Texas Cooperative
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The Texas A&M University System

UNDERSTANDING WATER ANALYSIS REPORTS: WATER FROM FRESHWATER FISH PONDS AND THEIR WATER SUPPLIES

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INTRODUCTION

Water analyses are conducted by water testing laboratories for a variety of purposes. The selection of measurements printed on the report forms will reflect the kind of analysis normally expected. Laboratories specialize in irrigation water testing will have measurements that are thought to affect plant life. Laboratories that are concerned with pollution might emphasize pesticides, heavy metals or petroleum byproducts on their water test forms.

Quite often people who acquire a water analysis do so with the idea that they will obtain help from some expert in interpreting the result. Not knowing what measurements to ask for they leave it up to the laboratory to “run the tests” and as a consequence often purchase a lot of useless information. The following is presented with hopes that it will aid the pond owner or his advisor in determining which measurements are helpful in examining water quality and how to interpret the results obtained.

WHY TEST?

There are a number of reasons why one would want to have pond water tested. The selection of water tests information would be different for each. Examples of reasons for testing are:

1) A catastrophe with sudden die-off of fish and no clue to a cause.
2) A catastrophe with sudden die-off of fish and a good idea of cause.
3) Little or no die-off but with knowledge or suspicion of some accident or malicious action in the vicinity of the pond.
4) Evaluation of suitability of pond water or water source.

In the cases where knowledge of probable cause agent is known the test, requirements can be easily narrowed down. If a pesticide is suspected it is very helpful for the pond owner to do an initial investigation to determine what probable type of pesticide was used. Otherwise the testing may be no more than searching for a "needle in a haystack" because of the great variety of manufactured pesticides.

In a case where no good clue is had to the cause of a catastrophe or where water is merely being evaluated, a general spectrum of tests that are known to commonly affect aquatic life can be conducted.

REVIEW OF SOME WATER CHEMISTRY CONCEPTS

Elements such as hydrogen and oxygen associate to form compounds such as water H_20. Compounds of a particular sort when viewed in nature are called substances. As a pure substance, water would only consist of the compound H_20. In nature, however, we know it not as pure but consisting to some degree of a number of dissolved and suspended substances. Unless the water is particularly muddy these substances would consist predominately of dissolved ions. On a very basic chemical level, ions are elemental forms or groups that carry an electrical charge in solution. Positive ions are called cations and examples are: calcium, potassium, magnesium and sodium. Negative ions or anions are represented by carbonate, bicarbonate, sulfate, and chloride. Substances that

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dissolve readily in water to form simple ions are called salts. Because many of the dissolved ions in solution would combine upon evaporation to form salt compounds, the content of simple ions in solution is frequently referred to as salt content.

If a sample were taken from a natural surface water and evaporated it would contain organic matter in addition to the usual salts. Organic matter consists of living material, it excretions or decomposing dead material. This is usually only a small percentage of a residue. Organic matter can have a great effect on water chemistry by requiring oxygen for living processes as the complex organic matter is built up from and torn down into simple compounds.

In addition to the dissolved salts and organic material a surface sample could contain some amount of suspended clay or silt. This content develops in the water column in cases where clay particles have appropriate size and surface charge to favor suspension or where temporary effects of bottom disruption or watershed erosion takes place.

Gases are also present in water, either dissolving at special underground pressure in the case of groundwater or under normal pressure at the surface from the gas mixture of the air. Some gases enter the water as they are formed by living agents in water or by chemical release from muds in the bottom.

The principal ions dissolved in water include carbonate, chlorides, sulfates, nitrates, sodium, potassium, calcium and magnesium. Other dissolved inorganic materials are grouped as trace elements and include heavy metals. Gases normally represent a small portion of dissolved substances in water.

UNITS OF MEASURE

The most common unit of measure of trace elements, gases, ions and pesticides is parts per million (p.p.m.). A part per million is the same as a milligram/liter (mg/1). Smaller concentrations are sometimes reported as parts per billion (p.p.b.) which is the same as a microgram/liter (ug/1). Larger concentrations are sometimes reported as parts per thousand (g/1).

Sometimes, and particularly with ionized components of salts, a measure called equivalents per million (e.p.m.) is used. Equivalents per million is the same as the expression milliequivalents/liter (meq/1). To convert e.p.m. to mg/I one can multiply by the following factors for each ion: calcium, 20; magnesium, 12.2; potassium, 40; sodium, 23; carbonate, 30; bicarbonate, 61; sulfate, 48 and chloride, 35.5.

