences from the real impacts of land use or management practices.

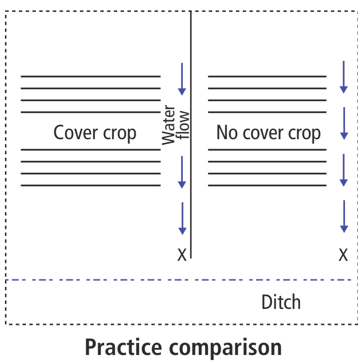

Figure 1. Assessment of a practice's effectiveness: comparing a treated area to an untreated area. "X" indicates monitoring location.

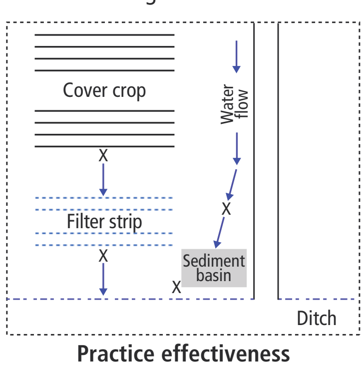

Figure 2. "Above-and-below" design to assess the effectiveness of a practice. "X" indicates monitoring location.

Where to Test

The key to effective water quality self-assessment is the establishment of well-planned and concise objectives for your sampling effort. A good first step to help you better understand your landscape would be to review current and historical topographic maps and aerial photos. It would also be helpful for you to tour your property in order to try to get a sense of where potential problems may lie and how you should lay out your sampling sites (see Figures 1, 2, and 3). You will also want to take into account the physical characteristics of the site — such as soil type, depth to ground water, slope, and distance to the nearest surface water — in estimating vulnerability. You can find this information in soil surveys (at your local NRCS office) or in drilling records that you as the landowner may possess.

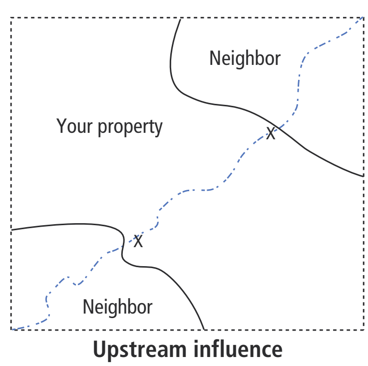

Figure 3. "Above-and-below" design to assess upstream offsite influences. "X" indicates monitoring location.

You can begin your actual assessment by testing upstream (from the point where the water body enters your property) and downstream (from the point where the water body leaves your property). This will tell you how clean the water is when it flows into your property and whether or not conditions on your property are contributing to downstream water quality problems. If a given measured parameter is higher at the downstream end of your property than at the upstream end, test the water at locations likely to be contributing to the water body. Areas to sample might include

- upstream and downstream from an established erosion control practice
- irrigation runoff areas
- seasonal and perennial streams
- animal confinement areas
- any low spot where water is leaving your property

If you are sampling irrigation water *before* it reaches the field, make sure to collect your sample as close to the wellhead as possible. Also, make sure that the well is purged sufficiently (3 to 10 well-bore volumes) before sampling to ensure that the sample is representative of the ground water.

When to Test

The concentration of most nutrients, chemicals, and pathogens during a storm event tends to rise and fall in a pattern correlated to rainfall intensity, and for this reason you should consider sampling *before, during*, and *after* the storm event. Storm event sampling is extremely important because the majority of the annual water flow and nonpoint source constituent loading occurs during major storm events, which are few in the Central Coast region. You might also think about scheduling your sampling around planting periods (preplant vs. postplant vs. harvest) or at collection points (field runoff, ditch, or tile drains) during an irrigation event.

To begin, set up a sampling schedule. Consider how many sites you plan to sample and whether or not sampling is feasible year-round (e.g., periodic drought or flooding may make sampling impractical). Think about the types of test you will perform, how much time they will require, and what goals you have set (e.g., to learn to recognize water quality problems and their sources, and to know what can be done to alleviate the specific problems).

- Testing should be done once a month throughout the year, and more often during the winter rainy season, especially after any significant storm event.
- Runoff from early rains can have high concentrations of nutrients or animal wastes that have accumulated during the dry summer months. Water testing should be conducted during the first storm that causes runoff.
- Testing should be done immediately after each significant storm event. Rainfall of 1 inch (2.5 cm) or more within 24 hours poses the greatest risk.

