

The Book on Water Clarity

Reliable, Safe and Effective
Water Treatment Solutions

by Terry Arko, SeaKlear Product Specialist



SeaKlear[®]

Reliable. Safe. Effective.

The Book on Water Clarity

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**Reliable, Safe, and Effective
Water Treatment Solutions**

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This book is dedicated to Barry H. Hall, my first boss in the pool business. He told me in 1979, "If you work hard and stick to it, you can make a good living in the pool business." Also, thanks to Chuck Pettis, who had the vision of consolidating years of class notes and articles into a useful resource for our dealers and pool pros. Thank you to Aimee Samuelson for editing help (which was desperately needed). And finally, my thanks to Vanson HaloSource for giving me the opportunity to do what I really love: Help others to shine—or maybe I should say sparkle!

Preface

Every pool owner wants his or her pool to look clean and clear. At the same time, most pool owners are afraid of water chemistry and don't know how to take care of their pool. That's why they rely on their pool dealer and service pro.

This book helps you, the pool professional, understand the causes of and cures for cloudiness in swimming pool water and navigate the most effective and reliable solutions for keeping pools clear and clean. Every customer who contacts your business with a water chemistry problem can benefit from the information in this book. You will be the hero to your customers when you give them the ability to easily keep their pool clear and clean.

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Chapter 1

An Overview of Water Clarity

Water clarity in a swimming pool is something that is taken for granted. Your customers don't spend much time thinking about clear water, until the pool becomes cloudy. That's when they come to your store or call you, demanding an immediate solution to the problem of their cloudy pool. When you're facing this situation, knowledge of the causes of water cloudiness along with a good grasp of the effects and proper standards can help you offer your customers real solutions.

CAUSES OF CLOUDINESS

Cloudy pool water is caused by the presence of suspended particulate matter. *Suspended particulate matter* is a fancy way of saying:

- Contamination from swimmers
- Dirt
- Silt
- Organic matter
- Algae
- Suntan oils and lotions
- Bacteria and protozoa
- Minerals and metals

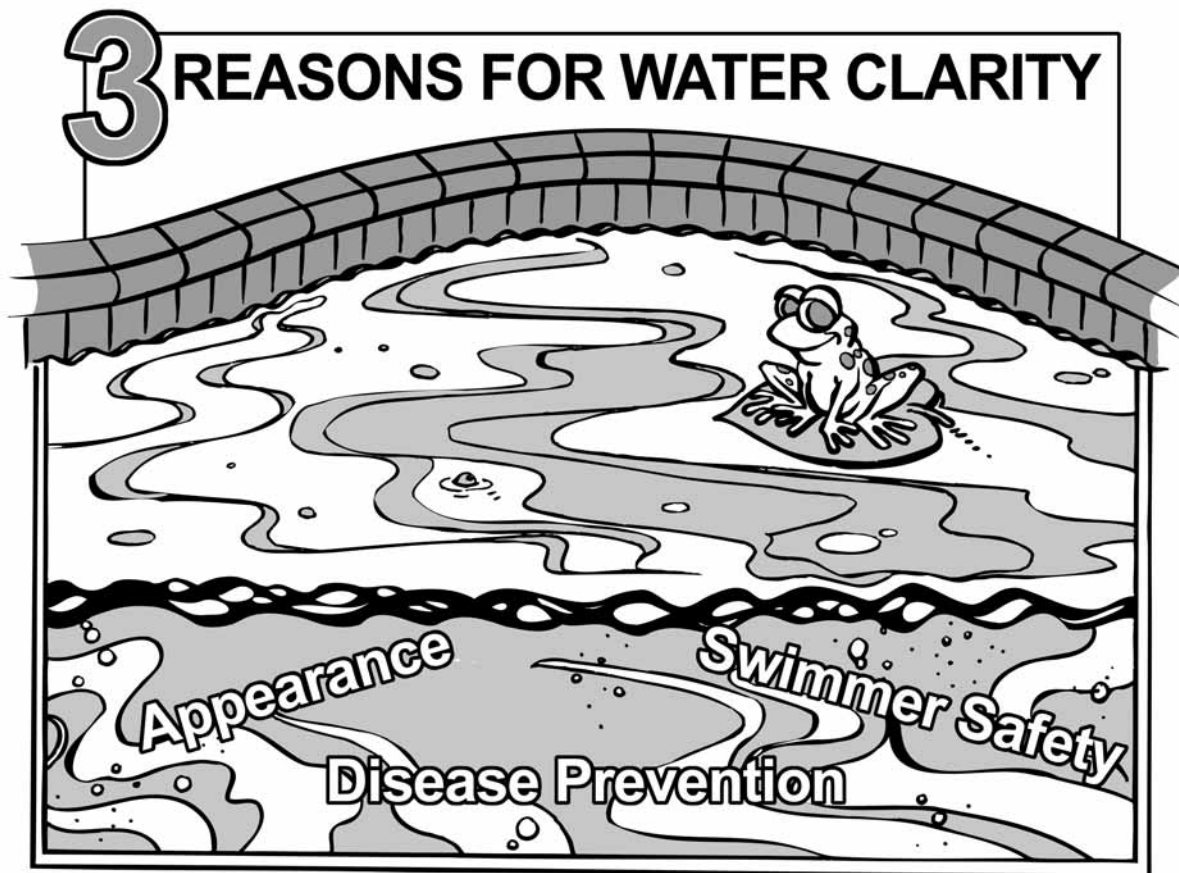
Two other common causes of pool water cloudiness are improper filtration and the lack of a sanitizer such as chlorine. In the chapters ahead, we will look at all of these causes in more detail and offer practical solutions.

IMPORTANCE OF WATER CLARITY

Water clarification is defined as the removal of suspended particulate matter from swimming pool water. Water clarity in pools and spas is important for three reasons: appearance, disease prevention, and swimmer safety.

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1. **Appearance.** Unsightly, cloudy, or discolored water makes swimming undesirable. The majority of swimmers want to swim in sparkling and transparent water.
2. **Disease prevention.** Cloudy water can harbor bacteria and viruses, which can cause earaches, pinkeye, and flu-like symptoms. Two common bacteria—E.coli and Giardia—can cause diarrhea and even death. Also, dangerous, life-threatening, chlorine-resistant protozoa such as Cryptosporidium can lurk in cloudy water.
3. **Swimmer safety.** Accidents can occur when swimmers entering the pool can't see people already swimming under the cloudy water. If someone is in trouble under water and he or she can't be seen because of water cloudiness, the risk of drowning increases.



In June 2002, a seven-year-old child drowned during a pool party, where more than 30 people were present. The pool was so cloudy that no one could see the boy drowning in the deep end. The boy's parents called the police, and they spent two days looking for him. Finally, a detective thought to look in the pool, and the boy's body was found on the pool floor (*Los Angeles Times*, June 6, 2002).

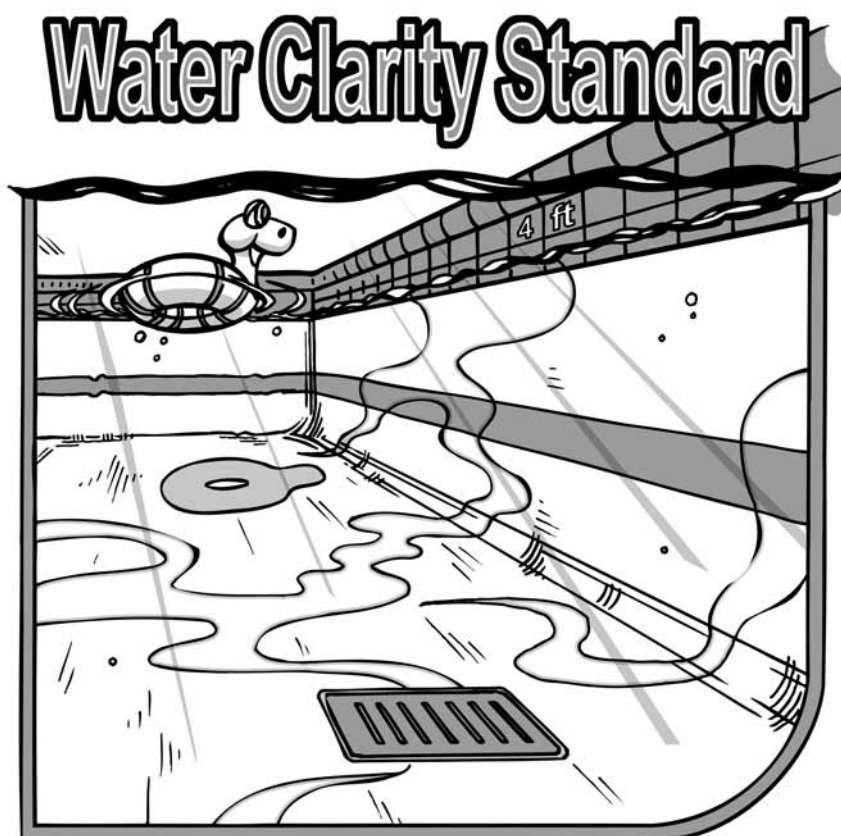
A number of incidents similar to this one have been reported recently. All were attributed to cloudy water and the inability to see clearly in the pool. For safety's sake, swimmers must be visible from the pool deck at all times.

An Overview of Water Clarity

Pool Pro Tip

Turbidity

Turbidity is the technical term for cloudy swimming pool water. According to the *Certified Pool-Spa Operator Handbook* (National Swimming Pool Foundation 2005), turbidity is defined as “a measurement of the cloudiness or haziness of an otherwise clear liquid due to the presence of small liquid or solid particles in the liquid. Turbidity is measured in nephelometric turbidity units (NTUs).” When a swimming pool is referred to as having too much turbidity, it simply means that the water is cloudy.



Most state health departments require that the main drain be visible from the pool deck at all times.

STANDARDS FOR WATER CLARITY

Most state health departments require that the main drain be visible from the pool deck at all times.

Formal standards for water clarity in public pools are based on drinking water standards determined by the National Sanitation Foundation (NSF). The NSF standard for water clarity is 0.5 nephelometric turbidity units (NTUs). At times of peak bather loads, the turbidity is allowed to

Chapter 1

increase to 1.0 NTU, but it must return to 0.5 NTUs within six hours following peak use (National Swimming Pool Foundation 2005).

NTU is measured by the use of a device called a *nephelometer*. This device measures particles by refracted light waves. The test is primarily done in a laboratory, although there are NTU measurement devices installed on many commercial pool systems.

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Causes of Cloudy Water and Their Solutions

The following sections detail some of the causes of cloudiness in swimming pool water. Also included are solutions to each cause that can restore superior water clarity.

CHLORAMINES

To disinfect the pool, most owners use chlorine. Sometimes, however, chlorine can combine with ammonia and nitrogen-based organics primarily from swimmer waste and form chloramines, which can impede water clarity.

Swimmers unknowingly deposit nitrogen in pools. Ammonia in swimming pools is a by-product of human perspiration and urine. High levels of chloramines in pool water can lead to poor disinfection, irritation of swimmers' eyes and skin, and cloudy water.

Combined available chlorine (CAC) is equal to the level of chloramines in the water. *Free available chlorine (FAC)* is chlorine that is not combined. When the CAC is higher than the level of FAC, the pool water will become cloudy and unsafe for swimming. Free available chlorine is the effective killer of bacteria that we rely on to disinfect pools. To maintain clear, safe, and clean water, the free

DETERMINING THE LEVEL OF CHLORAMINES OR CAC

1. Using a DPD* chlorine test kit (this kit tests both free and total chlorine), first test to measure the amount of free available chlorine (FAC).
2. Use the DPD chlorine test to measure the total available chlorine (TAC) in the pool.
3. Subtract the FAC reading from the TAC to get the combined available chlorine (CAC) level.

$$\text{TAC} - \text{FAC} = \text{CAC}$$

*diethyl-p-phenylene diamine

Source: Griffiths 1994

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available chlorine must be maintained between 2.0 and 4.0 ppm (parts per million) in swimming pools and between 3.0 and 5.0 ppm in spas and hot tubs.

Interestingly, chloramines are considered to be effective sanitizers and are used for purifying drinking water. However, for swimming pool and spa purposes, chloramines are not effective because they are slow acting and create problems for swimmers, such as odors, eye and skin irritation, and cloudy water.

Solution: There are two ways to reduce chloramines in a pool:

1. Use large amounts of chlorine, also known as *superchlorinating*. The formula for superchlorinating is to raise the parts per million level of chloramines by a factor of ten.
Example: If the CAC is 2.0 ppm, raise the FAC level to 20 ppm.
2. Use a chlorine-free shock such as SeaKlear Chlorine-Free Shock at a rate of 1 pound per 10,000 gallons. This will be discussed in more detail in Chapter 3, in the “Oxidizers” section.

Pool Pro Tip

Chlorine Odor

Heavy chlorine odor is a sign that chloramines are present. This occurs when there is an increased number of swimmers in the pool, which causes free available chlorine (FAC) to become bound to the excess nitrogen waste. Chloramines are commonly referred to as combined available chlorine (CAC). This simply means chlorine that has combined with the by-product ammonia from perspiration, urine, and other organic waste in the water.

In addition to chloramines, there are many other factors that contribute to cloudy water.

AIR POLLUTION

Cause: Water acts as a natural filter against whatever is in the air: car exhaust, dust, chemicals, bacteria, etc. When air passes through water, the water “traps” and filters any pollutants the air contains. A typical air blower on a spa will pump 50 cubic feet of air every minute into the water. That air can then contaminate the spa, leading to cloudy, brown, or gray-colored water. The same problem can occur in pools with fountains or airing devices.

Solution: Shock the pool at least weekly with SeaKlear Chlorine-Free Shock using 1 pound per 10,000 gallons. Use SeaKlear Natural Clarifier at a rate of 2 ounces per 10,000 gallons to gather fine dust and smog particles for quick removal by the filter.

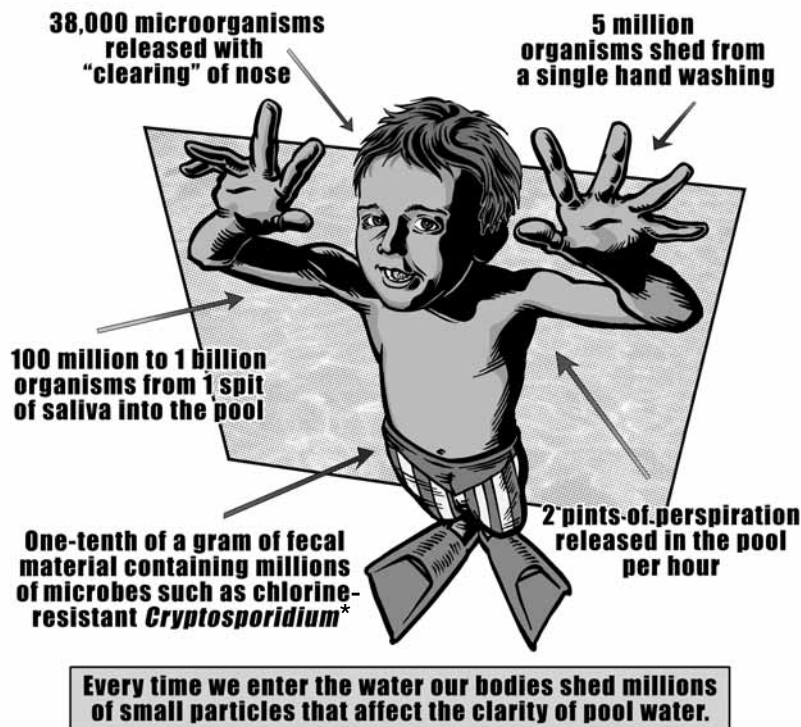
ENVIRONMENT

Cause: Nearby plants, trees, weeds, leaves, grass clippings, and fertilizers all contaminate pools and threaten the quality of pool or spa water.