Rarely the measure grains/gallon is used. One grain/gallon equals 17.1 parts per million. Other peculiar units of measure are described under appropriate subheadings below.

MEASUREMENTS COMMONLY REPORTED IN WATER TESTING

pH

The pH is a measure of hydrogen ions in the water. The pH scale spans a number range of 0 to 14 with the number 7 being neutral. Measurements above 7 are basic and below 7 are acidic. The farther a measurement is from 7 the more basic or acidic is the water. Acid and alkaline (basic) death points for fish are approximately pH 4 and 11. Growth and reproduction can be affected between pH 4 and 6 and pH 9 and 10 for some fishes. The pH of some ponds may change during the course of a day and is often between 9 and 10 for short periods of afternoons. Fish can usually tolerate such rises that result when carbon dioxide, an acidic substance, is used up by plants in photosynthesis. Water samples taken from such ponds are usually delayed for some time prior to laboratory testing and during the delay the pH can equalize and not show an extreme reading. The most common pH problem for pond fish is when water is constantly acidic. The nature of the bottom and watershed soils is usually responsible. Such water has a stable and low pH that is only correctable with liming.

Salinity

Salinity is the measure of the total concentration of all dissolved ions in water. Sodium chloride is the principal ionic compound in sea water but most inland ponds contain substantial concentrations of other ionic compounds (salts) such as compounds of sulfate and carbonate. Because sodium chloride is so important in measurement of marine waters, marine water laboratories sometimes base by proportion the value of salinity on a measure of the chloride of this salt (chlorinity). Salinity also can be and often is measured according to the density the salts produce in the water, the refraction they cause to light by electrical conductance. The result in all cases is reported in parts per thousand (ppt) salinity.

Standard seawater is 35 ppt and inland surface waters of arid West Texas may range up to 10 ppt. Well waters sometimes accumulate high amounts of dissolved ions due to ionization of compounds of underground minerals 'or as a result of leaching from the high salt content of arid land surfaces.

Most of the information which is available on aquatic animal tolerance to dissolved ionic material has been done as a result of exposure to various dilutions of sea water. Examples for freshwater fish with highest tolerable levels in milligrams/liter for good survival and growth are as follows:

Golden shiner fry -2000, goldfish fry – 2000 (Murai, T. and J. Andrews, 1977, Prog. Fish Cult. pp 122-123);

Channel catfish - 11,000 (W. Perry and J. Avault, 1969, Proc. Ann. Conf. Southeastern Game and Fish Comm. 23:592-605).

Specific Conductance or Conductivity

As mentioned above, dissolved ionic substances can be measured by electrical conductance. On laboratory reports this may be shown as specific conductivity. Conductivity is reported as micromhos/cm or ECx106. From such an electrical measure, tables can be used to derive tons/acre-ft., parts per million, grains/gallon, etc. Natural surface waters would be expected to have conductivities that measure from 50 to 1500. Where well waters from saline ground water strata are used, the conductivity could run higher. Problems with most freshwater fish species should only be encountered at measurements of over 15,000.

Total Dissolved Solids

Another measure reporting the presence of dissolved ionic constituents is total dissolved solids. This measurement is made by weighing the residue of an evaporated sample after it has passed through filter paper. If the sample is not filtered the reported value will be that of total solids (TS) instead of total dissolved solids JDS). Because ionic compounds dominate the content of dissolved substance in most water samples, TDS reflect closely the numerical quantity derived in the measure of salinity. TDS is reported in mg/liter of whole sample. In both surface and ground waters of inland areas where TDS exceed 2000mg/liter the principal anions are sulfate and chloride. The measure of these ions in mg/liter when added together will usually approximate 1/2 the measure of TDS. Although not the same as salinity where sodium chloride may greatly predominate as with seawater, TDS must sometimes serve as the only measure on which to make decisions regarding dissolved salts. As mentioned above for salinity, 2000 mg/liter (2 parts per thousand) is known as to adversely affect sensitive species or younger stages of some species. Catfish are known to handle 6000 to 11,000 mg/liter salinity quite well depending on acclimation.

Major Dissolved Ionic Components

It is helpful to have test results that break down the various ionic constituents. Calcium and magnesium compounds are preferred as major ionic components. Solubility of liming compounds is affected by the presence of sodium. Fish species are more affected by total ionic presence than individual ion concentrations.