Reliability of Collected Information

To obtain high-quality data, you must follow appropriate protocols. Growers who choose to evaluate water quality for themselves strive to obtain the best data possible. This is important, since you, the grower, are the primary user of this information. Following are suggestions for ways to improve the quality of your water sampling data.

A well-thought-out plan can help ensure that your test results are both accurate and precise. *Accuracy* refers to how close a measurement is to the true value. *Precision* refers to the ability to obtain consistent results. To achieve reliability in both accuracy and precision,

- select the proper sampling sites

- keep consistent with protocols, site location, and time of day sample is collected
- triple-rinse bottles with sample water *before* you collect the sample and with distilled water *after* you complete the test
- perform the test immediately after you collect the water sample
- carefully use and maintain your testing equipment
- follow the specific directions of each testing protocol exactly as described
- repeat measurements to check for accuracy and to understand any sources of error
- store test kits away from heat and light (refrigerate them if possible)
- minimize contamination of your test equipment and check the expiration dates on any chemicals

Standards, Blanks, and Splits

A *standard* is a sample of known concentration. You can buy standards from a nearby lab. A *blank* is a sample run using distilled water. By testing standards and blanks, you can check for bad reagents and equipment contamination. A *split* is one sample tested twice (for example, two nitrate tests performed out of the same bottle of water taken from a stream or irrigation ditch). Splits test for operator error, as both tests should yield the same results. You should consider using standards, blanks, or splits whenever you doubt the accuracy of your results or when any chemical reagent is approaching its expiration date.

Repeated Measurements

There are two good reasons for you to repeat measurements, and both have to do with improving the quality of your data. First, streams are variable. The water that flows past a point in the stream is constantly changing. By taking two or three measurements and averaging the values, you take into account some of the natural variations within the stream and obtain a better, more representative overall value. Second, when you take more than one measurement you reduce the chance that you will record incorrect data.

Let's Not Forget Safety!

- Always let someone know where you are, especially if you are monitoring a stream.
- Have a first-aid kit handy.
- Consider wearing surgical gloves.
- Be mindful of slippery rocks and unseen objects when you walk in moving water.
- Know chemical clean-up, disposal, and first-aid procedures.
- Do not eat food after handling chemicals.

CONSTITUENTS OF WATER AND THEIR IMPORTANCE

What Is Ammonia?

Ammonia (NH_3), a form of nitrogen, is commonly found in terrestrial and aquatic ecosystems. Other forms of nitrogen include ammonium (NH_4^+), nitrates (NO_3^-), and nitrites (NO_2^-). Ammonia is a colorless gas at standard temperature and pressure and is very soluble in low-pH (acidic) water.

Ammonia levels in zero-salinity surface water increase with increasing pH and temperature. Under low pH and temperature conditions, ammonia combines with water (H_2O) to produce an ammonium ion (NH_4^+) and a hydroxide ion (OH^-). The ammonium ion is nontoxic and not of concern to organisms. *Above a pH of 9, however, ammonia is of major concern*. Excess ammonia (NH_3) may accumulate in an organism and cause changes in its metabolism or increases in its body pH. Fish may be subject to poorer hatching success, reductions in growth rate and morphological development, and injuries to gill, liver, and kidney tissues.

What Is Dissolved Oxygen?

Oxygen in its dissolved form in water is measured as dissolved oxygen (DO). A stream system both produces and consumes oxygen. It gains oxygen from the atmosphere and from plants as a result of photosynthesis. Because running water churns, it dissolves more oxygen than still water. Respiration by aquatic animals, decomposition, and various chemical reactions consume oxygen in the water. DO levels fluctuate both seasonally and over a 24-hour period. Levels also vary with changes in water temperature and altitude.

Oxygen is as important to life in water as it is to life on land. Most aquatic plants and animals require oxygen for survival and the availability of oxygen affects their growth and development. When excessive organic materials such as animal waste enter a stream, microorganisms in the water feed on this organic material and consume DO in the process. With warm temperatures, these microorganisms can proliferate to such a degree that their consumption of DO will suffocate fish and other aquatic life.

What Are Nitrates?