Solution: Remove larger debris as quickly as possible using a net or pool vacuum. For pollen, dust, or fine debris use SeaKlear Natural Clarifier at a rate of 2 ounces per 10,000 gallons to help the filter remove particles quickly.

Causes of Cloudy Water and Their Solutions

How Swimmers Affect Water Clarity



* Dr. Charles Gerba, University of Arizona
(Washington State Public Health Association 1987)

HUMANS

Cause: We carry on our bodies bacteria and other materials that can contaminate water. Every time we enter the water, our bodies shed millions of small particles that affect the clarity of pool water. One person can sweat 2 pints of perspiration into a pool in one hour (Washington State Public Health Association 1987). Deodorants, hair spray, and perfumes can also compromise water quality and cause cloudy water.

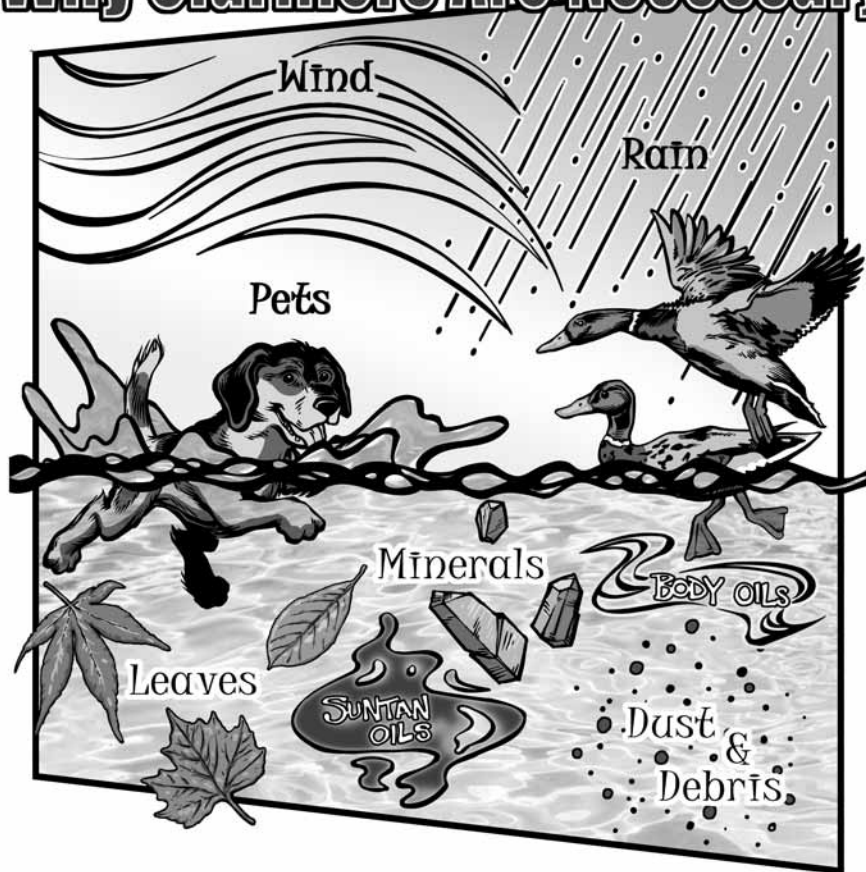
Solution: Maintain chlorine residual in pools at 2.0 ppm to 4.0 ppm and 3.0 ppm to 5.0 ppm in hot tubs or spas. Shock with SeaKlear Chlorine-Free Shock or superchlorinate with chlorine after heavy use such as a pool party. For maintenance use SeaKlear Natural Clarifier weekly. For consistent, superior waste particle removal use the SeaKlear Particle Removal System.

Pool Pro Tip

Avoid Organic Buildup

To prevent an excess of organic waste and oils that can lead to the formation of chloramines, it is important to shock the pool with SeaKlear Chlorine-Free Shock and use SeaKlear Natural Clarifier weekly to remove as much waste through the filter as possible.

Why Clarifiers Are Necessary



INSECTS AND ANIMALS

Cause: One dog in a pool is equal to the contamination of 50 people (Lowry 2003). Other culprits include ducks, frogs, birds, rats, and even bears! Ants, flying insects, and sow bugs all have an effect on the sanitizer residual of pool water.

Solution: Shock the pool weekly using SeaKlear Chlorine-Free Shock at a rate of 1 pound per 10,000 gallons. Use SeaKlear Natural Clarifier at a rate of 2 ounces per 10,000 gallons weekly or as needed. Immediately remove large debris, bugs, etc., by using a pool net. At least once a week, clean any debris out of the skimmer and pump baskets. When possible, install and maintain secure fencing around the pool area to keep Fido and other unwanted guests out of the pool.

OILS

Cause: One of the main sources of contamination of pool water is oil. Oil contamination comes primarily from the natural body oils of humans, as well as from the residue of sunscreen, tanning oils, lotions, and hair gels. As we all know, oil and water don't mix. An excess of oil can clog filters, create scum lines, and cause poor-quality, cloudy water.

Causes of Cloudy Water and Their Solutions

Solution: Use SeaKlear Natural Clarifier weekly at a rate of 2 ounces per 10,000 gallons to keep oils encapsulated and removed to the filter. The patented solution works to keep oil from accumulating in pool water and prevents waterline buildup of scum and clogged filter material. Commercial pools can have superior oil removal and prevent scum lines, oil clogging of filters, and fouling of oxidation-reduction potential (ORP) probes by using the SeaKlear Particle Removal System. For more information, see Chapter 5, “Water Clarity in Commercial and Public Pools.”

UNDISSOLVED SOLIDS

Cause: Small particles of dirt, dust, pollen, or floating algae.

Solution: All of these can be removed reliably and effectively by weekly use of SeaKlear Natural Clarifier at a rate of 2 ounces per 10,000 gallons.

WEATHER

Cause: Rain can drain dirt, smog, and silt into the pool. Acid rain can wreak havoc on the water balance and cause metal ions to precipitate. Windstorms can blow in materials that cause contamination. Evaporation, caused by the sun, results in a buildup of dissolved solids in pool water, causing cloudiness. The evaporation rate of a swimming pool in Southern California is approximately 8 to 10 feet per year (Service Industry News 1991c). When water evaporates, only pure water leaves in the form of a vapor. All contamination is left in the pool, making it cloudy.

Solution: When mud and silt are present, use the SeaKlear Particle Removal System. Or use SeaKlear Natural Clarifier at double or triple dosages. Use SeaKlear Natural Clarifier weekly to help reduce mineral and metal buildup in pool water.

METALS AND MINERALS

In many areas of the United States and around the world, groundwater contains dissolved metals or minerals. Iron, copper, and manganese are the most prevalent metals found in municipal and well

Pool Pro Tip

A Note on the Importance of Clarifiers

In addition to a good sanitizer program, clarifiers should be used to help remove all pool water contaminants. However, most clarifiers in the pool market are petroleum based; that is, they use an oil-based product to remove small organic materials in the water. When oil-based clarifiers combine with dirt, they form oily, sticky goo that clogs filters and creates unsightly scum on the waterline. This makes the pool pro's job harder as it leads to more scrubbing of the waterline and means more work on the filter.

To make the pro's job easier, a natural, non-oil-based clarifier, such as SeaKlear Natural Clarifier, should be used to effectively remove oils and other contaminants in the pool. SeaKlear Natural Clarifier utilizes a patented process that has been proven effective and reliable at removing oils and organic contaminants, without clogging filters or leaving behind scum.

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water. The minerals calcium and magnesium can cause “hard water” in swimming pools. Hard water is discussed in detail later in this chapter.

The symptoms of high metal and mineral content include:

- Cloudy water
- Discolored water
- Stains on surfaces
- Scale formation
- Increased use of sanitizer

Lowering Metal Levels

- **Metal sequestering.** When levels of metals or minerals are high, colored water and surface staining may occur. In most cases, metal-trapping or *metal-sequestering* chemicals are used to deal with high metal or mineral content in swimming pool water. Metal-sequestering products surround the dissolved metals and trap them so that they cannot stain the pool surface. Think of it like a sequestered jury: Nothing gets in or out.
- **Flocculation.** Two problems with metal-sequestering products are that they do not remove dissolved metals from the water and they can wear out, causing metal stains in the pool. A better way to deal with metals in pool water is to actually “grab” them by means of *flocculation* (a scientific technique that brings the metals all together into “fluffy masses”) and remove them from the pool through the filter. This way, the dissolved metals are completely removed from the pool with no chance of causing stains. SeaKlear Natural Clarifier is effective at floccing and removing metals to the pool filter, where they can be backwashed out of the system.

Green Water

Don’t mistake clear green water for algae. In most cases, when water takes on a greenish appearance but the pool is not cloudy and pool surfaces don’t feel slimy, copper could be the culprit. The level of copper in a pool should not be higher than 0.2 ppm. The high levels of copper present in corrosive or improperly balanced water can cause copper to drop out of solution, staining pool surfaces and turning pool water a clear green color. When water takes on a green or brownish color, it is most likely due to the presence of copper or iron that is dropping out as a solid.

That is why metal-sequestering products are used. Metal-sequestering products do not remove metals from the water; they just surround the ions to hold them in solution.

Copper can be naturally present in fill lines, heater exchangers, and other plumbing. That is why Tri-chlor tablets—which are an acid-based form of chlorine—should never be placed directly into a pool skimmer. The low pH of Tri-chlor tablets (pH 3.0) can cause copper in the heater or in piping to be stripped, resulting in staining and colored water.

It is also important to note that the copper in algacides such as SeaKlear Algae Prevention & Remover is a chelated form. This means that the copper has been combined to a binder that holds onto the copper and prevents it from dropping out of solution.

Causes of Cloudy Water and Their Solutions

A better way to deal with metals and colored water is to remove the cause entirely by a process of coagulating and floccing the metals to the filter, where they can be backwashed out of the system. This can be done by using SeaKlear Natural Clarifier at a rate of 1 gallon to 20,000 gallons of pool water. This formula will effectively remove 1 ppm of metal from water.



Yikes—Green Hair!

Green hair typically happens to swimmers with lighter hair colors. A common misconception is that green hair is caused by too much chlorine in the pool. This is wrong!

Diagnosis: Green hair is caused by excess copper ions in the pool, indicating the pool chemistry is not properly balanced. A low pH in pool water will cause copper to precipitate and drop out of the water. This precipitated copper ends up in hair, under fingernails, and on light-colored swimsuits, giving them a greenish cast.

Pool Pro Tip

Correct the pH

To solve the green-hair problem, correct the pH and use SeaKlear Natural Clarifier to remove the precipitated copper through the pool's filter.

One gallon of SeaKlear Natural Clarifier removes 1 ppm of metal from 20,000 gallons of pool water.

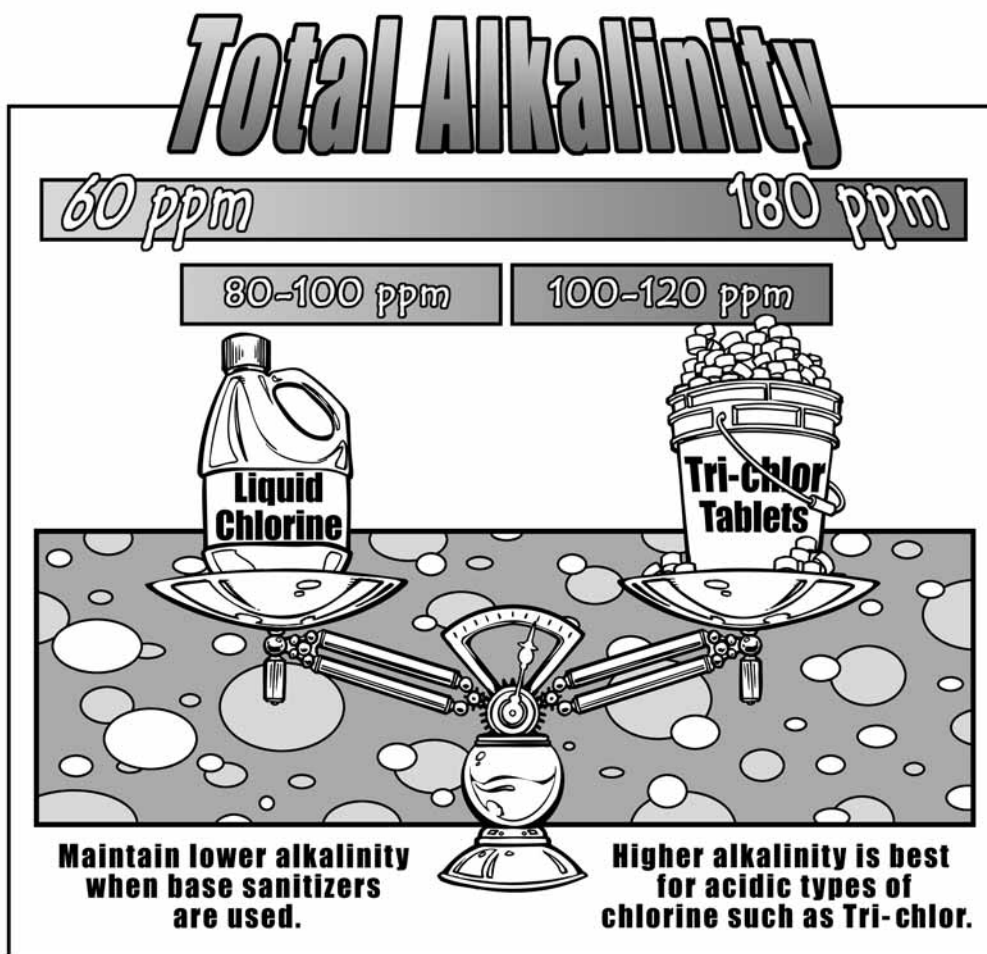
Chapter 2

WATER CHEMISTRY BALANCE

Total Alkalinity

Balanced water is vital to the quality of a pool or spa and the comfort of the swimmers. Total alkalinity is one of the most important adjustments to be made in water chemistry to clarify pools. If water is not balanced properly, cloudy or discolored water can result.

Water balance can be confusing because many owners don't understand the difference between total alkalinity and pH. Some people think that total alkalinity and pH are the same. Total alkalinity and pH are related, but they are not the same. Explain the relationship to owners by comparing it to a family structure: Total alkalinity is the father, and pH is the son. They are related, but not the same.



Total alkalinity is “the buffering capacity of water” (Service Industry News 1991c). It helps keep pH in line by giving pool and spa water the ability to resist pH changes from the addition of acids. In the analogy of total alkalinity and pH as father and son, the job of the father is to keep his son from wandering off where he doesn't belong.

Causes of Cloudy Water and Their Solutions

Total Alkalinity Standards

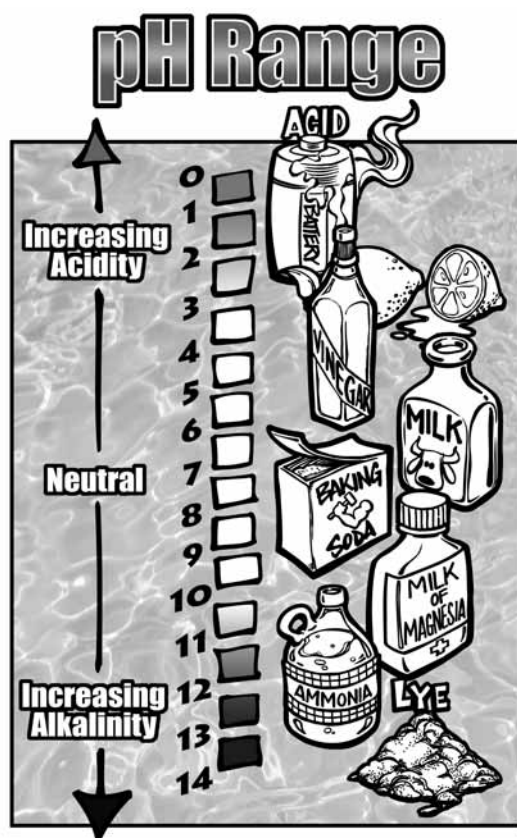
The National Swimming Pool Foundation's suggested standard for total alkalinity is 60–180 ppm (2005). This level may vary depending on the type of chlorine being used. For example, if the main source of chlorine being used in a pool is sodium hypochlorite (liquid), which is alkaline, the total alkalinity should be maintained in the lower range from 80–100 ppm. If acid-based chlorine such as Tri-chlor is being used, the total alkalinity should be maintained in the 100–120 ppm range.