Carbonate, Bicarbonate, Sulfate, Chloride, and Less Abundant: Nitrate, Phosphate, Silica, and Fluoride

Carbonate and bicarbonate are present in both surface and ground water supplies at levels consistent with their solubilities. Measurements normally range below 300 mg/liter and are considered harmless to fish life. Sulfate and chloride are expected to range higher than carbonate/bicarbonate in well and surface waters where the water comes in contact with appropriate mineral strata such as those dominated by aluminum sulfate. Normal surface waters contain less than 50 mg/l of sulfate and chloride but some well waters far in distance from coastal areas reach 1000 to 2000 mg/I sulfate and several times that amount in chlorides. Sulfate and chloride when present are in amounts below. Those considered as salinity stress. They are considered harmless except where acidity is especially influenced.

Nitrate is generally nontoxic to fishes and can be expected to occur at less than 2 mg/liter in natural surface water. Fish can tolerate several hundred mg/liter. In some recycled waters or where feeding causes enrichment nitrate could climb to several mg/liter.

Phosphate, fluoride and silicate are minor constituent anions, Phosphate like nitrate is usually present in slight amounts (less than 0.1 mg/1) in natural surface and well water. Aside from promoting unwanted growth of algae in ponds it is considered harmless. Fluoride concentrations in surface water would be considered normal at less than 0.5 mg/l; high at 1 to 2 mg/liter and rare at over 10 mg/liter. Fish react differently to fluoride according to overall water conditions and species. In some cases major losses have been noted at 3 mg/liter whereas normal populations have been recorded in lakes where concentrations reach over 13 mg/liter (W.F. Sigler and J.M. Nuehold, 1972, J. Wildlife Dis. 8:252-254). Silica is rather unreactive and harmless and is normally present in pond waters at less than 10 mg/L.

Calcium, Magnesium, Sodium, Potassium

Potassium is usually represented by a very low percentage of surface water cations. Calcium and magnesium are typically greater and vary from site to site in proportion to sodium. Many well waters in Texas. However, have high sodium low calcium-magnesium ratios, Sodium is much more soluble than the other cations and can range into the thousands of mg/I where the others are limited to hundreds of mg/l. Water with 5 or less mg/I calcium is considered very low and 10 mg/I. solids (salts). Some waters fed by wells have calcium and magnesium ions dissolved to perhaps twice considered possible for natural surface water and yet will maintain living populations of fishes and other aquatic animals. Excess sodium has a detrimental influence on liming efforts and can cause liming to have little positive effect.

Sodium Absorption Ratio

Commonly seen on report forms this test is used to check the alkali hazard of irrigation water. It compares the amount of sodium concentration with calcium and magnesium to assess the potential for sodium buildup in cropland.

Sodium Percentage (Sodium Hazard)

This is another irrigation water test that compares the amount of sodium to all cations present. The effect of sodium on aquatic microplant production is not well understood. On crops, the sodium percentage should be less than 60.

Total Alkalinity and Total Hardness

Total alkalinity is a measure of the basic substances of water. Because in natural water these substances are usually carbonates and bicarbonates the measurement is expressed as mg/I of equivalent calcium carbonate. In special cases such as many groundwater and western ponds, sodium carbonate is the predominate basic substance. These basic substances resist change in pH (buffering) and where an abundance of calcium and magnesium bicarbonate is dissolved the pH will stabilize between 8 and 9. If an abundance of sodium carbonate is present the pH may exceed 9 or 10. Some laboratory forms report carbonate (Co3) and bicarbonate (HC03) in addition to total alkalinity. These are typically derived from alkalinity measurements by multiplication by standard conversion factors.

Total hardness is the measure of the total concentration of divalent metal ions (primarily calcium and magnesium) expressed in milligrams per liter of equivalent calcium carbonate. Because calcium and magnesium are usually present in association with carbonate as calcium carbonate or magnesium carbonate, total hardness is related 254). Silica is rather unreactive and harmless and is to total alkalinity and can give one an idea of the waters potential for stabilizing pH. Waters can be high in alkalinity and low in hardness if sodium and potassium are the dominant ions.

Fish do best when measurement of hardness or alkalinity measures between 20 and 300 milligrams/Liter. Below 20 milligrams/liter can result in poor production. Cases where total hardness is considerably below the measure for total alkalinity is also not desirable. Total hardness and total alkalinity may be raised by liming.