Nitrates (NO_3^-) are another form of nitrogen. Nitrates from land sources end up in water bodies more quickly than other nutrients such as phosphorus. This is because they dissolve in water more readily than phosphates, which have a stronger affinity for soil particles. Together with phosphorus, nitrates in excessive amounts can cause dramatic increases in aquatic plant growth, which in turn reduces dissolved oxygen (DO) concentrations. Elevated levels of nitrates can be toxic to humans, especially children, because the nitrates prevent hemoglobin from binding oxygen and transporting it to vital tissues.

What Is pH?

The alkalinity or acidity of a solution is described in terms of the solution's pH level. Water (H_2O) contains both hydrogen ions (H^+) and hydroxide ions (OH^-). The relative concentrations of these ions determine whether a solution is acidic or basic (*alkaline*). The pH scale ranges from 1 (most acidic) to 14 (most basic), with 7 (pure water) being neutral. It is important to remember that pH is measured on a logarithmic scale: A change of 1 pH means a ten-fold change in the ion concentrations.

The pH value affects many chemical and biological processes in the water. For example, different organisms flourish within different ranges of pH. The largest variety of aquatic animals prefers a pH range of 6.5 to 8.5. When the pH value falls outside of this range, the stream's biological diversity suffers because of stresses to the physiological systems of most organisms that can, among other things, reduce reproduction. Low pH conditions can also allow toxic elements and compounds to become available for uptake by plants and animals.

What Is Phosphorus?

Phosphorus is the eleventh-most abundant mineral in the earth's crust and commonly occurs in water in the form of phosphate ions (HPO_4^{2-} and $H_2PO_4^-$). Phosphorus is in short supply in most water bodies, but even a modest increase in phosphorus can, under the right conditions, set off a chain of undesirable events in a stream including accelerated plant growth, algae blooms, decreased dissolved oxygen, and the death of certain fish and invertebrates. Unlike nitrogen and other nutrients, phosphorus does not have a gaseous phase; it adsorbs to soil particles or is incorporated into organic matter. Once phosphorus enters an aquatic system, it tends to remain there unless physically removed.

What Are Salinity and Conductivity?

Conductivity is a measure of the ability of water to pass an electric current. It is used to determine the salinity of water. The natural concentration of salts in a waterway is largely influenced by the geology of the area through which the water flows. Streams that run through areas with clay soils (e.g., ancient marine sediments) tend to have higher conductivity because of the presence of materials that ionize when washed into water.

High salinity may interfere with the growth of aquatic vegetation. Salt may decrease the osmotic pressure, causing water to flow out of the plant in order to achieve equilibrium, and this in turn causes stunted growth, leaf tip burn and marginal leaf burn, bleaching, or defoliation. Some freshwater organisms are salt tolerant and may invade or replace native species.

Inadequate drainage or excessive evaporation from agricultural fields may lead to an accumulation of salts in the soil. High salt concentrations in the soil around plant roots may cause plant dehydration by reversing osmotic conditions. In some cases, rather than destroying a crop, elevated salt levels may simply reduce crop yields and leave the plants prone to disease.

Why Is Temperature Important?

The rates of biological and chemical processes depend on temperature. Temperature affects

1. ***dissolved oxygen levels* —** Colder water can hold more dissolved oxygen than warmer water, so colder water generally has a higher diversity of macroinvertebrates. Warmer water has less dissolved oxygen. Lower oxygen levels weaken fish and aquatic insects, making them more susceptible to illness and disease.
2. ***rate of photosynthesis* —** Photosynthesis by algae and aquatic plants increases with increasing temperature. Increased plant/algae growth leads to increased death and decomposition, resulting in increased oxygen consumption by bacteria.
3. ***metabolic rates of aquatic organisms* —** Many animals require specific temperatures for survival. Water temperature controls their metabolic rates, and most organisms operate efficiently within a limited temperature range. Aquatic organisms die when temperatures become too high or too low. Fish species are particularly sensitive to temperature changes, which can affect reproduction and the growth of juveniles.

What Is Turbidity?

