A high-angle, top-down photograph of a person swimming in clear, vibrant blue water. The person is positioned in the lower half of the frame, with their arms extended forward in a freestyle stroke. The water's surface is textured with ripples and reflections of light, creating a shimmering effect. The overall scene conveys a sense of cleanliness and refreshment.

The Book on Effective Water Treatment

For Pools, Spas & Hot Tubs

Foreword by Dr. Everett Nichols

SeaKlear®

Reliable & Effective



The Book on Effective Water Treatment

For Pools, Spas & Hot Tubs

SeaKlear[®]
Reliable & Effective



Since its beginning, SeaKlear[®] has been a leader in supplying eco-friendly pool products. Our first product, SeaKlear Natural Clarifier, is made from all-natural chitosan—a substance derived from shrimp and crab shells. The chitosan we use to create a natural solution for cloudy pool water is recycled waste from the seafood industry. Last year SeaKlear processed more than 900,000 pounds of shrimp and crab shells that otherwise could have ended up in a landfill.

SeaKlear products displaying the SeaKlear Eco-Friendly icon are made from naturally occurring substances that can lower your pool's impact on the environment by extending the life of the water in your pool and reducing the amount of harsh chemicals required to treat your water.

HaloSource, Inc.

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Water, “the universal solvent,” presents a variety of challenges to pool and spa professionals in their efforts to maintain both clarity and safety. Because any strategy for ensuring safe, clear water must be based on balanced water, we start by providing a fundamental understanding of basic water chemistry, which is key to achieving that balance. The proper treatment and balancing of recreational water is dynamic and can often be challenging due to a bewildering number of variables and influences such as weather, quality of fill water, dissolved organics, dust and dirt, exposure to windborne chemicals such as fertilizers, bather loads, animals, and even the chemicals that we add. This book provides the detailed information you need to deal with those variables and achieve clear, clean water. Areas of particular focus include filtration and the importance of properly functioning equipment. In addition, strategies for dealing with algae, stain-causing metals, and bacteria and protozoan parasites that are responsible for recreational water illness will also be discussed.

Material of special interest to you, the pool professional, includes several field tests and suggestions for opening and closing a pool or spa, a detailed troubleshooting guide, and a guide to effective merchandising.

It is our desire that you and your customers will benefit from our product innovation and cutting-edge research and development efforts so you can grow your business, make your job easier and improve your sales and customer service.

We thank you for your business and hope you find this book useful and rewarding.

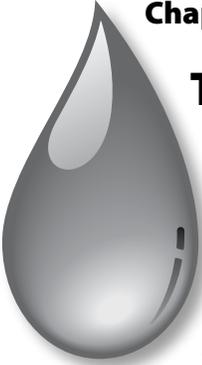
Dr. Everett Nichols
Scientific Director of Biopolymer Research

Dr. Everett Nichols is Scientific Director of Biopolymer Research for HaloSource Inc. He received his BS in bacteriology and public health from Washington State University and his MS in public health and PhD from the University of Washington, specializing in pathobiology and the biochemistry of complex carbohydrates. Dr. Nichols has over 28 years of experience working with natural carbohydrate biopolymers and complex oligosaccharides, including both chitin and chitosan. He has directed and participated in the discovery, development and commercialization of a variety of products, many of which are chitosan based and are used in recreational, industrial, storm and aquaria water applications. Dr. Nichols provides a technical, strategic perspective to the solution of complex problems and also manages HaloSource’s intellectual property portfolio, which consists of more than 130 patents and pending patent applications.



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Chapter 1

The Elements of Water Chemistry

Water chemistry is the key to a properly run pool. When the water is in balance—that is, properly saturated with equal amounts of acids and alkalis—life is good. When the water becomes either too acidic or too basic, problems begin. These problems may be as simple as skin or eye irritation or as dangerous as blistering of the swimmer’s skin and damage to the equipment or vessel. The primary factors in proper water maintenance are keeping the water in chemical balance and maintaining an appropriate level of sanitizer in the water. This maintenance is critical to the safety of swimmers, avoiding damage to the pool surface and equipment, and maintaining clean, clear water.