Symptoms of Alkalinity Problems

- **Discolored water.** Low alkalinity induces stain-causing metals to drop out of the pool water as solids, stain pool surfaces, and change the color of the water. Low alkalinity will also cause the pH to be erratic—bouncing high and low.
- **Cloudy water.** High alkalinity can cause calcium carbonate suspension in pool water, making it appear cloudy.

Controlling Alkalinity

- **Low alkalinity.** Raise total alkalinity by using sodium bicarbonate. One and one-half pounds of sodium bicarbonate (baking soda) will raise total alkalinity 10 ppm in 10,000 gallons of pool water. Sodium bicarbonate works best because it raises the alkalinity with little effect on pH.
- **High alkalinity.** Adding an acid such as muriatic acid or sodium bisulfate will lower total alkalinity.



pH

The term pH means *parts of hydrogen*. This is a measurement of the amount of acid or base substances in the water. Bite into a lemon and you will get a feeling for what an acid is. Milk of magnesia, on the other hand, is base. The pH scale measures from 0 to 14, with 7 being the neutral point. On the low end you are measuring the predominance of acidity (hydrogen ions). This would be the lemon. On the high end you are measuring the predominance of base (hydroxyl ions). This would be the milk of magnesia.

It is important to understand that the pH scale is logarithmic. This means that the values on the pH scale differ by a factor of ten. For example, a pH of 6 is ten times more acidic than 7, while a pH of 8 is ten times more base than 7. The values are also exponential, meaning that with each increase or decrease on the scale there is a multiplier of ten times. In

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this case, a pH of 5 would be one hundred times more acidic than 7. Every move on the pH scale is a big leap.

Symptoms of pH Problems

- **Discolored water.** Low pH will discolor water because of corrosion of metal pipes or heater exchanger and pool surfaces.
- **Cloudy water, buildup of scale, increased sanitizer use.** These mean a high pH.

Controlling pH

- **Low pH.** To raise pH in a pool, use sodium carbonate (soda ash), which is a base. In spas, use sodium bicarbonate to raise pH and alkalinity.
- **High pH.** Lower pH in a pool with muriatic (liquid) acid. In spas, use dry sodium bisulfate (acid) to lower pH and alkalinity.

The amount of acid or soda ash needed for pH adjustment should be determined by use of the acid demand test. Use chemicals in accordance with the manufacturer's dosage rates and directions for use.

The acceptable range of pH according to the National Swimming Pool Foundation is a minimum of 7.2 to a maximum of 7.8 (2005).

TOTAL HARDNESS

Total hardness is a measurement of the mineral salts present in the water. Mineral salts include calcium, magnesium, aluminum, iron, and manganese. The main culprit present in hard water is calcium. Some 70 to 75 percent of total hardness is made up of calcium. The ideal level of hardness is 200 to 400 ppm.

Symptoms of Total Hardness Problems

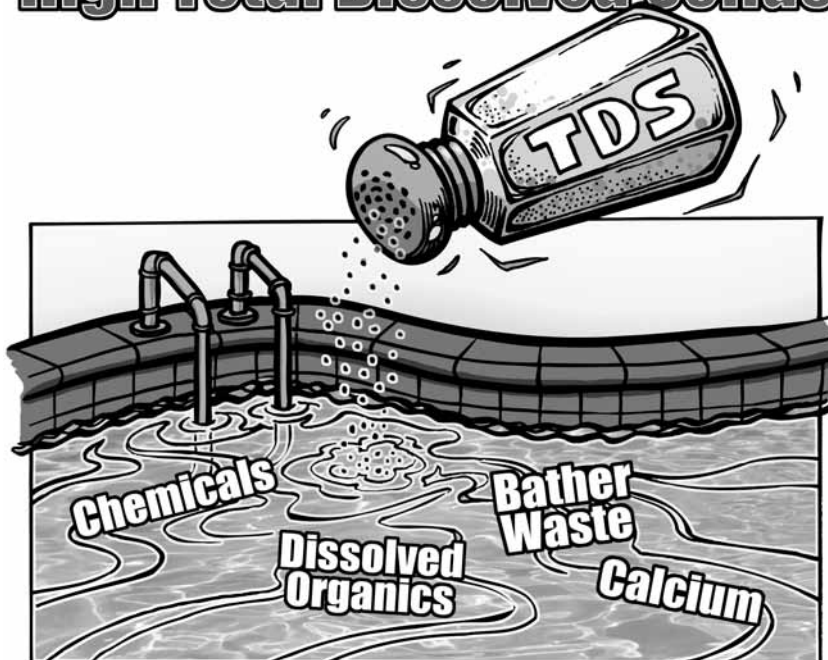
- **Corrosion of pipes or equipment and dissolving pool wall plaster.** These signal a low total hardness.
- **Cloudy water.** This signals high total hardness from suspended calcium carbonate and scale. High total hardness will also cause chlorine to lose its effectiveness as a sanitizer. Lots of calcium in milk is a good thing, but in a swimming pool, lots of calcium can be a bad thing. High calcium will cause other minerals to fall out of solution.

Controlling Total Hardness

- **Low total hardness.** To raise calcium hardness, add calcium chloride according to the manufacturer's instructions.
- **High total hardness.** The most effective way to deal with high hardness in the water is by draining the pool.

Causes of Cloudy Water and Their Solutions

High Total Dissolved Solids



High TDS is one of the primary sources of cloudiness in pools. A TDS test should always be conducted when a customer complains of persistently cloudy water.

HIGH TOTAL DISSOLVED SOLIDS

Total dissolved solids (TDS) is the sum of everything that has ever been added to the pool. This includes calcium carbonates, dissolved organic and inorganic materials, salts from chlorine residue, and swimmer waste. The ideal TDS level is 1,000 to 2,000 ppm. Levels of 1,500 ppm above water supply level can reduce chlorine efficiency by up to 50 percent, which can lead to dangerously cloudy water. High TDS water tastes salty because of its high mineral content (seawater has a TDS of 35,000 ppm).

High TDS water can be dangerous because the sanitizer is not able to oxidize organic matter and algae. Also, chlorine is used up more quickly by all the excess contaminants in the water. When this occurs, cloudy, dull water becomes the norm. This condition can also mean an increase in hazardous bacteria.

Symptoms of High TDS

- Dull, cloudy water
- Increased sanitizer demand
- Salty water

Controlling TDS

Dilution by draining or backwashing is the only way to deal with high TDS.

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Pool Pro Tip

Two Ounces of Prevention

SeaKlear Natural Clarifier is a biodegradable water treatment. Weekly use at a rate of 2 ounces per 10,000 gallons will effectively slow down the buildup of TDS. Regular use also allows for quick removal of accumulated and un-oxidized organic material by the filter.

POOR FILTRATION AND CIRCULATION

Two of the most common causes of cloudy water are the lack of proper filtration and poor water circulation. When one of these conditions is suspected, check for the following:

- **Improper filter sizing.** The filter installed may be too small to handle the volume of water in the swimming pool. Check the square footage of the filter with the flow rate of the pump. Your filter manufacturer can help you determine the proper filter sizing.
- **Improper circulation for the pump size.** Check with the pump manufacturer to make sure you have the proper flow rate for the filter being used with the pump.
- **Inadequate plumbing lines.** Improperly sized lines or clogs may prevent full water flow.
- **Bad filter media.** Dirty, old sand; worn-out cartridges; or D.E. (diatomaceous earth) filters with torn screens won't work properly.
- **Low pool water level.** Water may be below the skimmer and not allowing debris to be properly skimmed from the top.
- **Poor suction.** The main drain may not be doing its job.
- **Dead spots.** These areas of stagnant water form in pools because of incorrect placement or direction of return-circulation water jets.
- **Dirty, oil-clogged filters.** An excessive number of swimmers with sunscreen lotions and cosmetics, soaps from bodies, and detergents from swimsuits may cause this.

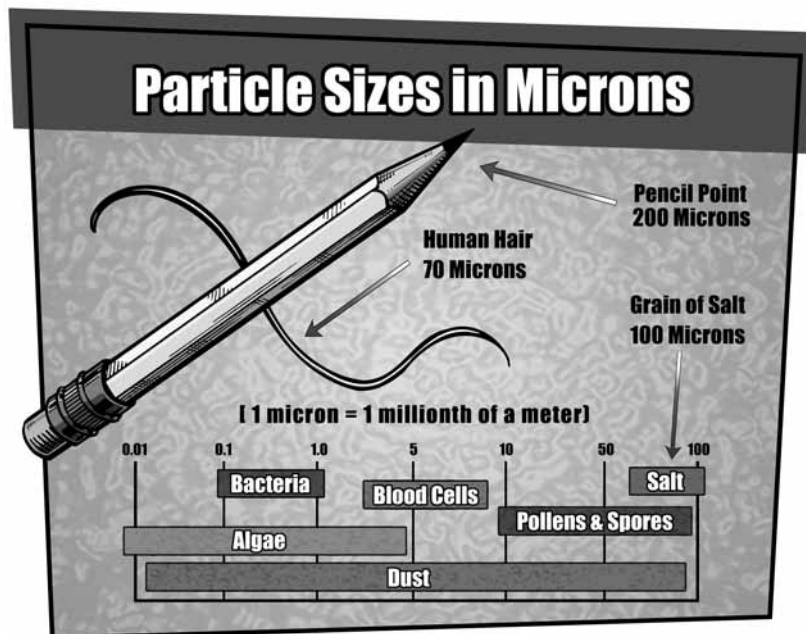
Chapter 3

Water Clarification

Proper filtration and a good chemical treatment system are the keys to clear water in a swimming pool. Without a good filter system, chemicals, clarifiers, and algaecides will not be able to accomplish what they were designed to do. The efficacy of every product created for water clarity is contingent upon the vital role of filtration in the pool. In this chapter, we will look more closely at the role filtration and chemicals play in helping to clear cloudy water.

FILTERS AND CLARITY

Filters clarify water by removing suspended particulate matter from the water. *Particulate matter* includes small dirt particles, skin flakes, algae spores, bacteria, and other debris. Most particulate matter varies in micron size, and when it builds up, the pool water becomes cloudy.



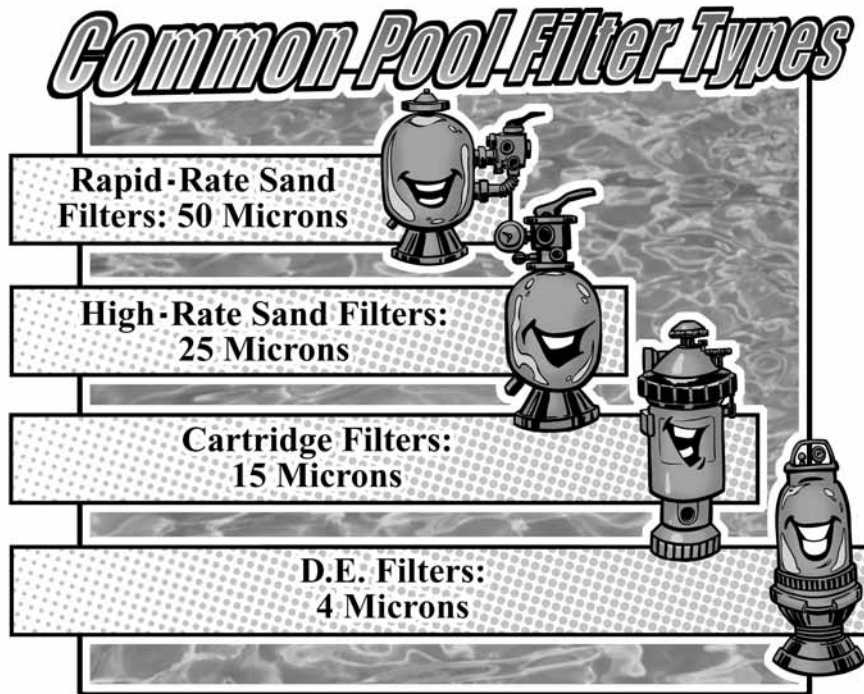
WHAT'S A MICRON?

A micron is one-millionth of a meter.

- A grain of salt = 100 microns
- A human hair = 70 microns
- A red blood cell = 8 microns
- A bacterium = 1 micron

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Different types of filters are designed to remove micron-sized materials. The most common filters and their micron-removal capabilities are shown in the illustration below.



The filter must be in proper working condition to ensure clean and sparkling water. For example, sand filters work by passing the water through a bed of specialized sand media. However, most sand filters remove only matter larger than 25 microns. Any smaller particulate matter cannot be caught by a sand filter. Also, sand can wear out and lose its ability to grab small particles.

Sand, cartridges, and D.E. (diatomaceous earth) filters all lose their effectiveness when oils and organics clog filter media and increase backflow pressure. Increased backflow pressure creates poor circulation in the pool. This will lead to a buildup of small-micron materials in the pool, resulting in cloudy water.

Filter Problems That Can Cause Cloudy Water

Sand Filters

- Debris such as pine needles or leaves in the sand bed
- Uneven dispersion of the sand bed in the filter
- Channeling of the sand media caused by rocks or oily mud balls
- Old, worn-down sand granules that can no longer grab small particles (most sand media should be replaced every three to five years)
- A leak on the suction side of the equipment that allows air to enter the filter tank

Cartridge Filters

- Dirty, oil-clogged cartridge
- Holes or tears in the cartridge material

- Cartridge improperly seated in the filter bottom fitting
- Worn cartridge that needs replacement
- Improper sizing of cartridge filter

D.E. Filters

- Uneven D.E. coverage of the filter screens
- Caking of the D.E. between the filter screens
- A torn filter screen that allows D.E. media to pass into the pool
- Leaks in the equipment system that allow air to enter the filter tank

Filters should be cleaned regularly according to manufacturers' specifications. SeaKlear Filter Cleaner and Degreaser is effective at removing debris and oils.

Pool Pro Tip

Always Check the Filters

When a customer comes in with a cloudy water complaint, remember that the first thing to check is the filter. Chemicals for water clarity will not be effective if there is a filter problem. Water clarifiers especially are contingent upon good filtration. If the water doesn't clear or becomes cloudier after using a clarifier, the problem could be with the filter.

CHEMICALS AND CLARITY

The primary reason to use chemicals in a swimming pool is to achieve superior, safe, and sparkling water. Chemicals play a vital role in maintaining clear and clean water. A variety of chemicals accomplish water clarity in pools, including sanitizers, oxidizers, and clarifiers.

Sanitizers

The first and most basic chemical is chlorine, which is a disinfectant or *sanitizer*. That means that the primary purpose of chlorine in pool water is to seek out and kill small, disease-causing organisms.

Note: Chlorine can also be an oxidizer because it has the ability to destroy nonbacterial organic waste such as algae, skin cells, and various other body wastes. See the next section for more on this.