Turbidity is the measure of water clarity, the degree to which suspended material in the water decreases the passage of light through the water. Higher turbidity increases water temperatures because the suspended particles in water absorb heat. This reduces the water's concentration of dissolved oxygen (DO), since warm water holds less DO than cold water. Higher turbidity also reduces the amount of light that can penetrate the water, which reduces photosynthesis and the production of DO. Suspended particles can clog the gills of fish. If the particles settle out of the water, they can smother spawning beds (gravel), fish eggs, and benthic organisms. Sediment can also carry pathogens, nutrients, and pesticides downstream.

Note that turbidity is not a measurement of the *amount* of suspended solids present or the rate of sedimentation in a stream; it measures only the scattering of light by suspended particles. Measurement of total solids is a more direct means for measuring the amount of material suspended and dissolved in the water.

Table 1. Water quality tests and what they measure

Test for	Why measure it?	Measuring tools
Ammonia	Toxic levels of ammonia can kill fish and other aquatic organisms. Water temperatures strongly influence the toxicity of ammonia.	Ammonia test kit or ammonia meter
Dissolved O_2 (DO)	Low levels of dissolved oxygen affect the growth and development of plants and animals.	Dissolved oxygen test kit or meter
Nitrate	If enough phosphorus is available, a high concentration of nitrates will result in an increase in algae growth.	Nitrate test kit, meter, or test strips
pH	pH affects many chemical and biological processes in the water.	Meter or litmus test strips
Phosphorus	If too much phosphate is present, algae blooms may develop that could later lead to the depletion of dissolved oxygen.	Phosphate test kit, meter, or test strips
Salinity/ conductivity	The level of salinity in water is often critical to the survival of many aquatic plants and animals.	Alkalinity (chloride) test kit or TDS/conductivity meter
Temperature	Every aquatic organisms has upper and lower temperature limits; temperatures outside these limits will affect the health of the organism.	Alcohol-filled thermometer, if available
Turbidity/sediment	Sediments can carry pollutants that bind to soil particles. They can also have a negative affect on fish health and spawning habitat.	Imhoff cone or turbidity meter

NOTE: There are many different constituents you can test for and many different methods for measuring them. Several commercial sources for tests are listed at the end of this publication.

WATER QUALITY SELF-EVALUATION

Ammonia

How do I measure ammonia? *Ammonia test kits* determine ammonia (nitrogen) levels by comparing water samples mixed with pre-measured reagents against color standards. The ranges of detection are 0 to 1 and 1 to 10 mg/L. Ammonia test kits cost $45 and up (sufficient for 30 tests). Tests take approximately 10 minutes to complete.

Ammonia-specific meters determine ammonia levels by reading a change in color using a silicon photocell on an LCD. Simply add reagents to a water sample and place the vial into the meter. The range of detection is 0 to 1 mg/L with a resolution of 0.01 mg/L. Meters cost $200 and up. Tests take 10 to 15 minutes to complete.

Laboratory testing requires that you collect a water sample according to lab specifications. Mail your sample to the lab or drop it off. Costs range from $25 to $35. Processing can take 1 to 7 days. Accuracy is assumed to be absolute.

Where do I test for ammonia? Conduct your test *anywhere* water leaves your farm, especially after you apply ammonia-rich fertilizer or if livestock are present. If applicable, take tests where water enters and leaves your property.

When do I test for ammonia? Test for ammonia during your scheduled irrigation activities and during the first rain event following the application of ammonia-rich fertilizer. Always measure pH and temperature when you measure ammonia. Without these other measurements it will be difficult to evaluate the true value of your ammonia sample.

Water quality objectives for the Central Coast

- *Beneficial use of concern:* General objective = The discharge of wastes should not cause concentrations of un-ionized ammonia (NH_3) to exceed 0.025 mg/L as nitrogen in receiving waters.

Dissolved Oxygen

How do I measure dissolved oxygen (DO)? *Dissolved oxygen test kits* determine DO levels by comparing water samples mixed with pre-measured reagents against color standards. The range of detection is 1 to 12 mg/L. DO test kits cost $40 and up (sufficient for 30 tests). Tests take approximately 10 minutes to complete.

Dissolved oxygen-specific meters determine DO levels by reading a change in color using a silicon photocell on an LCD. Simply add reagents to a water sample and place the vial into the meter. The range of detection is 0 to 14 mg/L with a resolution of 0.1 mg/L. Meters cost $180 and up. Tests take 10 minutes to complete.