Lime Requirement

This test, which is to determine the amount of liming needed to neutralize acid because of leached-out-cropland cations, has found use in aquaculture for water improvement. Sediment (mud) is removed and analyzed to determine the amount of ground limestone needed to bring the pH of soils to an acceptable level and hold it there for 2 to 5 years. For aquaculture use the test designed to determine the amount of lime necessary to raise the pH of the bottom mud to 5.8 and raise the water hardness to acceptable levels. The lime requirement of the bottom mud must be satisfied before lasting effects can be expected in the water column. The lime requirement is reported in pounds/acre and may amount to one to several tons of lime per acre. Liming efforts may be futile where sodium presence is great or muds are extremely acid.

Suspended Solids and Turbidity

Suspended solids (unfiltered residue) will measure less than 2000 mg/l in muddy pond waters. Many times this amount is needed to directly affect fingerlings and adult fishes. Muddiness can affect natural food production at 250 mg/liter suspended solids by shutting out sunlight and can interfere with reproduction of some fish at less than 500 mg/liter. Sometimes turbidity is used as a measure of suspended solids and is given in turbidity units. Turbidity units are derived by light transparency. Turbidity in fertile surface waters is largely due to organic material, particularly algae. Expected measurements would be: clear, 2 units; and algae-rich, 200 units.

Trace Elements

Trace elements are those ionic constituents of water that dissolve to a small extent even though the concentration in the soil of bottom and watershed may be considerably greater. Some elements are routinely included in reports of irrigation water and soil tests because of the impact on plants. Boron is most common in this category. More generalized water reports will likely include certain metals which could have toxic effects and some laboratories offer metal analyses as special order items.

Aquatic organisms of all types are sensitive to metal poisoning when the concentration of these reaches a certain level in the water column. Certain fish groups tend to be more sensitive than others to particular metals. Copper for example is more toxic to rainbow trout than to channel catfish. Exact levels of tolerable metals in solution which are considered safe for aquatic life are the subject of much discussion and disagreement (U.S. EPA, 1976, Quality Criteria for Water, 256 pp; Water Quality Section of Amer. Fish. Soc., 1979, A review of the EPA Red Book: Quality Criteria for Water, 313 pp.). Authors of some reference books have searched out the lowest recorded level of a substance which for one reason or another was considered safe and then reduced various metals is difficult to find. The recommendation on how to determine actual toxicity in a certain body of water then is often merely to conduct a bioassay.

Availability of trace elements to do toxic damage much affected by water hardness, dissolved organics, and suspended clays. Toxic action is also influenced by the form (i.e., free ion, bound in organic compound) in which the element is present. Trace elements can be toxic and some are essential for health of aquatic life. If a report form shows dashes or zero in the appropriate space the element is probably in the water but present at concentrations too low for analytical detection.

The following trace elements are normally present in unpolluted surface waters at concentrations of less than one mg/liter: aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, and zinc. Except for aluminum, arsenic, barium, and iron, the elements of the previous list should be considered potentially harmful when present in concentrations above 0.1 mg/l.

Dissolved gases should be given consideration in determining the basic suitability of water for fish survival. Dissolved gases include oxygen, carbon dioxide, nitrogen, ammonia, hydrogen sulfide, chlorine and methane. Dissolved gases are usually not found on water analysis report forms because the manner by which samples are collected and shipped can cause gas measurements to be much unlike the actual on-site water condition. Ammonia is the most stable of the group and if a sample is processed within a day after collection it should measure fairly accurate. Other measures are best taken at the water site using appropriate meters or chemical test procedures. Dissolved oxygen gas is especially important because of vital need of the fish life and the facts that it can vary greatly in natural surface water and is characteristically absent in ground waters. Most aquatic animals need more than a 1 mg/I concentration for survival and, depending on culture circumstances more than 3 to 5 mg/I to avoid stress. Concentrations considered typical for surface water are influenced by temperature but usually exceed 7 to 8 mg/l.

Carbon dioxide is present in surface water at less than 5 mg/1 concentrations but may exceed 60 mg/I in many well waters and 10 mg/I where fish are maintained in large numbers. Some aquatic animals, including fish, can endure stress and survive at up to 60 mg/l but where oxygen is lowered into its stress-causing range this carbon dioxide limitation is reduced to 20 mg/l.

Hydrogen sulfide is present in some well waters but is so easily oxidizable that exposure to oxygen readily converts it to harmless form. Its toxicity depends on temperature, pH, and dissolved oxygen. Any measurable amount after providing reasonable aeration could be considered to have potential to harm fishes life.