Other sanitizers, such as bromine or biguanides, also prevent disease and keep water clean. While these basic chemicals are an effective part of water clarity, they each have side effects, and the performance of each is based upon the overall quality of the water. For example, chloramines are a side effect of chlorination that can lead to serious water-quality problems, including cloudy water. (For more information on the effects of chloramines, see Chapter 2.)

Chapter 3

Oxidizers

There is a distinct difference between a *sanitizer* and an *oxidizer*. A sanitizer destroys disease-causing germs in water. Whenever you talk about sanitizing water, you are referring to the removal of bacteria from pool water.

An oxidizer, on the other hand, does not destroy bacteria and is not a sanitizer. Instead an oxidizer uses active oxygen to consume nonbacterial waste and convert it into harmless gases that can be released into the atmosphere. Sanitizers kill germs. Oxidizers are designed to remove nonbacterial contaminants and organics.

Chlorine and bromine are two sanitizers that also act as oxidizers. So they both kill bacteria and remove nonbacterial waste.

Dealing with Large Amounts of Waste

If a pool has a high amount of organic matter or swimmer waste, and chlorine or bromine is added, each chemical becomes quickly consumed as an oxidizer before having the chance to sanitize. What this means is that the sanitizing ability of chlorine or bromine was sacrificed for the oxidizing. When this occurs, the safety of the pool water can be compromised because dangerous bacteria have not been destroyed. The solution here is to shock the pool using SeaKlear Chlorine-Free Shock at a rate of 1 pound per 10,000 gallons. This should be followed by adding SeaKlear Natural Clarifier at a rate of 4 ounces per 20,000 gallons.

WHAT DOES IT MEAN TO SHOCK A POOL?

Shocking a swimming pool doesn't mean throwing a live electrical wire in the pool (or saying something naughty to it)! The term *shock* means the oxidation or burning up of chemical by-products, microscopic dirt, algae, and swimmer waste. One person in a pool releases 2 pints of perspiration per hour into the water (Washington State Public Health Association 1987). Our perspiration is made up largely of nitrogen waste (urea), a major source of water contamination, and is responsible for many pool problems, including cloudy water.

Two Ways to Oxidize Waste in Pools

- **Superchlorination.** In the past, the practice for dealing with high amounts of nonbacterial waste was to add high amounts of chlorine to the water. This is known as superchlorination or hyperchlorination. The theory behind this practice is that it takes seven molecules of chlorine to oxidize effectively one molecule of combined chlorine. A formula for oxidation of waste was created based on the addition of ten times the level of combined chlorine. The old theory was that you could burn up waste materials, such as chloramines, and still have some residual free chlorine left over for sanitizing. This practice is known as *breakpoint chlorination*.
- **Chlorine-free oxidizing.** A better way to oxidize and remove nonbacterial waste and chloramines is to use a chlorine-free oxidizer in addition to a sanitizer. SeaKlear Chlorine-Free Shock is a superior blend of potassium monopersulfate (MPS) and contains 4.75 percent oxygen. It works to destroy waste and even stubborn organic chloramines. Because SeaKlear Chlorine-Free Shock is such an effective oxidizer, it can be used along with chlorine to help keep the pool water both clear and sanitized.

It should be noted that there are several problems with breakpoint chlorination.

- Success is hard to determine. For example, there could be a buildup of so many chloramines that it is difficult to reach the actual breakpoint. This is because chloramines can be forming as soon as the chlorine is added to the pool.
- There could also be a buildup of organic chloramines that are more complicated for chlorine to split apart.
- Dumping high amounts of chlorine into pools is hard on equipment and pool surfaces.
- The pool will have to be closed for an extended period of time to allow the chlorine level to come down.

Pool Pro Tip

Schedule It

A good system of sanitizing and oxidizing helps keep pool water clear, clean, and safe. Regular weekly use of an oxidizer shock such as SeaKlear Chlorine-Free Shock reduces the number of nonbacterial molecules in the water. The chlorine or bromine can then do a better job of killing dangerous bacteria.

Extreme Oxidizing

Ozone, classified as an extreme oxidizer, is a gaseous oxidizer composed of three oxygen molecules. Ozone is dispensed with an ozonator. There are several ozonators available on the market for both spa and swimming pool use. Ozone does not sanitize the water. It is strictly used as an adjunct to chlorine or bromine.

Clarifiers

Clarifiers vs. Alum

Clarifiers work by grabbing small, negatively charged, suspended particles. Once the material is grabbed, the particles become somewhat buoyant and continue to float in the water. Eventually gravity begins to take effect, and the gathered material slowly sinks to the bottom. In a pool with a healthy, working filtration system, the gathered material will be caught up in the filter before it has a chance to sink.

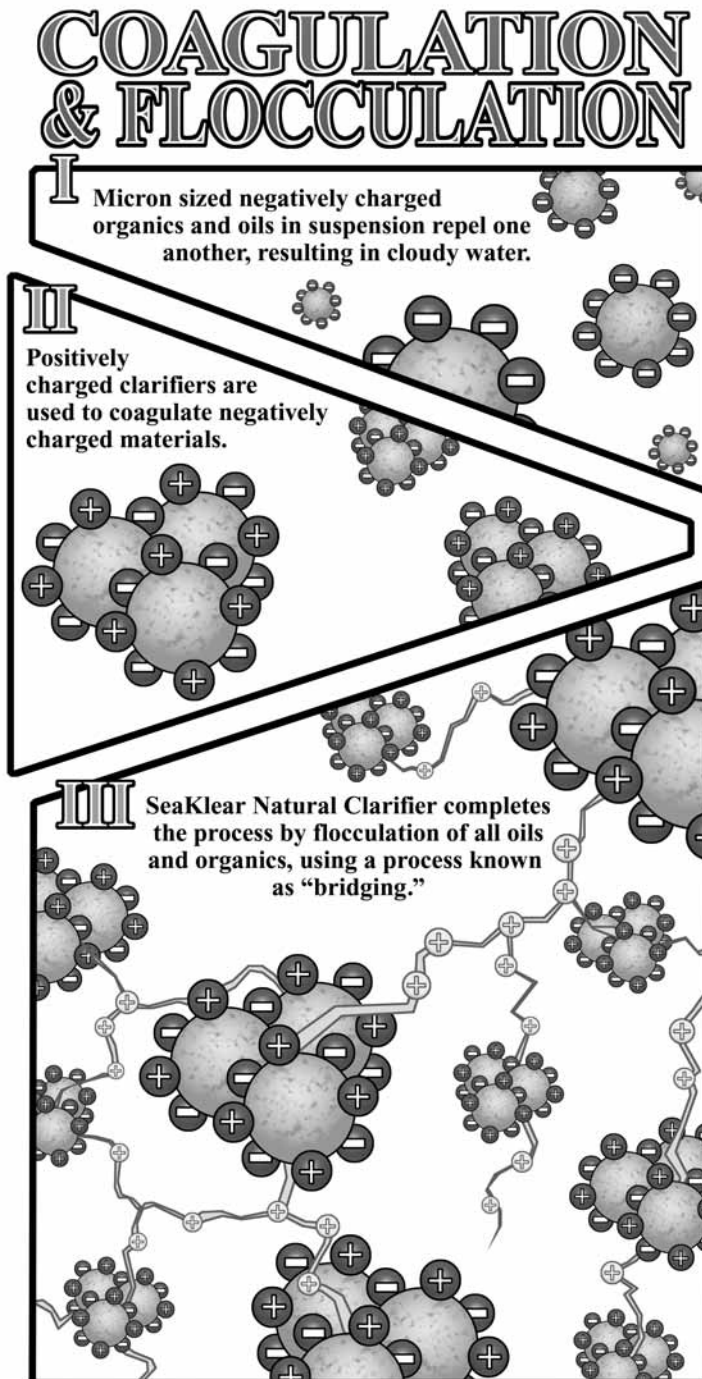
Alum, on the other hand, creates very heavy flocs of suspended particulate matter that drop rapidly to the bottom of the pool, where the matter must then be vacuumed out. Poly-aluminum chlorides are liquid forms of alum used to clear pools. Many of the liquid alums depend on the proper pH balance and will not work if pH is above 7.8. SeaKlear Heavy Flocc is a non-alum-based heavy flocculant that clears water in as little as eight hours by dropping particulate material to the bottom of the pool.

Coagulation vs. Flocculation

Most clarifiers used in swimming pools are coagulants. Be wary of some synthetic clarifiers that claim to be a flocculant when in fact they are not true flocculants, but rather strictly coagulants. SeaKlear Natural Clarifier is the only nonsynthetic, nonpetroleum, all-natural clarifier on the market.

Chapter 3

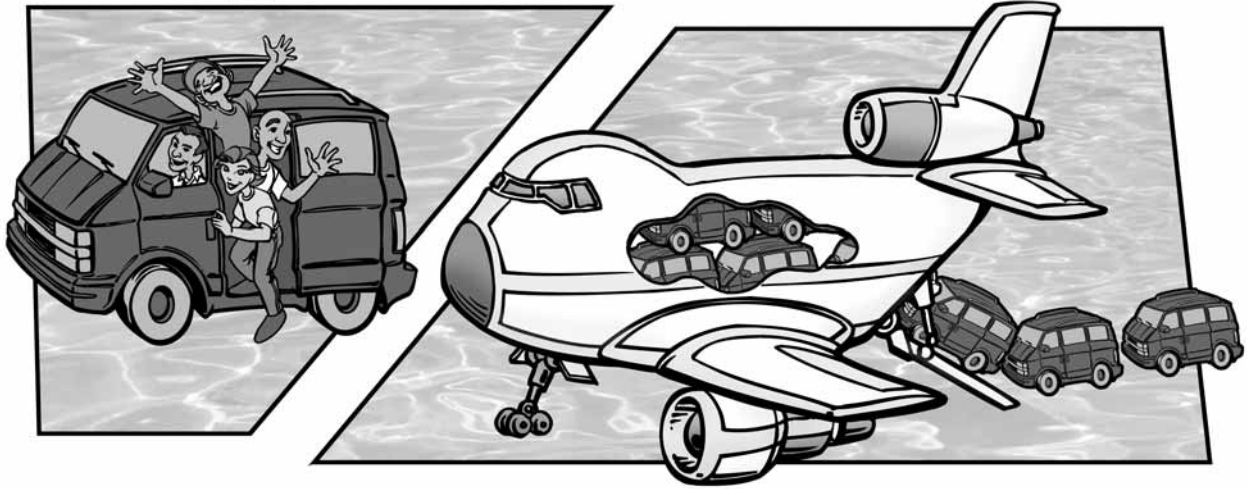
- **Coagulation.** The transformation of small particles into a soft, semisolid, or solid mass. Much of what is coagulated is caught in the filter. However, even some coagulated material can be small enough that it passes through filters (particularly sand filters) and returns into the pool water.
- **Flocculation.** Flocculation takes coagulation a step further by creating larger masses (flocs) through a process known as *bridging*. Bridging binds already coagulated materials into flocs for quicker and better filter removal. The bridged flocs are bigger and thus more easily trapped by filters.



Water Clarification

Coagulation is to flocculation what a minivan is to a military transport plane. The minivan (coagulation) is able to pick up passengers and transport them. The military transport plane (flocculation) is able to pick up several minivans—passengers and all.

Coagulation & Flocculation



Pool Pro Tip

Size Matters

Flocculation is the superior process when it comes to water clarity. Therefore, it is best to choose a clarifier that is a complete flocculant. Ideally, you will want a clarifier that removes the most particulate matter to the filter in the largest form possible. SeaKlear Natural Clarifier both coagulates and flocculates for complete removal of particulate residues and waste, including oils.

Chapter 4

Algae and Phosphates

In this chapter we look at the relation of algae and phosphates to pool water clarity. The proliferation of resistant forms of algae in swimming pools can be linked to the presence of phosphates. Understanding the relationship between algae and the presence of phosphates in the water will help you offer solutions that can get your customer's pool from green to clear quickly.

ALGAE

Algae Explained

When pool water or surfaces turn yellow, green, or black, most likely algae are the cause. Pool owners hate algae in their pool. They are embarrassed to have guests over and confused about how to deal with the problem. The following pages explain what the presence of algae does and how to keep pools clear of algae.

Algae are microscopic forms of plant life that enter the pool by rain, wind, and dust storms. There are numerous varieties and colors of algae. Some are free floating, while others grow on pool walls and surfaces, making those surfaces slimy.

The types of algae found in pools include:

- Green—Free floating or on pool walls
- Yellow (mustard)—Powderlike algae that clings to walls, steps, and corners
- Blue-green (Cyanobacteria)—Mistaken for green algae but are actually bacteria that thrive on phosphates
- Black—Small to quarter-size algae patches embedded into a surface

Green, yellow, or black algae—which are phytoplankton (free-floating microorganisms)—can be present in pool water at various times. Blue-green algae can also be present in pool water. Blue-green algae, however, are actually Cyanobacteria because they are bacteria that thrive especially on phosphates.

Chapter 4

Some algae are more resistant to chemical treatment than others. The following pages describe the conditions that algae need to thrive and the chemical treatments used to eradicate them.

Algae Growth Factors

There are many things that can contribute to the growth of algae. Listed below are some of the causes in swimming pools.

- **Sunlight.** Algae have the ability to absorb light and, through photosynthesis, utilize light to convert nutrients such as phosphates to glucose energy. This energy is what empowers the algae to bloom.
- **Lack of sanitizer.** High bather load or an excess of organic debris in the pool puts a demand on the chlorine. Excess nitrogen ammonia (from bathers) uses chlorine very rapidly. Chlorine levels should be carefully monitored at times of peak bather load. If the chlorine demand is not met and there is not sufficient residual of chlorine left over, algae can grow. It is important that the chlorine is maintained between 1.0 and 4.0 parts per million (ppm) at all times.
- **Warm water.** Most common pool algae love warm water. Algae can become a problem for many pools in the spring, often because of solar bubble covers left on for extended periods. The solar cover allows the water to heat very rapidly, so algae are able to grow as chlorine residuals go down. The algae can then grow under the cover unchecked.
- **Rough surfaces, cracks, and crevices.** Rough plaster or cracked surfaces and tile lines offer areas where many algae can gain a strong foothold. It is also difficult to reach into many of those areas with brushes, and so the algae are able to grow undisturbed.
- **Poor circulation.** Algae thrive in still waters. If the pool has areas where the water doesn't move well, the result can be "dead spots" where algae can settle. Strong circulation and filtration help keep algae from taking hold.
- **High iron content.** In October 2000, the scientific journal *Nature* published a study in which New Zealand scientists successfully initiated an algal bloom in the Southern Ocean surrounding Antarctica by adding dissolved iron to the sea (National Institute of Water & Atmosphere 2000).
- **Carbon.** Carbon dioxide (CO₂) is what algae (like other plants) breathe. Algae need CO₂ to survive.
- **Nutrients: nitrates and phosphates.** Just like the human body, algae need nutrients to grow and be healthy. More details on nitrate and phosphate nutrients can be found in the "Phosphates" section later in this chapter.

Killing Algae

- Chlorine is the most common chemical used to fight algae. It possesses great killing power and also acts as a bleaching agent and oxidizer to destroy waste material.
- Algaecide is a good second choice. In cases of extreme green algae, chlorine is the best first choice. However, residual algae can still remain in places such as the filter, where it may not be effectively killed by the chlorine. A good second choice, to ensure complete annihilation of algae, is a copper-based, broad-spectrum algaecide. SeaKlear Algae Prevention & Remover is a broad-spectrum algaecide that kills all types of common pool algae and includes a long-lasting residual to prevent further outbreaks.