Hand-held DO meters give fast and accurate readings. Place the attached probe into your water sample. The range of detection is 0 to 50 mg/L. Meters cost $250 and up. The digital readout is ready in 20 seconds.

Laboratory testing requires that you collect a water sample according to lab specifications. Mail your sample to the lab or drop it off. Costs range from $20 to $30. Processing can take 1 to 7 days. Accuracy is assumed to be absolute.

Where do I test for DO? Rapid decomposition of organic matter, high ammonia concentrations, high air temperatures, and lack of turbulence all contribute to lowered DO levels. Conduct your test at midstream, making sure to sample from the middle of the water column, if possible.

When do I test for DO? Measure for DO once a month if you have a stream running through your property. Remember to be consistent in the time of day you take your sample. Depending on your site, you should be able to document a change in values between the summer (low-flow) and winter (high-flow) months.

Regional Water Quality Control Board water quality objectives for the Central Coast

- *Beneficial use of concern:* Cold/warm freshwater habitat and fish spawning = DO concentration should not fall below 7.0 mg/L for waters that support cold-water fishes or 5.0 mg/L for waters that support warm-water fishes. For fish spawning, DO should not fall below 7.0 mg/L.

Nitrate

How do I measure nitrate? *Nitrate test kits* determine nitrate levels by comparing water samples mixed with pre-measured reagents against color standards. The ranges of detection are 0 to 25 and 25 to 125 mg/L. Nitrate test kits cost $50 and up (sufficient for 30 tests). Tests take 10 minutes to complete.

Nitrate-specific meters determine nitrate levels by reading a change in color using a silicon photocell on an LCD. Simply add reagents to a water sample and place the vial into the meter. The range of detection is 0 to 30 mg/L with a resolution of 0.1 mg/L. Meters cost $150 and up. Tests take 10 minutes to complete.

RQflex meters can be programmed to provide accurate results in seconds for a wide variety of tests. Simply dip the test strip in the sample, insert the strip into the meter, and read the results on the digital display. The range of detection is 3 to 90 mg/L. Meters cost approximately $575. Tests take 10 minutes to complete.

Laboratory testing requires that you collect a water sample according to lab specifications. Mail the sample to the lab or drop it off. Costs range from $25 to $35. Processing can take 1 to 7 days. Accuracy is assumed to be absolute.

Where do I test for nitrates? Collect your sample above and below any potential nitrate source. For example, take your samples from a stream above an area where water enters the stream from your farm, and again below the runoff area. If a stream does not flow through your property, you can sample anywhere water leaves your farm.

When do I test for nitrates? Test for nitrates during your scheduled irrigation activities and during the first rain event after fertilizer application.

Regional Water Quality Control Board water quality objectives for the Central Coast

- *Beneficial use of concern:* General objective = All waters shall be maintained free of toxic substances in concentrations that are toxic to or that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analysis of species diversity, or other appropriate methods specified by the Regional Board.

pH (Power of Hydrogen)

How do I measure pH? *Pocket pH meters* display immediate results with a high degree of accuracy (±0.2 pH). Meters should be calibrated frequently to maintain accuracy (recommend calibration solutions of 7 and 10 pH). Pocket pH meters cost $40 and up. Calibration solutions cost $8 each. Testing takes 10 minutes to complete.

pH test strips measure pH from 0.0 to 13.0 with a simple, single-color match for each pH value. Simply dip the strip into the water sample and compare it to the color chart. pH strips are not as accurate (±0.5 pH) as meters, but they are easier to use because they do not require calibration. Use strips only to get a general idea of the pH. Cost is $8 and up (100 strips per package). Testing takes 2 minutes to complete.

Laboratory testing requires that you collect your water sample according to lab specifications. Mail the sample to the lab or drop it off. Costs range from $10 to $25. Processing can take 1 to 7 days. Accuracy is assumed to be absolute.

Where do I test for pH? Conduct your test above and below any area where livestock are confined. You should also test above and below any point where water leaves your property and enters a water body.

When do I test for pH? Measure pH once a month if livestock are present. Since aquatic organisms are sensitive to pH, especially during reproduction, you may wish to measure pH once a week during spring and summer months. Note that higher-temperature water bodies have slightly lower pH values.