Ammonia is present in slight amounts in some well and pond waters. As fishes become more intensively cultured or confined, ammonia can reach harmful levels. Any amount is considered undesirable but stress and some death loss occurs at more than 2 mg/l and at more than 7 mg/I fish loss can be expected to increase sharply.

Chlorine is rarely not listed on report forms but is usually present at approximately 1 mg/liter in municipal water supplies as a result of chlorination. Fish will succumb quite easily at these levels and in some cases ponds have been filled with chlorinated water causing a fish loss.

Nitrogen and methane are normally not considered to play a critical role. Nitrogen could be considered an exception when it contributes to an abnormal total dissolved gas concentration. Total gasses may be driven high in waters that are plunged deeply at dam outfalls or experience pump cavitation. As total gas concentrations exceed 115% of normal amount, fish are affected by bubble formation in the blood.

Total gases is a measure sometimes used in aquatic analyses but is not often seen in laboratory reports.

Organic Material and its Breakdown Products

In water, organic material consists of living organisms and various dissolved organic chemicals of their excretion and dead matter and with its associated decomposition products. Additional organic material can be contributed intentionally or by accident by the activities of man. Organic chemicals or tissues consist mostly of the elements carbon, oxygen, hydrogen, nitrogen and sulfur. It is constantly subject to decomposition into its ultimate breakdown products of carbon dioxide, sulfide, ammonia, nitrate, hydrogen ion, and water. Carbon is always a component of organic chemicals. In the analysis or organics, the characteristics of decomposition potential and carbon presence have become useful to measurement. Measurement of organics can give the pond owner an idea of overall enrichment and because decomposition requires oxygen, a general idea of what will be demanded of a pond's oxygen content.

Some organic materials such as pesticides will act as toxins to fish at very low levels. For low level detection of these specific organic constituents sophisticated instrumentation techniques such as chromatography are used.

Total Organic Carbon

This test is commonly reported on laboratory forms and is given in mg/l. Natural surface water would be expected to contain 10 mg/l and water that receives regular feeding could build up to over 30 mg/liter. Water with decomposing plant life could also be expected to have high organic carbon. The measure of total organic carbon includes dissolved organic carbon and suspended material which is commonly called particulate organic carbon. The former can be derived if the water sample is passed through a fine filter.

COD

Chemical oxygen demand is a speedy and reliable estimate of organic load that is reported in mg/liter. A
normal measure would read less than 10. A measure of 60 would be considered rich.

BOD

Biochemical oxygen demand is a standard test for organic material. It is reported in mg/I per hour or per total test time. On a per hour basis 0.5 would be considered rich and 0.05 lead in SOD. BOD is usually measured over a 5 day test period.

Chlorophyll a

The measure of this photosynthetic pigment gives an estimation of plant life suspended in the water column. Unfertile ponds range up to 20 micrograms/I and fertile ponds with rich phytoplankton blooms range 20 to 150 micrograms/I.

Oil and Grease

This test is used for cases of pollution and is selective since most oils and grease float at the surface. Aquatic animals suffer at rates above 0.1 mg/I where the oily products are not those of the natural release of plants or other living agents of the pond. Roughly, sudden die-off of fishes would be expected to occur when such concentrations exceed 100 mg/l. An "oil slick" is usually apparent in cases of pollution but a sudden die off of an algae population will cause a slick from oil material of the plants.

Phenol

Phenol causes flavor problems to fishes in polluted waters but has not been attributed a major role in fish loss in pond waters. Its presence on forms is related to its requirements in meeting water criteria of regulatory agencies and help as an indicator of pollution. Levels in normal water would be less than 1 mg/liter.

Cyanide

Cyanide will kill fish at less than 1 mg/liter. Although present to some extent in all living systems fish loss is considered to happen only in cases of special pollution.

Nitrite

Nitrite is one of the basic breakdown products of organic matter decomposition and acts as an intermediate stage in the conversion of ammonia to nitrate. It is changed quickly to nitrate if oxygen is present. In culture events sometimes results in a temporary accumulation of this chemical in harmful amounts. Nitrite measurements of more than 1 mg/I should be suspect in causing deaths to fish life.

Pesticides

Unlike heavy metals, pesticides are not a natural part of the environment and their presence is determined by past activities of man. A knowledge of the historical application of pesticides in the watershed will give a clue to which chemicals should be tested for. Test laboratories offer "scans" of pesticides known to retain their integrity months and years after application. Contemporary pesticides have been developed on the basis of short residual characteristics and many quickly disappear from detection soon after application.