Preventing Algae

A good prevention program for algae includes the following:

- Maintaining a proper sanitizer level at all times
- Weekly shocking with a chlorine-free shock such as SeaKlear Chlorine-Free Shock—use 1 pound per 10,000 gallons
- Regular addition of a broad-spectrum, long-lasting copper algaecide such as SeaKlear Algae Prevention & Remover—use every 90 days at a rate of 16 ounces per 10,000 gallons
- Monthly testing for levels of phosphate
- Weekly use of a concentrated, effective phosphate remover such as SeaKlear Phosphate Remover at a rate of 1 ounce to 5,000 gallons
- Weekly use of a natural clarifier such as SeaKlear Natural Clarifier to effectively remove dead algae and organic waste—2 ounces per 10,000 gallons

PHOSPHATES

Pool Pro Tip

Treat First, Then Test

Algae can store phosphate, which is released when the algae are killed off. This released phosphate then helps more algae flourish. This is why it is important to kill algae existing in a pool before doing a phosphate test. Always test for phosphate after algae have been treated and removed.

Phosphates Defined

Phosphates are the biological building blocks formed when phosphoric acid meets various metals. Phosphates exist in many forms. Most of these are from natural sources such as occur in rivers, lakes, and oceans or from mined phosphate rock. Other phosphate sources include fertilizer, organic debris such as leaves and bark, and some pool chemicals.

Phosphate is also prevalent in soaps, detergents, shampoos, and even soda pop. Phosphates can become a pollutant when overdevelopment of housing results in the extreme buildup of by-product waste in natural water systems.

In terms of pool water clarity, the most important thing to know is that phosphates are essential nutrients for plants and will stimulate the growth of photosynthetic algae, which can turn the pool green, yellow, or black.

Sources of Phosphates in Pools

- **Body waste.** Phosphates from the food and beverages we consume are present in fecal matter, urine, and perspiration. Much of the food (meats, poultry, and seafood) and beverages we consume contain phosphates. Many carbonated beverages contain phosphoric acid to enhance flavor and improve storage stability.

Chapter 4

- **Dirt and soil.**
- **Fertilizers.** Nitrogen and phosphate are the two main ingredients in most lawn and agricultural fertilizers.
- **Forest fires and atmospheric dust.** A ten-year study conducted by the University of California–Santa Barbara and Stanford University showed that on the lush Hawaiian island of Kauai, forests thrived on phosphate-laden dust from as far away as the deserts of China (Chadwick, et al. 1999). Also, in areas where phosphate is mined (such as Florida), phosphate dust enters the atmosphere and eventually falls into pool water.
- **Hair conditioners and shampoos.** These are introduced when swimmers enter the water.
- **Microorganisms.** These lead to the break down of organic debris that release phosphate.
- **Minerals.** Such as calcium phosphate or sodium phosphate.
- **Plant debris.** Leaves, bark, pollen, and seeds.
- **Pool chemicals.** Chemicals containing TSP (tri-sodium phosphate) or polyphosphates. Many cleaners contain phosphoric and phosphonic acid. All forms of phosphates in these and other chemicals end up as orthophosphate, which is a food source for algae.
- **Rain.** Rain can wash phosphate from plants and soil.
- **Soaps and detergents.** Residue from swimmers and their bathing suits.
- **Water.** Phosphate can leach from rock within groundwater.

Symptoms of Phosphate Problems

- **Lack of chlorine residual.** In many cases, it can be difficult to maintain a free-chlorine reading because of high levels of phosphate. High phosphates can also interfere with a chlorine generator.
- **Cloudy water.** In many indoor pools, algae blooms may not be present. However, other water-quality problems can exist, such as persistent cloudy water and slimy walls and floors, that indicate high phosphates.
- **Resistant, frequent algae.** Some algae may continue to be a problem even though sanitizer levels are correct and algaecides have been used. High phosphate combined with carbon and nitrogen can produce resistant algae.

Testing for Phosphates

Orthophosphate is the only form of phosphate that algae can utilize as a nutrient. Its presence may be the root of a cloudy water or algae problem. Several test devices are available in the pool industry for testing orthophosphate. These, along with their test times, are listed below:

- Tablet reagent test—six minutes
- Liquid reagent A+B test—three to six minutes
- Powder pouch—one minute
- Test strip—twenty seconds

All of these methods test for orthophosphate and measure results in parts per billion (ppb). Most of these tests top out at 1,000 ppb. However, it is possible for phosphates to exist at a level as high as 10,000 ppb or more. To find the exact level of phosphates, conduct a dilution test as follows.

DILUTION TEST FOR PHOSPHATES

1. Mix 1 part test water sample with 9 parts distilled water.
2. Conduct a test of the mixed (diluted) sample.
3. Multiply the result by 10. This number is your true orthophosphate reading.

Controlling Phosphates

- **Test and treat weekly.** Once high phosphate levels have been reduced, maintain levels of phosphate by testing monthly and treating weekly with SeaKlear Phosphate Remover at a rate of 1 fluid ounce per 5,000 gallons.
- **Minimize dirt entering the pool.** Keep deck areas clean and free from dirt and dust. Provide footbaths for bathers who may run across lawns or dirt to the pool.
- **Remove dead plant leaves and insect matter immediately.** These can break down and leave organic phosphate behind. Use a pool cover to protect against these materials or install an automatic cleaner to remove them as quickly as possible. Keep the skimmer and pump baskets clean and free of leaves, pine needles, etc.
- **Minimize the input of phosphate-containing chemicals.** Avoid phosphate-containing chemicals such as TSP-based cleaners. Also avoid pool chemicals that include phosphoric acid and phosphonic acid, which can eventually break down into the free form of orthophosphate and encourage algae growth.
- **Use SeaKlear Natural Clarifier weekly.** This will help prevent algae from flourishing by quickly removing by-product waste to the filter, where it can be backwashed out of the system. Use SeaKlear Natural Clarifier at a rate of 2 ounces per 10,000 gallons.

RESISTANT ALGAE

Resistant Algae Explained

When a swimming pool is properly maintained and algaecide is used, algae are normally not a problem. However, algae are one of the greatest fears of pool owners because they make the pool look bad, unclean, and unsafe.

When high levels of phosphates exist in pool water, they interfere with chlorine's ability to kill microorganisms. As a result, it is harder to maintain free chlorine in a high-phosphate pool. High phosphates also interfere with a chlorine generator's ability to produce hypochlorous acid (the killing agent of chlorine).

Phosphate is an essential nutrient for algae. The algae take in phosphate along with other nutrients and through a process of photosynthesis convert it to energy. When there is an abundance of

Chapter 4

Pool Pro Tip

The Phosphate Connection

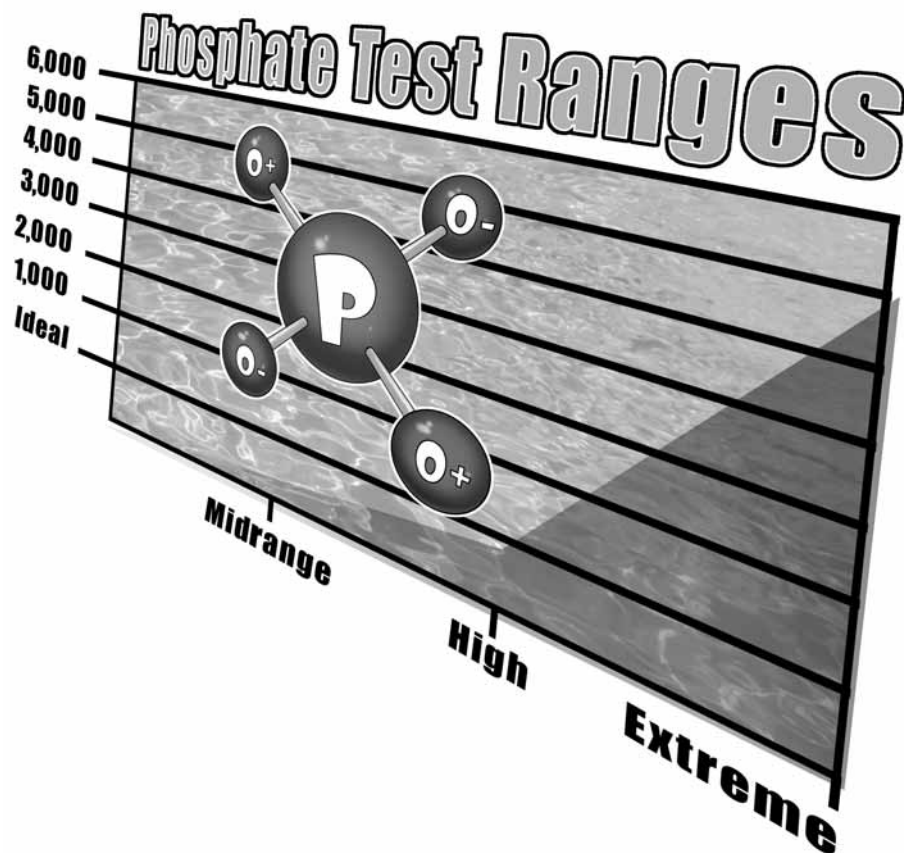
The problem of recurring resistant algae has proven to be the result of high phosphates in pool water. High phosphates are like steroids for algae. The more phosphate that the algae obtain, the more resistant and “strong” they become. Testing and phosphate removal are key elements in dealing with resistant algae. Use SeaKlear Phosphate Remover according to the dosage chart on the back of the bottle to effectively remove high levels of phosphate in swimming pools.

phosphates, the algae will become prolific and increase in strength. The algae then have the ability to be much more resistant to traditional treatments such as chlorine, shocking, and algaecides.

Testing and treating for phosphates should become a normal part of the opening, closing, and maintenance procedures for all pools. However, since phosphate removal in swimming pools is still a relatively new technology, it isn't the first thing we think about when dealing with resistant-algae problems. In cases of resistant algae, it is imperative to test and deal with phosphates quickly. Algae can begin to thrive at phosphate test levels between 200 and 500 parts per billion (ppb), which is considered the midrange. When levels reach 1,000 ppb, phosphate is high and resistant algae will be present.

Preventing ALGAE

- DAILY**
 - Maintaining a proper sanitizer level at all times.
- WEEKLY**
 - Weekly shocking with a chlorine-free shock such as SeaKlear Chlorine-Free Shock.
 - Weekly use of a concentrated, effective phosphate remover such as SeaKlear Phosphate Remover.
 - Weekly use of a natural clarifier such as SeaKlear Natural Clarifier to effectively remove dead algae and organic waste.
- MONTHLY**
 - Monthly testing for levels of phosphate.
- SEASONALLY**
 - Seasonally add a broad-spectrum, long-lasting copper algaecide such as SeaKlear Algae Prevention & Remover.
 - Seasonally treat for phosphates using SeaKlear Phosphate Remover.



Killing Resistant Algae

The following list is a detailed elimination program for resistant algae:

1. Make sure all equipment is in good working order. This includes checking all baskets for debris, especially the pump lint pot basket and the filter. Make sure the filter is working properly and that there is good circulation throughout the system.
2. Superchlorinate the pool by adding up to 30 parts per million (ppm) chlorine to kill existing algae and oxidize organic waste (1 gallon of liquid chlorine will raise 10,000 gallons to 10 ppm). If you are using granular chlorine, be sure to predissolve it in water.
3. Add SeaKlear Natural Clarifier at a rate of 1 fluid ounce per 5,000 gallons to help remove dead floating algae. Brush the entire pool with the filter system on. Watch the filter pressure.
4. The next day, vacuum the dead algae off of the pool floor. Also brush the entire pool again. Check all baskets and pump again for debris. Backwash the filter and clean the media if necessary.
5. Add SeaKlear Algae Prevention & Remover at a rate of 32 ounces per 10,000 gallons. Set the filter to run six to eight hours a day. Brush the pool.
6. Test the water for phosphates, using an approved kit that tests for free orthophosphate.
7. Use SeaKlear Phosphate Remover at a rate of 1 quart per 20,000 gallons for phosphate readings of 1,000 ppb. A dosage of 32 ounces of the SeaKlear Phosphate Remover product is designed to effectively remove up to 1,000 ppb of phosphate in a 20,000-gallon swimming pool. For lower

Chapter 4

levels of phosphate, follow the dosage rate on the back of the SeaKlear Phosphate Remover bottle. Make sure the filter is clean and that there is good circulation throughout the pool. Leave the filter running for 24 hours. Maintain the phosphate level at 125 ppb by using 1 ounce of SeaKlear Phosphate Remover per 5,000 gallons weekly.

8. Maintain the pool sanitizer at 1 to 3 ppm. Brush and vacuum the pool every week. Clean the filter regularly—backwash monthly—and tear down and clean the elements or media twice a year. Use SeaKlear Natural Clarifier at the rate of 2 ounces per 10,000 gallons weekly to keep organic waste and algae spores encapsulated and captured by the filter.
9. Shock the pool every week with 1 pound of SeaKlear Chlorine-Free Shock per 10,000 gallons to oxidize organic residue and algae. This process also eliminates all types of chloramines.
10. Use SeaKlear Algae Prevention & Remover every 90 days at a rate of 16 fluid ounces per 10,000 gallons. To keep phosphate levels down and prevent resistant algae, use SeaKlear Phosphate Remover at a rate of 1 ounce per 5,000 gallons weekly.

This SeaKlear program is guaranteed to reduce occurrences of resistant algae.

PHOSPHATE: THE GROWTH-LIMITING NUTRIENT

There are three vital resources that algae need to grow:

1. Nitrates
2. Phosphates
3. Carbon

Of these three, phosphate is scientifically termed as a “growth-limiting nutrient.” This simply means that algae cannot thrive and flourish without phosphates. Even if nitrates and carbon are still present, algae cannot bloom without the presence of phosphate.

Chapter 5

Water Clarity in Commercial and Public Pools

As a professional pool operator, you have a responsibility to keep your facility clean and safe for the public to enjoy. Swim meets, aquatic exercise classes, and swim lessons are going on virtually around the clock, and this challenges the quality of the pool water. Your job is to meet the challenge and keep equipment and pool water up to standards. Cloudy water in a public pool can lead to dangerous situations and cause the pool to be shut down. Clear, clean water is a symbol of pride for the operator because it shows that you have done your work and are doing the very best to keep your facility safe, profitable, and fun. In this section we discuss the challenges to clear water and a solution to help every professional pool operator.

OBSTACLES TO CLARITY IN PUBLIC POOLS

Swimming is one of the most popular activities in the United States and around the world. The United States Bureau of the Census reported that in 1995, 368 million swimmers visited public pools and water parks in the United States. Along with the swimmers comes an influx of tiny particles that can cause degradation of water quality.