Regional Water Quality Control Board water quality objectives for the Central Coast

- *Beneficial use of concern:* Municipal/domestic supply, agriculture supply, contact and non-contact water recreation = pH should fall between 6.5 and 8.5;
  Cold/warm freshwater or marine habitat = pH should range between 7.0 and 8.5. Changes in normal pH should not exceed 0.5 for cold- or warm-water fisheries or 0.2 for marine habitats.

Phosphate

How do I measure phosphate? *Phosphate test kits* determine phosphate levels by comparing water samples mixed with pre-measured reagents against color standards. The ranges of detection are 0 to 1 and 1 to 10 mg/L. Phosphate test kits cost $45 and up (30 tests). Tests take 10 minutes to complete.

Phosphate-specific meters determine phosphate levels by reading a change in color using a silicon photocell on an LCD. Simply add reagents to a water sample and place the vial into the meter. The range of detection is 0 to 2.5 mg/L with a resolution of 0.1 mg/L. Meters cost $170. Tests take 10 minutes to complete.

Laboratory testing requires that you collect a water sample according to lab specifications. Mail the sample to the lab or drop it off. Costs range from $25 to $35 for orthophosphate and $40 to $75 for total phosphate. Processing can take 1 to 7 days. Accuracy is assumed to be absolute.

Where do I test for phosphate? Since phosphate enters surface water in organic matter (dead plants, animals, and animal waste), attached to soil particles, or through detergents and fertilizers, you will want to test above and below any water body where there is a livestock confinement area or above and below a management practice if you want to measure its effectiveness. If this is not applicable, conduct your test anywhere water leaves your property.

When do I test for phosphate? Test for phosphate during your scheduled irrigation activities and during the first rain event after you apply fertilizers.

Regional Water Quality Control Board water quality objectives for the Central Coast

- *Beneficial use of concern:* General objective = All waters shall be maintained free of toxic substances in concentrations that are toxic to or produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analysis of species diversity, or other appropriate methods specified by the Regional Board.

Salinity and Conductivity

How do I measure salinity or conductivity? A *TDS* or *conductivity tester* measures salt content. To use the instrument, place it into your water sample. This equipment features automatic temperature compensation with a ±2% degree of accuracy, but testers do require calibration. A typical unit costs $60. Test takes 10 minutes to complete.

Refractometers measure the concentration of dissolved substances in liquid based on the principle of light refraction. Only 1 to 2 drops of solution are required for measurement. A refractometer reads in parts per thousand (0 to 100 ppt) or specific gravity (1.000 to 1.070 sp. gr.). Units cost $150. Test takes 10 minutes.

A *combination tester* is a floating, waterproof instrument that allows you to accurately measure the pH, conductivity, TDS, or temperature of a solution without switching meters. The tester features automatic temperature compensation and auto-calibration. It comes with pH buffer solutions (4.0 and 7.0), a pH electrode, four 1.5 volt batteries, and an electrode replacement tool, and costs $145. Test takes 10 minutes to complete.

Laboratory testing requires that you collect a water sample according to lab specifications. Mail the sample to the lab or drop it off. Costs range from $20 to $30. Processing can take 1 to 7 days. Accuracy is assumed to be absolute.

Where do I test for salinity? Test for salinity at the wellhead or in any area where water collects (e.g., a tailwater ditch) or leaves your property. You may also want to test your runoff or a stream section above and below a management practice.

When do I test for salinity? Test your water at least twice per year (6-month intervals). If you are testing runoff from a field, wait until the field becomes saturated before you take a runoff sample.

Regional Water Quality Control Board water quality objectives for the Central Coast

- *Beneficial use of concern:* General objectives = There are no objectives for conductivity, but there are objectives for total dissolved solids (TDS). The TDS objectives range from 150 to 1400 mg/L depending on the water body.

Temperature

How do I measure temperature? An *armored thermometer* that does not use mercury costs approximately $20. For best results, immerse the thermometer in the middle of the water column and allow sufficient time for the thermometer to achieve equilibrium. Try to take your reading while the thermometer is still under water.

A *digital thermometer* displays the time and temperature. Place the thermometer's probe into the middle of the water column. Even though you will get an immediate reading, allow sufficient time for the thermometer to adjust. The range of detection is 0° to 160°F (–18° to 71°C). This type of thermometer costs approximately $40.