This chapter examines these aspects of good water chemistry and how to achieve it, and clearly demonstrates that it is much easier and much more effective to prevent problems such as waterborne diseases than it is to treat them.

Balancing the Water

The following sections explain what is meant by balanced water. Procedures for balancing water chemistry, including opening a pool or spa, can be found in the “Routine Maintenance and Troubleshooting” chapter.

Alkalinity

Total alkalinity and pH are like a father and son because although they are related, they are not the same. 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 in water chemistry.

In the analogy of total alkalinity and pH as father and son, it is total alkalinity that is considered the father. The job of the father is to keep his young son from wandering off where he doesn’t belong. Likewise, total alkalinity helps to keep pH in line. Total alkalinity is a measurement of alkaline compounds, which produce basic solutions when ionized. Because the alkaline

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compounds, called buffers, ionize when it is necessary, they are capable of holding the pH steady. For this reason, total alkalinity is defined as the buffering capacity of water.

The standard suggested by the Association of Pool & Spa Professionals (APSP) for total alkalinity is 60 parts per million (ppm) to 180 ppm. The ideal range for alkalinity is 80 to 100 ppm. This level may vary, depending on the type of sanitizer being used. For example, if the main source of chlorine used in a pool is sodium hypochlorite (liquid chlorine), which is alkaline, the total alkalinity should be maintained in the lower range—no higher than 100 ppm.

Alkalinity exists in three forms: carbonate, bicarbonate and hydroxide. At the pH values commonly found in swimming pools, the majority of alkalinity exists in the bicarbonate form.

The best method for raising total alkalinity is to use sodium bicarbonate, or baking soda. A dose of 1.5 pounds of sodium bicarbonate will raise total alkalinity 10 ppm in 10,000 gallons of pool water. Sodium bicarbonate works well because it is able to raise the alkalinity with little effect on pH.

pH

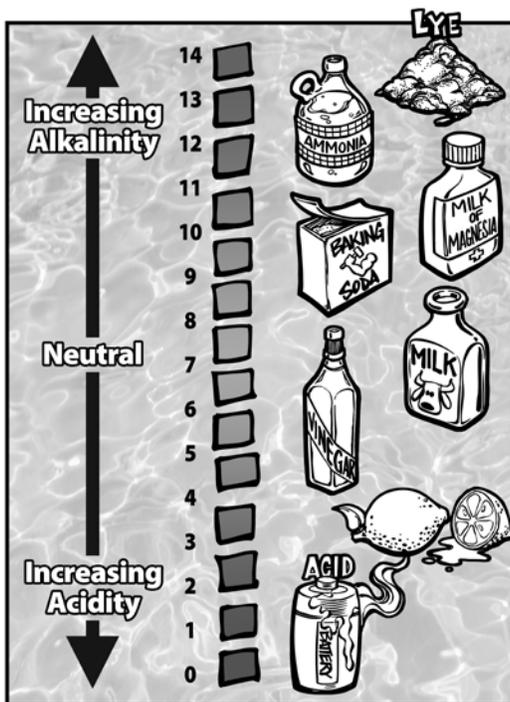
This is a measurement of the acidity of the water. The low end of the pH scale indicates the predominance of hydrogen ions (acidity). A high pH measurement indicates the predominance of hydroxyl ions (base). The APSP standard for pH is a minimum of 7.2 to a maximum of 7.8. The ideal pH is 7.4 to 7.6.

It is important to understand that the pH scale is logarithmic and that the values on the pH scale differ by a factor of 10. In other words, with each increase or decrease on the scale, there is a multiplier of 10. For example, a pH of 6 is 10 times more acidic than 7, whereas a pH of 8 is 10 times more base than 7. A pH of 5, therefore, would be 100 times more acidic than 7. Every move on the pH scale is a big leap.