The tiny particles that come from the outside environment and from increased bather load include such things as:

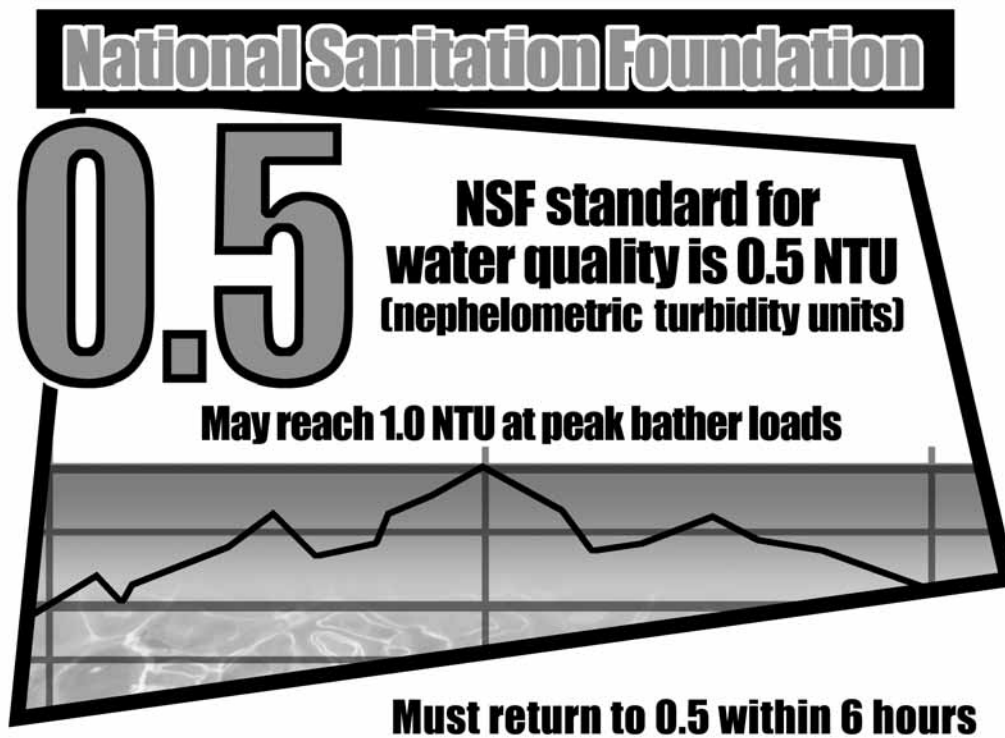
- Organics
- Suntan lotions and sunscreen
- Body oils
- Skin flakes
- Fine dust and debris
- Minerals

Chapter 5

These, as well as other tiny particle sources, can be present in pool water, particularly during times of heavy use. The molecules of these particles are primarily negatively charged. Think of what you learned in science about magnetic force. Simply put, in magnetism opposites attract, so positive ions are strongly attracted to negative ions. When there are a lot of particles in water that all possess the same charge, like these negatively charged particles, you then have a charge-to-charge repulsion. This means that the particles continually bounce off one another to create a cloudy suspension—in other words, cloudy water.

These particles are of such a small size that traditional pool filters can't effectively remove them. The tiny particles continue to pass through filter media and bounce in suspension in pool water. As more and more of these particles are introduced into the water, the pool becomes cloudy. This is what is meant by *turbidity*.

TURBIDITY AND VISIBILITY



(Source: National Swimming Pool Foundation 2005)

Turbidity is an indication of water clarity. Pool water can appear clear, but when light is passed through, it will scatter as it encounters particles. Perhaps the best example of this is to think of a pool light turned on at night that reveals particles that can't normally be seen. The turbidity standard for public pools is the ability to clearly see the center main drain from the deck of the pool. Health inspectors will close a pool down if the main drain is not clearly visible from the deck.

Water Clarity in Commercial and Public Pools

Some states will use a 2-inch disk with red and black squares that must be visible through 15 feet of pool water. Immediate pool closure is the result of turbid, cloudy water.

It is the paramount responsibility of any aquatic facility operator to keep turbidity at the acceptable standards at all times. An inability to maintain and keep pool water clear and clean can result in unsafe conditions for swimmers and lead to increased consumption of pool chemicals.

TURBIDITY STANDARDS

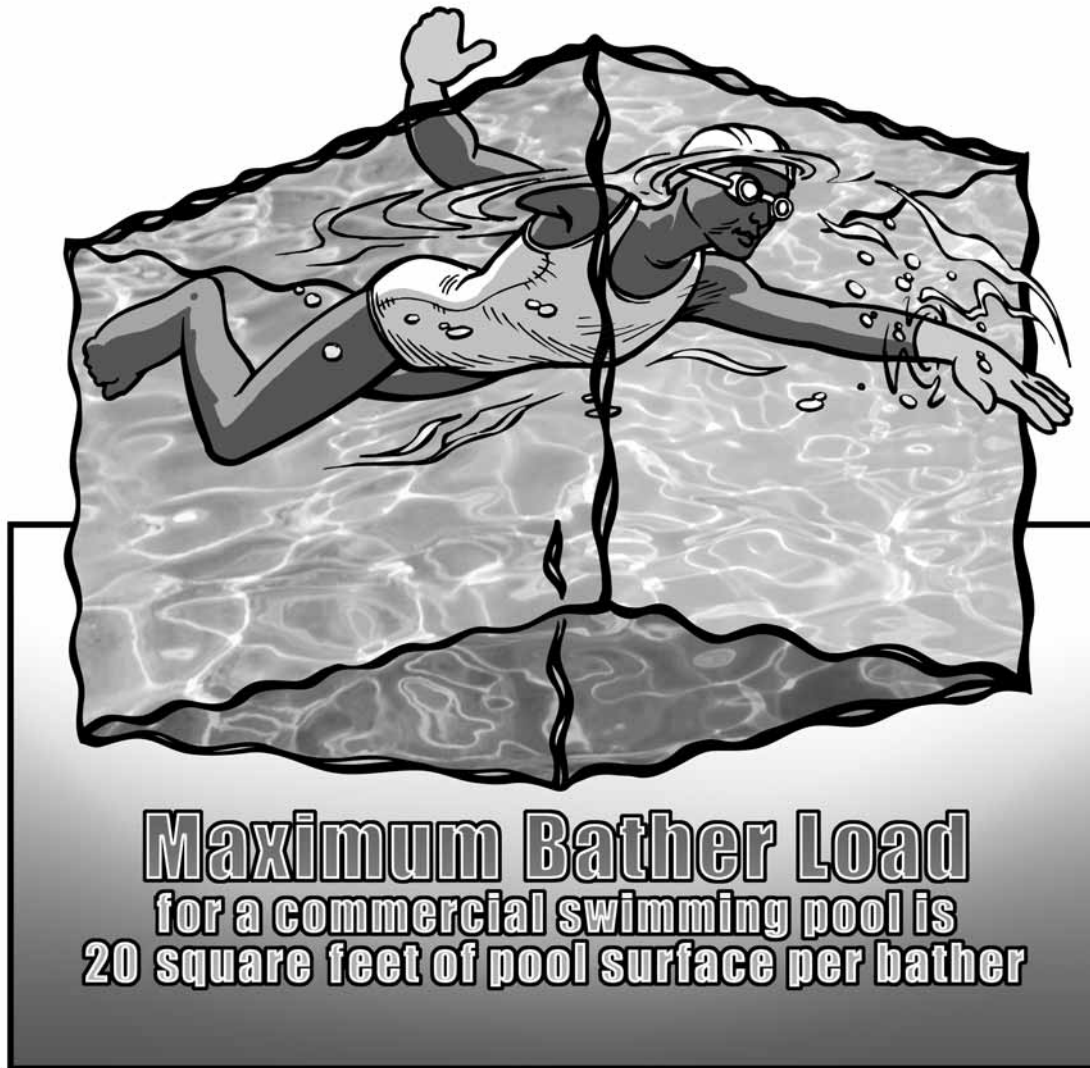
As explained in Chapter 1, there is a standard for turbidity in swimming pool water. The standard is the same as that used for drinking water by the National Sanitation Foundation: 0.5 NTUs. *NTU* stands for *nephelometric turbidity units*, which are measured by use of a nephelometer in a lab. The nephelometer measures the amount of refractive light rays from the presence of particles in a suspension of water. Commercial operators know that the water is allowed to go up to 1.0 NTU at times of peak bather loads. However, water must return to 0.5 NTUs within one turnover rate of the pool (National Swimming Pool Foundation 2005).

REDUCING TURBIDITY IN PUBLIC POOLS

Reducing turbidity will maintain crystal clear water. For best results, use the SeaKlear Particle Removal System (PRS), an advanced, two-stage polymeric system that removes particles as small as 0.5 microns that can pass through the filter. The two-stage SeaKlear Particle Removal System (PRS) is designed to remove small particles quickly and more efficiently than other clarifiers can. Turbidity is substantially reduced on a continual basis, even during times of peak bather load. In addition, the pool returns to acceptable turbidity levels quickly and consumes a smaller amount of chemicals.

The SeaKlear PRS two-stage system works by a complete coagulation and flocculation process.

1. Stage one is added early in the day and begins the process of grabbing small particles that cause turbidity.
2. Stage two is added later in the day and aggressively collects grabbed particles into dense masses that are removed by the filter. When SeaKlear PRS is used as a daily system, turbidity is dramatically reduced, the buildup of particles is effectively delayed, and water remains sparkling and transparent.



(Source: Griffiths 1994)

BATHER LOAD

Bather load refers to the number of swimmers in a pool. Because each swimmer brings millions of microorganisms into the pool, excessive or high bather load can lead to turbid or cloudy water. Cloudy pool water can cause dangerous incidents such as drowning and disease outbreaks.

Maximum bather load refers to the maximum number of bathers allowed per square foot of pool surface. The maximum bather load standard in commercial swimming pools is 20 square feet of pool surface per bather. For example, the maximum bather load in a 30-foot-by-50-foot pool is 75. This formula is widely used, but can vary from state to state.

$$30 \text{ ft.} \times 50 \text{ ft.} = 1,500 \text{ sq. ft.}$$

$$1,500 \text{ sq. ft.} \div 20 \text{ sq. ft. of pool surface per bather} = 75 \text{ bathers}$$

(Griffiths 1994)

Appendix A

Superior Water Clarity Treatment Solutions and Products

No one wants a cloudy, discolored, dull-looking pool. Besides the aesthetic concerns, transparent and clean water is important to the safety of anyone who swims. Pool owners want clear, clean, and safe water.

Pool owners want a proven, reliable, and effective way to accomplish this goal. SeaKlear offers an effective, simple-to-use system of water treatment solutions. The SeaKlear water treatment products are guaranteed to provide superior water clarity in swimming pools, or your money back!

SeaKlear reliable water treatment solutions keep pools clear and safe, easily and effectively. Used together, the SeaKlear product line provides a total solution to all water clarity problems.

SeaKlear water treatment products are:

- Proven effective and reliable
- Superior to competitors' products
- Fast acting
- Easy and simple to use
- Convenient
- User-friendly
- Hassle-free, giving pool owners more time to enjoy their pool
- Safe for your family and our environment

Appendix A

SEAKLEAR NATURAL CLARIFIER FOR POOLS

SeaKlear Natural Clarifier works better and does more than other clarifiers. Quite simply, SeaKlear is the best clarifier money can buy.

SeaKlear Natural Clarifier has been proven reliable at keeping pools clear and safe, easily and effectively. Superior performance is guaranteed or your purchase price will be refunded. You can rely on SeaKlear Natural Clarifier!

Made from all-natural *chitosan*, a renewable resource obtained from the shell of crustaceans, SeaKlear Natural Clarifier naturally clarifies cloudy water by “magnetically” attracting particles, debris, oils, sunscreen, lotions, cosmetics, scum, metal residues and other impurities so that your filter can remove them more effectively. The result is the clearest pool you have ever had.



Key Features

- Is safe to use with all sanitizers
- Removes excess oils and lotions to prevent scum at the waterline
- Makes all filters quicker and easier to clean. Improves filter efficiency. Prevents filter clogging by keeping impurities above the filter media, making the filter easier to clean and allowing your filter to run longer between cleanings
- Has proven its effectiveness and reliability
- Includes natural components—no thickeners added. Will not harm plants, animals, or fish. Safe for your family and our environment
- Is easy and simple to use, convenient, user-friendly, and hassle-free
- Delivers quick results

SEAKLEAR NATURAL CLARIFIER TABLETS FOR POOLS

Use SeaKlear Natural Clarifier Tablets for Pools as an easy, quick, and simple way to clarify cloudy water and eliminate particles, oils, sunscreen, lotions, cosmetics, scum, metal residues, and other impurities so that the pool filter can remove them more effectively.



Superior Water Clarity Treatment Solutions and Products

SEAKLEAR CHLORINE-FREE SHOCK FOR POOLS

SeaKlear Chlorine-Free Shock works better than other shock products. It helps keep pool water clear and odor-free, and you can swim just fifteen minutes after treatment. Superchlorinating can make a pool unsuitable for swimming for up to twenty-four hours after treatment. Quite simply, SeaKlear is the best shock product money can buy.

Superior performance is guaranteed or your purchase price will be refunded. You can rely on SeaKlear Chlorine-Free Shock!

Key Features

- Works quickly—the pool can be used fifteen minutes after use
- Removes odors and chlorine smell
- Helps reduce chlorine usage—the product shocks with active oxygen, not chlorine
- Eliminates contaminated chlorine, suntan oils, and perspiration
- Has been proven to be effective and reliable
- Is easy and simple to use



SEAKLEAR ALGAE PREVENTION & REMOVER FOR POOLS

SeaKlear Algae Prevention & Remover works better and does more than other algaecides. Quite simply, SeaKlear is the best algae prevention and remover product money can buy.

SeaKlear Algae Prevention & Remover has been proven reliable at preventing and removing all types of algae from pools so that your pool water can be kept clear and safe, easily and effectively. Superior performance is guaranteed or your purchase price will be refunded. You can rely on SeaKlear Algae Prevention & Remover!

Key Features

- Superior algae prevention and control
- Effective in killing and preventing blue, green, black, and yellow algae
- No need for multiple algaecides—the product kills and prevents all types of algae
- No-algae guarantee
- Proven effective and reliable
- Is easy and simple to use



Appendix A

For the Clearest and Cleanest Algae-Free Pool Possible:

1. Regularly brush the sides and surfaces of your pool
2. Regularly measure the pH of your pool and keep it between 7.2 and 7.8
3. Treat your pool weekly with SeaKlear Natural Clarifier to keep it clear and clean
4. Regularly measure the amount of phosphates in your pool and treat your pool with SeaKlear Phosphate Remover if the phosphate level is over 125 parts per billion (ppb)
5. Treat your pool with SeaKlear Algae Prevention & Remover every three months
6. Treat your pool with SeaKlear Chlorine-Free Shock every week or two, depending on the use of your pool

SEAKLEAR PHOSPHATE REMOVER FOR POOLS

Key Features

- Capable of removing up to 1,000 ppb of orthophosphates per 20,000 gallons of water
- Proven to eliminate phosphates from fertilizers, rainwater, soaps, decaying vegetation, and other pollutants
- Nontoxic—100 percent safe for your family and the environment
- Quick, easy, cost-effective, and simple to use
- Part of the proven family of SeaKlear water treatment solutions



SEAKLEAR PARTICLE REMOVAL SYSTEM

Key Features

- Keeps pools clear and pristine
- Enhances the filter's ability to remove particles that are too small to be trapped by current filter technology
- Ensures that swimmers, depth markers, debris, and your pool's drain covers are always clearly visible
- Effectively reduces turbidity and recovery time, especially during peak bather load and before or after a swim party
- Works with most pool filter media: sand, zeolite, diatomaceous earth (D.E.), cellulose, or cartridges
- Has been proven to be effective and reliable
- Is easy and simple to use
- Belongs to the proven family of SeaKlear water treatment solutions



Superior Water Clarity Treatment Solutions and Products

ABOUT VANSON HALOSOURCE

The company that stands behind SeaKlear water treatment solutions is Vanson HaloSource. A Seattle-area health science technologies company, Vanson HaloSource creates, develops, and commercializes effective and reliable solutions for the water treatment, health care, and antimicrobial coatings markets.

Our Brands

In the water treatment market, Vanson HaloSource brands:

- Keep swimming pools clear and clean, easily and effectively
- Purify drinking water
- Remediate storm and waste water
- Control odor

In the health care market, Vanson brands stop bleeding and help heal wounds.

In the antimicrobial coatings market, the Vanson HaloShield brand coats linens to reduce infections, odors, and the transmission of infections.

Our Company Values

The most important organizational values at Vanson are:

- Research and quality
- Our claims are backed by science
- Vanson has invested significant time and energy to make sure every product works and is safe
- Every project is completely tested to prove that the product does what it claims to do
- Continual product improvement
- Proven, documented results
- Published research papers
- Case studies

We believe in and provide high-quality educational materials, such as this book, to help pool owners, dealers, and commercial operators keep their pools clear and clean, easily and effectively.