Where do I test for temperature? You should test for changes in stream temperature above and below an area where runoff occurs. If you have a stream running through your property you may want to take a temperature reading one-half mile above and below your property line and compare those readings with readings taken on your property. Remember that warmer water holds less oxygen, so if you also test for dissolved oxygen you should see a correlation. Also, keep in mind that ammonia levels increase with increasing temperature.

When do I test for temperature? Measure water temperature at the same location once a month. You may wish to test more frequently (once a week) during prolonged periods of hot or cold climatic conditions. This will provide you with a general indication of the rate at which the water temperature is changing.

Regional Water Quality Control Board water quality objectives for the Central Coast

- *Beneficial use of concern:* Cold/warm freshwater habitat = Temperature should not increase more than 5°F (2.8°C) above natural receiving waters.

Turbidity

How do I measure turbidity? Turbidity can be measured in Jackson Turbidity Units (JTU) or Nephelometric Turbidity Units (NTU). Their values are not interchangeable.

Turbidity test kits determine turbidity levels by comparing water samples mixed with pre-measured reagents against color standards. The range of detection is 5 to 100 JTU. Turbidity kits cost $45 (50 tests). Tests take approximately 10 minutes to complete.

Turbidity meters are also available and are simple to use. Just place the vial of sampled water into the meter. The range of detection is 0 to 1100 NTU. Meters cost $650 and up. Test takes 10 minute to complete.

Laboratory testing requires that you collect a water sample according to lab specifications. Mail the sample to the lab or drop it off. Costs range from $15 to $25. Processing can take 1 to 7 days. Accuracy is assumed to be absolute.

Where do I test for turbidity? Collect your sample above and below a potential source of erosion. For example, take your sample from a stream above the area where water enters the stream from your farm and again below the same area where runoff enters the stream. If a stream does not flow through your property, you can sample anywhere that water leaves your farm.

When do I test for turbidity? Test for turbidity during your scheduled irrigation activities and during any significant rain event throughout the winter season.

Regional Water Quality Control Board water quality objectives for the Central Coast

- *Beneficial use of concern:* General objective = Water quality objectives for turbidity require that surface waters be free of changes that cause nuisance or adversely affect the beneficial uses of water. If natural turbidity is 0 to 50 JTU, the maximum increase in inputs is 20%. If 50 to 100 JTU, the maximum increase in inputs is 10 JTU. If >100 JTU, the maximum increase in inputs is 10%.

Where to Purchase Test Kits and Other Equipment

Before you purchase any water quality test kits or other sampling equipment, contact your local Water District, UC Cooperative Extension, or Natural Resources Conservation Service/Resource Conservation District office. They can help you make sure that you get the proper test or equipment for your particular needs.

Estimated Pricing for Water Quality Tests (as of 8/1/04)

(Shelf life of 6 months at room temperature, 1 year if refrigerated)

Ammonia test kit, 30 tests	$45
Dissolved oxygen (DO) test kit, 30 tests	$40
Imhoff cone (1000 ml) for turbidity	$25
Imhoff cone stand (holds 3 cones)	$25
Nitrate test kit, 30 tests	$50
pH test strip, 100/package	$8
Phosphate test kit, 30 tests	$45
Salinity test kit (chloride), 50 tests	$60
Thermometer	$20

Approximate Lab Cost for Individual Tests (as of 8/1/04)

Ammonia	$25
Dissolved oxygen (DO)	$20
Nitrate	$25
Orthophosphate	$25
pH	$10
Salinity (chloride)	$20
Total dissolved solids (TDS)	$20
Total phosphate	$40
Turbidity	$15

Suppliers of Water Test Kits and Equipment

Ben Meadows. 1-800-241-6401, http://www.benmeadows.com

Chemetrics, Inc. 1-800-356-3072, http://www.chemetrics.com

Cole Parmer Instrument Company. 1-800-323-4340, http://www.coleparmer.com

Forestry Suppliers, Inc. 1-800-647-5368, http://www.forestry-suppliers.com

Hach Company. 1-800-227-4224, http://www.hach.com

LaMotte. 1-800-344-3100, http://www.lamotte.com

NOTE: Test kits and electronic meters used to measure different concentrations among selective ions are highly variable, so it is important that you know what degree of accuracy you are striving to achieve before you select a product.