In pools, sodium carbonate (soda ash) is used to raise both total alkalinity and pH. Muriatic (liquid) acid is used to lower pH. An acid demand test should be used to determine whether acid or soda ash should be added.

Using soda ash in a spa or hot tub is not recommended because there is the potential for a spike in pH. In spas, sodium bicarbonate should be used to raise both pH and alkalinity. Dry sodium bisulfate (acid) is used to lower pH and alkalinity.

pH Range



Total Hardness

This is a measurement of the mineral salts present in the water, which could include calcium, magnesium, aluminum, iron or manganese. About 70 to 75 percent of total hardness is made up of calcium, and calcium is typically the mineral that causes hard water.

The ideal level of total hardness is 200 to 400 ppm. When hardness reaches 500 ppm or more, the pool should be at least partially drained. When it is necessary to raise calcium hardness, calcium chloride is added.

Total Dissolved Solids

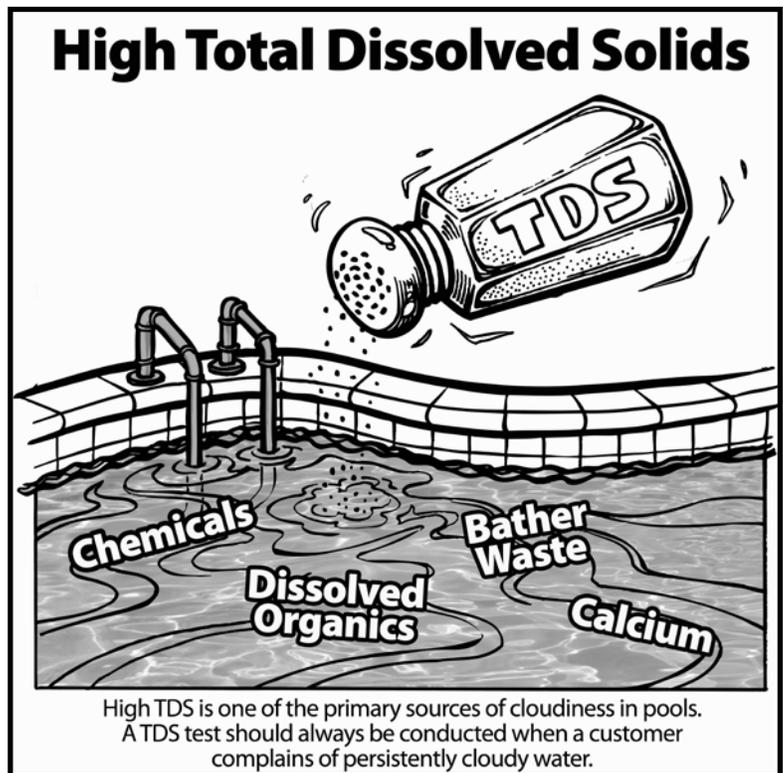
Total dissolved solids (TDS) includes everything chemical that exists in a soluble form. This can include calcium carbonates, dissolved organic and inorganic materials, salts from chlorine residue and swimmer waste. The ideal TDS level is 1,000 to 2,000 ppm. High TDS water tastes salty because of its high mineral content. Seawater, for example, has a TDS of 35,000 ppm.

It is important to monitor TDS because even levels of 1,500 ppm above that of the water supply can reduce chlorine efficiency by up to 50 percent. Dilution by draining and refilling or backwashing is the only way to deal with high TDS.

Saturation Index

The Langelier Index was originally designed for use in industrial water venues such as boilers and cooling towers. It was used to measure the degree of saturation of calcium carbonate in the water. The saturation degree is determined by measuring the following four items:

- pH
- Temperature
- Total alkalinity
- Calcium hardness



Most test kit manufacturers provide a Saturation Index table for use in determining whether pool water is oversaturated (scale forming) or undersaturated (aggressive). The actual pH level is used as a factor for pH; all other factors for temperature, total alkalinity and calcium hardness are pulled from the Saturation Index table and all are added together with the pH level. A value constant of 12.1 is subtracted from the total, giving the saturation of the water.