Appendix A



Complete line of pool and
spa products



Storm water clarification



Wastewater clarification



Drinking water purification



Odor-control applications



Hygienic coatings for
textiles, nonwovens, and
hard surfaces

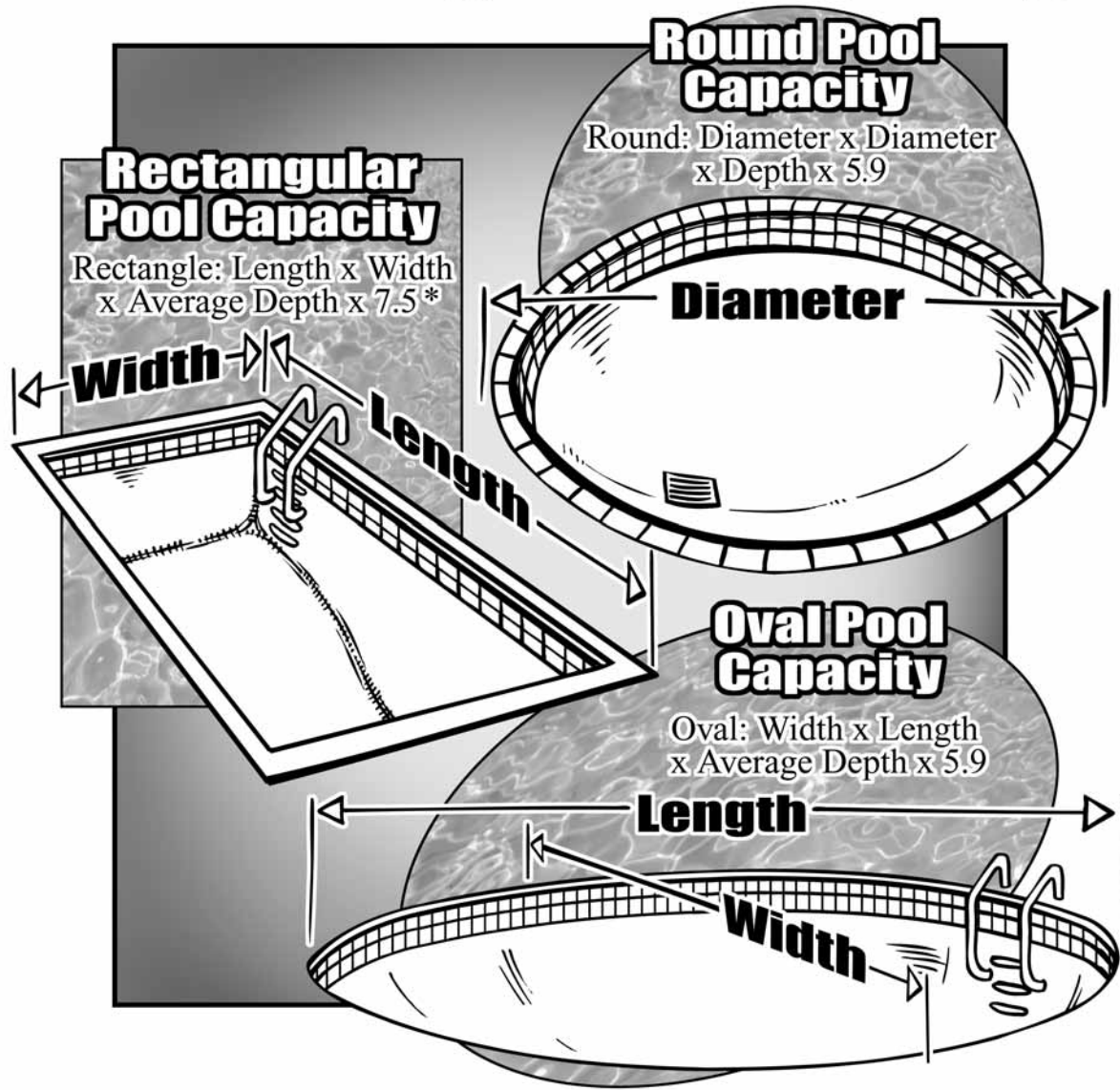
Biomedical Applications

Wound healing, hemostasis,
and other biomedical
applications

Appendix B: Troubleshooting

Problem	Possible Cause	Chapter	Treatment
Cloudy water	Chloramines	2	SeaKlear Chlorine-Free Shock, SeaKlear Natural Clarifier
	Organic waste	2, 5	Skim, vacuum, SeaKlear Natural Clarifier, SeaKlear Particle Removal System
	Mud and silt	5	SeaKlear Particle Removal System
	High alkalinity	2	Sodium bisulfate or muriatic acid
	High pH	2	Muriatic acid
	High total hardness	2	Drain the pool
	High TDS	2	Drain or backwash the pool
	Poor filtration	2, 3	SeaKlear Filter Cleaner and Degreaser
	High phosphates	4	SeaKlear Phosphate Remover
Discolored water	High metal content	2	SeaKlear Natural Clarifier or SeaKlear Heavy Flocc
	Low pH	2	Add sodium carbonate
Green water	High copper	2	SeaKlear Natural Clarifier
	Low alkalinity	2	Raise the pH with baking soda
	Algae	4	Chlorine, SeaKlear Algae Prevention & Remover
	Resistant algae	4	See p. 31 for elimination program
Yellow or black spots on pool surfaces	Black or yellow algae	4	SeaKlear Algae Prevention & Remover

Measuring Pool Capacity



* To determine the average depth, add the shallow-end and deep-end depths together, then divide by 2.

Glossary

A)

Acid—A chemical that brings hydrogen to lower the pH of pool or spa water. Liquid muriatic acid is commonly used in pools while dry granular sodium bisulfate is used in spas and hot tubs.

Acid demand test—A titration test to determine the exact amount of acid needed to lower the pH or total alkalinity.

Acidic-based chlorine—Tri-chlor tablets and granular dichlor are forms of acidic-based chlorine. Tri-chlor has a low pH of 2.9. Dichlor is 6.0 to 6.8. These forms of chlorine will pull the pH downward. Soda ash or sodium bicarbonate should be used to keep water properly balanced.

Acid rain—Caused by industrial air pollution, which reacts with water in storm systems and is deposited in a form of sulfuric acid, nitric acid, and other pollutants. Acid rain can cause a sudden drop in pool water pH.

Agricultural fertilizers—Used in rural farm areas. Fertilizers consist of nitrates and phosphates. Agricultural fertilizers are applied by spraying devices or aerial spray. When airborne, fertilizers can end up in swimming pool water. Nitrates and phosphates from fertilizers can also be found in groundwater.

Algae—Single-celled tenacious plant life that can grow on swimming pool surfaces or be free floating in pool water. Most common pool types are green, yellow, or black.

Algaecide—Product used to kill and prevent the growth of most common pool algae. Algaecides may be metal based, polyquatarnary, or ammonia based. There are also bromine-based products used as algaecides.

Algae spores—Free-floating microscopic algae that have not yet attached to surfaces or begun to bloom. Algae spores can be present in fill water, in plumbing, and on the filter medium. They can be contained within dust, dirt, or leaves and grass.

Alum—Aluminum sulfate. Alum is powdered flocculant used to clear cloudy pools by floccing suspended particles and dropping the flocced material to the pool floor. The dropped material must then be vacuumed and backwashed from the filter.

Glossary

Ammonia—Two types can be found in pool water. Chemical ammonia is sometimes used as an algaecide. Ammonia, derived from urea in swimmer perspiration and body waste, is a primary cause of chloramines and unpleasant odors.

Antimicrobial—Chemical or material that destroys and inhibits the growth of disease-causing germs.

Atmospheric dust—Fine particles of debris that are carried globally in the atmosphere. Phosphate-laden atmospheric dust was carried from the deserts of China to the faraway Hawaiian Islands.

B)

Backflow pressure—Caused from a dirty or plugged filter. Backflow pressure is measured on the filter by means of a PSI gauge. High pressure on the PSI gauge will lead to poor filtration and a lack of proper water flow through the pool system.

Backwash—To reverse the flow of water within the filter so that debris is flushed off of the medium and carried out of the system to waste. Most sand filters have a multiport valve on top that has a backwash position. D.E. and cartridge filters have a backwash valve that can be moved to reverse the water flow within the filter tank.

Bacteria—Microscopic organisms that are present in water. Some bacteria can cause illnesses such as pinkeye, rashes, earaches, and diarrhea.

Balanced water—Water that is neither scale forming nor corrosive. Many pool professionals use the Langelier Saturation Index as a guide to water balance.

Base—Alkaline chemical or material that is used to raise pH and total alkalinity in swimming pool water. Base also refers to the high end of the pH chart or any high-pH material. When the pH of pool water is high, it may be referred to as *base*.

Bather load—Refers to the number of swimmers in a swimming pool at a given time. The maximum bather load for commercial pools is one swimmer for every 20 square feet of pool surface. High bather load can lead to cloudy water, an increase in bacteria, and irritating chloramine odors.

Biguanide—A non-halogen-based liquid polymer sanitizer.

Black algae—Dark-green to black spots that range from dime to half-dollar size. Black algae burrow into plaster surfaces and protects itself by forming a carbohydrate shell. Brushing prior to treatment is very important when dealing with black algae.

Blue-green algae—Classified as bacteria known as Cyanobacteria. A toxic green floating slime that is often mistaken for common green pool algae.

Body oils—Oil deposited in pool water from swimmers. Body oils combine with dirt and small particles to form scum lines along the surface and clog filters.

Breakpoint chlorination—Complete reduction of combined chlorine, which effectively destroys irritating chloramines. Breakpoint chlorination uses a formula of ten times the combined chlorine

level in parts per million to accomplish the point where chloramines break apart and a free chlorine residual is left.

Bridging—A process of flocculation wherein coagulated particles are gathered together to form large filterable flocs. *Bridging* is also a term that refers to D.E. filters. When the D.E. coating on separate grids joins together in the filter, it is called bridging. Filters should be cleaned when this occurs.

Broad-spectrum algaecide—An algaecide that is designed to remove and prevent all types of algae that are common in pools.

Bromine—A halogen-based sanitizer similar to chlorine. Bromine is derived from deposits in deep salt oceans such as the Dead Sea. Bromine is used primarily for spas and hot tubs because it has no stabilizer to protect it from UV degradation. Also, bromine is more effective at higher temperatures than chlorine is. Bromines are still effective sanitizers and, unlike chloramines, do not have a strong, irritating odor.

Buffering capacity of water—Total alkalinity is the buffering capacity of water to resist changes from hydrogen (acid). High alkalinity means that water has a greater buffer and will be more resistant to changes from the addition of acids. Low alkalinity would mean very little buffer and quicker changes to water from acids.

By-product waste—Produced from high bather load and the overdosage of chemicals, such as enzymes and synthetic clarifiers, which can leave behind residue and petroleum.

C)

Calcium carbonate—Hard, crystallized scale formed when calcium combines with carbonates in hard water. Calcium carbonate will adhere to surfaces like plaster and can ruin filters and equipment. The crystals are sharp and, when on the pool floor, can cause severe swimmer discomfort.

Calcium chloride—A chemical used to increase hardness in soft water areas. Soft water with very little mineral content can be aggressive and destroy plaster surfaces and copper plumbing.

Calcium hardness—A measurement of the mineral content of pool water. Sometimes referred to as *total hardness*, the measurement is mostly made up of calcium.

Carbon dioxide (CO₂)—A gas used to lower pH. It is present in the atmosphere and converts to carbonic acid in water. Carbon dioxide is vital to the growth of planktonic organisms such as algae.

Channeling—A phenomenon in sand filters that causes channels within the sand bed. When oil, dirt, and other debris are driven by water pressure into the sand bed, hard mud balls are formed. The mud balls burrow through the sand bed and create channels through which water can pass without filtration.

Charge-to-charge repulsion—Micron-sized particles that share the same electrical charge are caught up in suspension and bounce off one another due to magnetic repulsion. A main cause of cloudy water.

Chelated—The binding of a metal ion to a compound to keep the metal in solution.

Glossary

Chitosan—A natural, renewable resource made from the shell of crustaceans. It is a by-product of seafood processing.

Chloramines—When chlorine molecules combine with ammonia, nitrogen, and other chemical by-product waste. Chloramines decrease the effectiveness of chlorine disinfection and cause odors as well as eye and skin irritation. The term *combined available chlorine* (CAC) also refers to chloramines.

Chlorine demand—The amount of free chlorine that is required to effectively sanitize bacteria, viruses, and protozoa, and also to oxidize ammonia, nitrogen, and organic contaminants.

Chlorine-free shock—Commonly known as MPS (potassium monopersulfate), chlorine-free shock is a white, granular material that is used in pools and hot tubs to oxidize and eliminate organic contamination without an increase of chlorine. MPS is able to effectively oxidize and remove irritating chloramines. A primary benefit of MPS is the ability to accomplish effective oxidation of contaminants without heavy chlorine use. The pool does not have to be closed for extended periods, and system equipment is not exposed to heavy amounts of chlorine.

Chlorine generator—A device that uses electricity and salt water to generate hypochlorous acid (the killing agent of chlorine).

Chlorine residual—The free chlorine reserve that remains after chlorine demand has been met.

Chlorine-resistant protozoa—Cryptosporidium has been proven to be a chlorine-resistant microorganism.

Clarifiers—Polymers that are positively charged and attract small, negatively charged, suspended particles for removal by filtration.

Coagulation—The result of using clarifiers when small, suspended particles are gathered together. Coagulation is a part of the flocculation process that gathers small particles and forms large, fluffy, dense masses that are easily caught by the filter.

Combined available chlorine (CAC)—The same as chloramines; formed when chlorine combines with ammonia, nitrogen, and organic waste. Combined available chlorine is determined by subtracting the free chlorine test reading from the total chlorine reading. The result is the combined chlorine level. Combined chlorine levels should never be higher than 0.2 ppm in pools and 0.5 ppm in spas.

Contaminants—Anything that causes demand on the sanitizer and deteriorates the quality of water. Contaminants can be nitrogen waste from perspiration and urine or organic material such as dust, pollen, and insects. Oil is also a serious water contaminant that causes scum and poor filtration, and creates chlorine demand.

Copper—Metal that can be present in many water systems or as a result of copper piping or heat exchangers. High levels of copper can lead to green to turquoise-looking water. Copper sulfate stains that are blue-green can appear when the pool water pH drops low or is driven too high. Copper is also present in many algaecides in a chelated form.

Copper algaecide—Algaecides that use copper as a toxin to effectively kill algae. The copper in most algaecides is chelated, which means it is bonded to a compound to prevent it from becoming insoluble and staining surfaces.

Corrosion—The result of soft, acidic, or “aggressive” water. When water is lacking in minerals, primarily calcium, the water seeks out minerals from other sources. In a swimming pool, the plaster or metal piping can be eaten away by soft water.

Cryptosporidium—A chlorine-resistant microorganism that can cause illness when ingested. The main source of Cryptosporidium is from the fecal waste of swimmers. Crypto exists in the form of microscopic cysts that can cause severe flu-like symptoms and even death in small children or the elderly.

Cyanobacteria—Bacteria that appear in the form of a blue-green slime and are often mistaken for common green algae. In fact, green algae can actually contain Cyanobacteria. Cyanobacteria thrive in lakes and ponds because of the high phosphate content. They can also be found in swimming pools where high phosphate is present.

D)

Dead spots—Areas in the pool where there is little water movement or no circulation. Algae can thrive in areas where there is little to no water movement. It is best to have returns placed strategically to ensure even water flow throughout the entire pool.

Diatomaceous earth—A fine white powder used as media for D.E. filters. The powder consists of tiny fossilized skeletons of aquatic animals known as *diatoms*. The material is porous with many microscopic holes that are effective at holding micron-sized particles.

Dilution—A way to reduce the concentration of chemicals or dissolved solids by partially draining and then refilling.