Insecticides are more toxic to crustacea than fish because of their closer kinship to insects. In following pesticide groups are present: organochlorides (i.e. DDT, toxaphene) 0.01-0.5 mg/l; organophosphates (i.e. methyl parathion, malathion) 1-10 mg/I; carbamates (i.e. carbaryl, methomyl) 0.1-10 mg/I; pyrethroids (i.e. permethrin) 0.1-10 mg/l; fungicides (i.e. benomyl, captan) 0.05-5 mg/l;

herbicides (aquatic and errestrial toxicity varies greatly) 0.05-500 mg/L.

Flesh Analysis

Fish flesh is often taken in large-scale fish kills to analyze for possible toxicants. Pesticides and heavy metals are the most common items investigated. Some metals will normally be found in much greater concentration in the flesh than the water is which that fish swims. Some pesticides characteristically also accumulate in quantities much greater than are present in the water. Without baseline information on the fish in question, it is difficult to assess the importance of pesticide or metal presence except to establish the fact that such chemical constituents are present.

SEDIMENTS

Sediments or muds from pond bottoms are usually checked for heavy metals and pesticides. Measurements of heavy metals in sediments are typically much higher than those measured in the water column. Usual measures of lake sediments in mg/I are cadmium 0.1-1.5; cobalt 4-40., chromium 50-250, copper 20-90, lead 10-100, lithium 15-200, manganese 100-1800., mercury 0.1-1.5; nickel 30-250., zinc 50-250 and iron 11,000-70,000 (Forsiner. U. and G. Wittmann, 1979, Metal Pollution in the Aquatic Environment, Springer-Verlag, Berlin, 486pp.)

Sediment pesticides are often checked when establishing a particular site as suitable for fish culture. The very persistent pesticides are the object of such checks and organochlorines are usually tested as "scans". In Texas toxaphene is the most common residual detected in quantities that would be considered a threat to fish life. Sediments are also checked for pesticides when they are suspect in a catastrophe situation. It is essential. However, that the testing laboratory be advised as to which particular type of pesticide has been used. Otherwise many useless tests may be conducted which result in a very high expense to the pond owner.

CIRCUMSTANCES AND USEFUL ANALYSES

Analyses listed on most laboratory forms are determined by the frequency that they are conducted and requirements established for water by regulatory agencies. Pond owners are often not normal users of testing laboratories and laboratory forms show many tests that are not basically essential. Some essential tests such as the dissolved oxygen test which provides critical information in most any fish kill may not be listed. Gases and pH will likely change from time of sampling and laboratory analysis. These measurements should be conducted at the pond or water supply site. In the cases of fish kills, fish examination at a disease diagnostic laboratory may also be essential. Suggestions are listed below for water circumstances at the sampling site (italics), and by a testing laboratory:

-Well water suitability for use in fish culture carbon dioxide, total dissolved solids major ionic constituents, iron, ammonia, sulfide, total hardness alkalinity, pH

- Surface water suitability dissolved oxygen, pH, total dissolved solids, major ionic constituents, total hardness, alkalinity, sediment analysis for metals and pesticides (only in areas where pesticides have special historical use)
- Release from drilling rig waste pit total dissolved solids, pH, metals, oxygen, alkalinity, major ionic constituents, oil and grease
- Contaminant wash in test for contaminant, oxygen and pH
- Malicious action conduct personal investigation to determine added contaminant and advise laboratory for specific test.
- Sudden fish kill with no good idea of cause Oxygen, p-Hm total dissolved solids, major dissolved ionic components, total alkalinity, total hardness, heavy metals, carbon dioxide, hydrogen sulfide, chlorine (if city water), ammonia, nitrite, total organic carbon or COD, pesticides only if known to be historically related to pond.

WHO CONDUCTS TESTING?

A number of state agencies conduct testing on water for various regulatory purposes. Such agencies are normally contacted by the public in cases where violation is thought to have occurred. The testing is usually contracted to private laboratories and costs are passed on to the agency's clientele. A number of private water testing firms are open to service pond owners.

Testing is available from private consulting biologists and engineers and associated firms.

Universities often have laboratories which are set up to conduct water analysis and may be available for an occasional test that would support research interest. The Texas Agricultural Extension Service operates a soil and irrigation water testing laboratory for Texas residents on a fee basis.

REPRINTED FROM THE PROCEEDINGS OF THE
1985 TEXAS FISH FARMING CONFERENCE
HELD AT COLLEGE STATION, TEXAS
JANUARY 23-24, 1985