DISPOSAL OF CHEMICAL WASTES

In any self-assessment program that performs chemical testing, you face the problem of how to dispose of chemical wastes. These include individual unused reagents and reacted sample waste (the waste generated during performance of tests).

Unused Reagents

You can reduce or eliminate the problem of leftover reagents by ordering quantities that take into account the reagent's shelf life and your rate of usage. Instructions for disposal of each reagent are included on the Material Safety Data Sheet (MSDS) provided by the manufacturer. Modest quantities of many common test kit reagents can safely be diluted and disposed of down the drain if you take necessary precautions regarding incompatibility. For example, you should neutralize acids and bases before disposal (see instructions on the MSDS). Note that neutralization often occurs as part of the test procedure, making the disposal of reacted sample waste simpler than disposal of unused reagents. For example, the reagents used in the dissolved oxygen test include both an acid (sulfuric acid) and a base (alkaline potassium iodide azide), but these neutralize each other when you perform the test.

Often the final instruction on an MSDS is "dispose of in accordance with applicable federal, state, and local regulations." People who use chemicals need to educate themselves on the regulations for their area and make a plan that follows those regulations and emphasizes prudent and responsible practices.

Tip: Form an alliance with the laboratory personnel at the agencies that deal with waste disposal regulations for your area. They should be familiar with the tests you are performing and may be able to provide advice and support. It is also very helpful to contact local government recycling coordinators and find out about household hazardous waste programs.

Reacted Sample Waste

Bring a designated waste receptacle to your sampling site whenever you perform chemical testing. Most chemical tests that are commonly used in volunteer programs produce wastes that can safely be disposed of by pouring them down the drain if it is flushed with plenty of water. These include field kits for testing dissolved oxygen, pH, phosphorus, turbidity, and alkalinity. A few test procedures include heavy metals that are not neutralized in the test procedure. **These might include nitrate or ammonia tests.** As a precaution, if you are using a reagent that comes in a packet, be sure to hold the packet away from your face and stand upwind of the packet when opening it.

Tip: To discard chemical waste, take two separate containers with secure lids (such as recycled margarine containers). Label one container "Hazardous Waste" and the other "Non-Hazardous Waste." Place all liquids and solids in the plastic containers along with several cups of clean clay cat litter. Leave the lids off so the liquid can evaporate. The hazardous and non-hazardous chemical wastes are now in solid form.

For information on how to dispose of the hazardous waste, contact a lab or the Solid Waste Management District in your area. The non-hazardous wastes, once in solid form, can be thrown away with your regular trash.

Worksheet for Evaluating Water Quality

Your name:	**Date:**	**Time:**	**Air temperature:**
Site name:			
Site description (describe location and current condition of water, vegetation, and land uses on and above your property):			

Measurement taken from: ☐ Irrigation water (wellhead/field runoff) ☐ Surface water (stream/creek)

Weather in past 48 hours: ☐ Clear ☐ Overcast ☐ Showers ☐ Steady rain ☐ Storm (heavy)

Flow conditions: ☐ Dry ☐ Stagnant ☐ Slow ☐ Moderate ☐ High ☐ Flood

Method/equipment used to measure:

Ammonia ______________________ Phosphorus ______________________

Dissolved oxygen ______________________ Salinity/conductivity ______________________

Nitrate ______________________ Turbidity ______________________

pH ______________________

	Units*	Sample 1	Sample 2	Average
Ammonia†	mg/L			
Dissolved oxygen	mg/L			
Nitrate†	mg/L			
pH				
Phosphorus†	mg/L			
Salinity/conductivity	mg/L or µS/cm			
Turbidity	NTU or JTU			
Temperature	°C or °F	Upstream Temp.:	Downstream Temp.:	Difference:
Comments:				

* Milligrams per liter (mg/L) is the equivalent to parts per million (ppm).
† Indicate which type of test is conducted (e.g., nitrate or nitrate-nitrogen, phosphate or orthophosphate, etc.).

FOR MORE INFORMATION

You'll find detailed information on many aspects of water quality and resource conservation in these titles and in other publications, slide sets, CD-ROMs, and videos from UC ANR:

Developing a Farm Map, Publication 8062
Developing a Nonpoint Source Pollution Evaluation Program, Publication 8087
Fish Habitat in Freshwater Streams, Publication 8112

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