Dilution test—A method for determining the true value of a phosphate test. Since most phosphate test kits top out at 1,000 ppb, a dilution test may be needed to determine extreme phosphate levels. The common dilution test for phosphate is 1 part pool water to 9 parts distilled water. Test the diluted sample and multiply the result by 10 to get a true reading.

Disinfect—To purify by killing infectious bacteria.

Dissolved metals—Metal ions that are in a soluble form within water.

Dissolved solids—Any material that has dissolved as a result of contact with water. This material may consist of calcium, magnesium, phosphates, bicarbonates, carbonates, and metals.

DPD-N, N-diethyl-p-phenylenediamine—A colorimetric reagent test used to determine levels of total and free available chlorine in swimming pool water.

E)

E. coli—A bacterium that can be transferred by human fecal waste. E. coli can cause severe illness and can be fatal to small children. When chlorine is at standard levels of 1 to 3 ppm, E.coli bacteria can be destroyed within two minutes.

Glossary

Essential nutrient—Absolutely needed for healthy growth. Algae must have phosphate in order to accomplish prolific blooming. Phosphate is defined as an essential nutrient for plant growth.

Evaporation rate—The time ratio at which water is evaporated into the atmosphere, measured in feet. In Southern California the evaporation rate is 8 to 10 feet per year (Service Industry News 1991c).

Extreme oxidizer—A substance that uses active oxygen to reduce pool water contaminants. Ozone is classified as an extreme oxidizer. Ozone is able to oxidize E. coli twenty-five times faster than chlorine can.

F)

Filter sizing—A term for determining the proper size of filter in relation to the pump and the rate of water flow. The filter media rate is used to determine the proper gallons per minute per square feet of effective filter area.

Floating algae—A specific type of algae that use flagella (whiplike tails) to move about freely in water. Green floating algae do not adhere to walls or surfaces.

Flocculation—The effective gathering of micron-sized particles into large, dense flocs that are filterable. Complete flocculation removes fine dirt particles, organic waste, and oils.

Flow rate—A measurement of the water flow through the pool circulation system. Measured in gallons per minute and used to determine the pool filter's turnover time.

Free available chlorine (FAC)—Chlorine that is not combined. Free available chlorine exists as hypochlorous acid, which is the effective germ-killing agent of chlorine.

Free orthophosphate—The only form of phosphate that is available for algae growth. Free orthophosphate is the result of combined phosphates from environmental and chemical sources that break down in pool water.

G)

Giardia—A protozoan that is deposited through human waste and can cause severe stomach illness when ingested.

Green algae—A common type of pool algae that grows on pool walls and floors. It is slimy and dark green in color. Green algae can also be floating in water, causing a green, lake-water appearance.

Groundwater—Water that is found underground from runoff, springs, and agriculture and contained within natural aquifers.

Growth-limiting nutrient—Phosphate is termed a growth-limiting nutrient because it is the one nutrient essential to healthy plant growth. Without the presence of phosphate, plant growth is seriously limited.

H)

Hard water—Water high in minerals like calcium. Hard water is scale forming and requires extra chemicals in order to keep it balanced and sanitized.

Haziness—Another term for turbid or cloudy water.

Heater exchanger—The element within the heater where water passes to draw heat. Heat exchangers can be copper, bronze, or stainless steel.

Heavy flocs—Flocs that have a high gravity weight and sink rapidly to the pool bottom.

High pH—Means that water is base or alkaline. On the high end of the pH scale, the water is in need of hydrogen in the form of acid.

High-rate sand filters—Sand filters that filter and backwash at the same rate and are able to use less sand in smaller tanks.

High total dissolved solids—Everything chemically and environmentally that enters the pool ends up as a part of total dissolved solids. Total dissolved solids are considered high when they reach 1,500 ppm over the fresh start-up water.

High total hardness—Indicates high levels of minerals—primarily calcium—in the water.

Hydrogen ions—Acidic ions, which affect water balance. Lowers pH and total alkalinity.

Hydroxyl ions—The opposite of hydrogen ions. Hydroxyl ions are alkaline and contribute to total alkalinity.

Hyperchlorination—Another term for superchlorination, which is to raise the chlorine level to 20 ppm for eight hours.

Hypochlorous acid—The effective germ-killing agent of chlorine.

L)

Liquid alum—Poly-aluminum chloride used as a flocculant to drop material to the pool floor.

Liquid chlorine—Sodium hypochlorite.

Liquid reagent—Liquid colorimetric test reagents used in many different pool tests.

Logarithmic—The pH scale is called a logarithmic because each number on it is raised or lowered exponentially to a power of 10. Example: A pH of 6 is ten times more acidic than a pH of 7. Conversely, a pH of 8 is ten times more base or alkaline than a pH of 7.

Low pH—The predominance of hydrogen (acid) causes low pH. The low pH scale is measuring acidic water. Low pH leads to staining and damage of pool surfaces and equipment. Base materials such as soda ash and sodium bicarbonate are used to raise a low pH.

Low total hardness—The lack of needed minerals such as calcium to provide a proper saturation of the water. Soft water is low hardness and can be aggressive toward plaster surfaces and equipment. Calcium chloride is used to raise the total hardness of soft water.

M)

Magnesium—A mineral like calcium that is present in plasters and pool water.

Glossary

Manganese—A metal that can be present in some fill water. High levels of manganese can cause purple to black stains when oxidized.

Maximum bather load—The maximum level of swimmers allowed per square foot of pool surface. Maximum bather load is one swimmer per 20 square feet of pool surface area.

Metals—Common metals found in source water can be copper, iron, and manganese.

Metal-sequestering products—Products that when added to water surround metal ions to keep them in solution.

Micron—A measurement of small particles. A micron is equal to one-millionth of a meter. One grain of salt is equal to 100 microns. The human eye can see down to 30 microns.

Microorganisms—Micron-sized living organisms such as bacteria, viruses, and algae.

Microscopic dirt—Micron-sized dirt.

Minerals—Naturally occurring substances from the earth. Many minerals, such as calcium and magnesium, are found in the ground and transferred into pools in the fill water.

MPS (potassium monopersulfate)—Chemical used as an oxidizer to remove chloramines and organic waste. Typically known as chlorine-free shock.

Muriatic acid—Liquid acid used to lower the pH of pool water.

N)

Natural body oils—Naturally occurring oils of hair and skin, which can be deposited by swimmers in pool water.

Natural clarifier—A chitosan-based natural clarifier that does not use synthetic ingredients or petroleum in the formula.

Nephelometer—A device used to measure suspended particles in liquid by determining the degree to which the suspension scatters light. A nephelometer is used to measure turbidity, which is measured in nephelometric turbidity units (NTUs).

Nitrates—A cycle by-product of ammonia in water.

Nitrogen ammonia—One of the main causes of chloramine contamination.

Nonbacterial contaminants—Small particles that contribute to turbidity yet are not living organisms.

Nonpetroleum—Contains no oil by-products.

Nonsynthetic—Contains nothing artificial—no thickeners or polyacrylamides.

NSF—National Sanitation Foundation.

NSPF—National Swimming Pool Foundation.

NTU (nephelometric turbidity unit)—The units of measurement that make up turbidity, as measured by a nephelometer.

Nutrient—Something that is able to nourish and give growth and strength.

O)

Oil-based clarifiers—Most clarifiers in the pool market use petroleum as an ingredient.

Oils—Natural body oils, sunscreen lotions, and cosmetic products all contribute to filter clogging and the formation of unattractive scum.

Oily mud balls—Oil combined with dirt and small bits of rock forms oily mud balls that can burrow through sand and cause channeling.

Organic contaminants—Dirt, body oils, hair, and skin flakes are some examples of organic contaminants.

Organic matter—Anything organic in the water, from leaves to pollen.

Organic waste—Any by-product residue of organic contaminants left behind from oxidation or enzymatic treatment in pool water.

ORP probes—Used on sensor control devices for the measurement of oxidation-reduction potential (ORP).

Orthophosphate—The same as free phosphate. Orthophosphate is the essential nutrient for algae growth in water.

Oxidation—A process of eliminating water contamination by use of oxygen atoms. Increased oxygen content reduces electrons of contaminants, causing a higher oxidation state. This causes organic waste to be converted to gases, which are harmlessly released into the atmosphere.

Oxidation-reduction potential (ORP)—The electric potential required to transfer electrons from one compound or element (the oxidant) to another compound (the reductant); used as a qualitative measure of the state of oxidation in water treatment systems. In practical terms, it is a measurement to oxidize contaminants.

Oxidation-reduction potential meter—A device that measures the oxidation level of a sanitizer and displays results in millivolts.

Oxidizer—Any substance that brings an increase of oxygen atoms into the water. Chlorine, bromine, ozone, and MPS are all effective oxidizers.

Ozone—The allotropic form of oxygen having three atoms per molecule (O_3) instead of two (O_2). Created when a strong electrical charge comes in contact with oxygen, ozone is a more powerful oxidant than either chlorine or bromine.

Ozonator—A device used to generate ozone. There are two types of ozonators used in the swimming pool industry. One is *ultraviolet* (UV), which works by passing dried air in front of UV lamps. The other is *corona discharge* (CD), which works by producing strong electrical charges in a chamber of air and uses a special injector to introduce the ozone gas into the water.

Glossary

P)

Part per billion (ppb)—One in a billion.

Part per million (ppm)—One in a million.

Particulate matter—Micron-sized particles that are suspended in pool water. These particles can possess the same electrical charge, resulting in a magnetic charge-to-charge repulsion of the particles. Because these particles are too small to be trapped by most filters, they build up in the pool and cause cloudy water.

Petroleum-based—Chemicals that contain petroleum distillates.

pH—Parts of hydrogen. A term for the measurement of hydrogen in water.

Phosphates—Sources of pollution from soaps, fertilizers, human and animal waste, and organic debris. Phosphate is an essential nutrient for algae growth.

Phosphonic acid—An acidic compound of phosphate used in chemicals such as metal-sequestering products and tile cleaners.

Phosphoric acid—An acidic phosphate compound.

Photosynthesis—The process by which algae utilizes light to convert carbon dioxide, water, and other nutrients into glucose for growth energy.

Pinkeye—A type of conjunctivitis that is highly contagious and causes inflammation of the eye.

Pollutants—Any substance or chemical that causes deterioration of air, water, or land. The Environmental Protection Agency classifies phosphates as pollutants to public water because they increase algae growth, which leads to destruction of aquatic life and lake ecosystems.

Poly-aluminum chlorides—A liquid form of alum that is used to quickly drop suspended particulate matter to the pool floor. Poly-aluminum chlorides do not work well in high-pH water.

Protozoa—Cryptosporidium and Giardia are two common protozoa found in swimming pool water. These are single-celled parasites that cause stomach diseases in humans and animals. Protozoa are capable of releasing oocysts, which when present in the digestive tract of humans, can be released in the feces. These released oocysts can infect others if ingested. Oocysts are more commonly found in diarrhea, which can be released into pool water unknowingly by swimmers, especially small children. Protozoa are typically chlorine resistant and require heavy chlorination along with enhanced filtration for removal.

R)

Rapid-rate sand filters—A sand and gravel filter. These have a slower filter rate than the high-rate sand filters do.

Reagent—A liquid that produces color changes when mixed with other liquid samples and used as a measurement for tests such as chlorine, pH, total alkalinity, or phosphate. There are three classifications of reagents:

- **Titration**—The reagent is dropped into a water sample until a color change occurs within the sample. The number of drops used to accomplish a color change is then multiplied by a stated factor. Each drop used represents a level of the factor being used.
- **Colorimetric**—The reagent added to water brings an immediate color change, which is compared to a provided standard such as a color comparator.
- **Turbidity**—The reagent reacts with another chemical in the water sample to create turbidity. The cloudiness of the water is used to determine a reading level. Cyanuric tests are usually turbidity tests.

Resistant algae—Algae that recur in properly maintained pools that have been shocked and treated with algaecide. Resistant algae are a result of high phosphate levels in the water.

S)

Sanitizer—A chemical that is used in water treatment to effectively destroy disease-causing germs. Chlorine and bromine are two common sanitizers in the pool industry.

Scale—The formation of hard, sharp, crystalline-type material that forms on pool surfaces and in heaters. In swimming pools the main culprit of scale formation is calcium carbonate.

Shock—A term for the oxidation of swimming pool water to break apart chloramines and remove organic waste.

Silt—Very fine particles of sand.

Skin irritation—An inflammation of the skin caused from overexposure to chemicals.

Sodium hypochlorite—Made by passing chlorine gas through a solution of caustic soda. Liquid chlorine is one of the most widely used types of chlorine. The liquid used for swimming pools has an available chlorine of 12 percent and a pH of 13. Sodium hypochlorite is an alkaline or base form of chlorine and requires that the total alkalinity be adjusted in a lower range of 80 ppm to 100 ppm.

Stagnant water—Water that is not being circulated or treated with chemicals.

Superchlorination—A method of shocking using high amounts of chlorine to obtain breakpoint chlorination.

Suspended particulate matter—Organics, dirt, dust, and silt that possess a negative charge and are actively suspended within water. Suspended particulate matter exists in a micron size, which is too small to be removed by filtration. Complete flocculation is an effective way to completely grab and remove this material to the filter.

Swimmer waste—Nitrogen waste from perspiration and ammonia is a primary waste that comes from swimmers. Also, body oils, skin flakes, hair, and bacteria.

Glossary

T)

Tablet reagent test—Similar to liquid reagents but in tablet form. The tablet is dropped into a water sample, then crushed and mixed to create a color change within the sample.

Test strip—Reagent material is on small pads contained on a plastic strip. The entire strip is dipped into pool water, and a color change occurs on the pads, which are then compared to a color comparator.

Total alkalinity—The buffering capacity of water to resist pH changes from acid. Total alkalinity consists of carbonate, bicarbonate, and hydroxyl forms, which make up the total. In a swimming pool the majority of total alkalinity should be in the bicarbonate form.

Total chlorine (TC)—Also known as *total available chlorine*. Free available chlorine and combined available chlorine together make up total chlorine.

Total dissolved solids (TDS)—The sum of every substance or chemical added to the water. Total dissolved solids are deposited and left behind in the process of evaporation.

Total hardness—A measurement of minerals in the water, particularly calcium. Also known as *calcium hardness*.

Tri-chlor—Trichloro-s-triazine-trione made by drying and cooling the salt of cyanuric acid in the presence of chlorine gas. This compound has an available chlorine of 90 percent and a pH of 2.9. Because Tri-chlor is an acidic form of chlorine, the total alkalinity should be maintained at higher ranges between 100 and 120 ppm. Tri-chlor is available in 3-inch tablets, in 1-inch tablets, and in granular form.

Turbidity—The technical term for cloudy water. A high amount of suspended particles and organic waste causes turbidity levels to increase. The result of high turbidity is cloudy, unsafe water.

U)

Undissolved solids—Material that is insoluble or has not yet dissolved in water. These would be small particles of dirt, dust, pollen, or floating algae.

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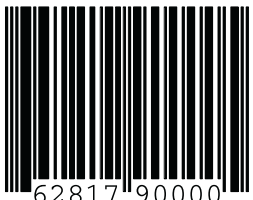


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Terry Arko has worked in the pool and spa industry for over twenty-five years. He has worked in service, equipment repair, retail management and chemical manufacturing. Terry is a Certified Pool/Spa Operator and has spent the last fourteen years as a technical consultant specialist in the area of chemical water treatment. He is the author of numerous articles relating to pool and spa chemistry. Terry is currently serving as president of the APSP (Association of Pool and Spa Professionals) Region VIII board. He has been called upon to teach water-related seminars at several industry trade shows. Terry is a technical product specialist for Vanson HaloSource, the makers of SeaKlear pool and spa products.

Notes

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