Any value between -0.5 and $+0.5$ is considered to be balanced water. A value under -0.5 is considered aggressive, and over $+0.5$ is scale forming. When the TDS reading is over 1,000 ppm, a value constant of 12.2 should be used.

Methods of Sanitizing

Sanitizers should be viewed as disinfectants for pool and spa water. As mentioned earlier, improperly sanitized water leaves the user vulnerable to diseases. In addition, unsanitary water may become malodorous, visually unappealing and dangerously turbid. Everyone deserves to enjoy clean, healthy swimming pool or spa water. The pool owner or operator has an obligation and responsibility to maintain an inviting and sanitary water environment at all times.

In this section we place an emphasis on chlorine as the primary sanitizer because of its worldwide acceptance and cost-effectiveness. There are, however, several alternative sanitizers available today; we have highlighted only a few.

Chlorine

Chlorine is the most widely used, inexpensive and readily available sanitizer (or disinfectant) of pool water. There are several forms suitable for pool and spa sanitation:

- **Gas chlorine** (99 percent available chlorine, $\text{pH} < 1.0$). The strongest form of chlorine, this is rarely used due to hazardous application, regulation and licensing requirements. It is the most dangerous form of chlorine, and precautions must be taken when handling it.
- **Tri-chlor** (90 percent available chlorine, $\text{pH} 2.9$). Usually sold in 1-inch and 3-inch tablet form and applied to the pool by inline feeders or floaters or placed in the skimmer, Tri-chlor is widely used in both residential and commercial pools because of its cost-effectiveness, ease of use and ability to resist degradation by exposure to the sun. It is the second-strongest form of chlorine and when it is properly used, it is considered safer to apply and store than other forms of chlorine. It is stabilized by adding cyanuric acid to the chemical makeup. Tri-chlor is also available in granular form, but that form is very expensive and generally used only to combat stubborn algae.
- **Di-chlor** (55 to 68 percent available chlorine and a pH of 6.5 to 6.8). Di-chlor is also stabilized with cyanuric acid but is more pH neutral due to its sodium base. Di-chlor is a granular compound that is applied broadcast over the pool surface. It is widely recommended for vinyl-liner and fiberglass pools due to its quick-dissolving nature. Although it may also be used as a shock, it will drive the cyanuric acid level up and out of the acceptable range.

- **Calcium hypochlorite** (55 to 73 percent available chlorine, pH 11.7). An unstabilized form of granular chlorine that is widely used in the industry to shock pools, calcium hypochlorite is very high in pH and therefore not widely used as a primary sanitizer except in large commercial applications where cyanuric buildup is a concern. In these instances, it is dispensed in tablet form and only by a dedicated Cal-Hypo feeder system.
- **Lithium hypochlorite** (27 to 39 percent available chlorine, pH 10.7). Another granular chlorine that is sometimes used in aboveground pools, and in vinyl-liner and fiberglass applications, lithium hypochlorite is weaker than Di-chlor and Cal-Hypo and is also unstabilized.
- **Liquid chlorine** (10 to 13 percent available chlorine, pH 13). Although convenient, liquid chlorine is a weak form of chlorine that is widely used as a shock and in some areas of the country as a primary sanitizer. Because liquid chlorine is not stabilized and has a short shelf life, prolonged performance is difficult to attain, and it degrades very quickly.

Bromine and Other Alternatives to Chlorine

Bromine is an alternative to chlorine but does include some chlorine, which is used to activate the bromide molecule. It is a very effective sanitizer but must be protected from sunlight. Because it is more effective in heated water, however, bromine is used primarily for sanitizing indoor pools and spas. It is important to remember that bromine is more effective when a chlorine-free shock oxidizer, such as SeaKlear Chlorine-Free Shock Oxidizer, is used regularly.

Other alternatives to sanitizing water with chlorine are copper-based and silver-based products, which are usually dispensed in some type of control device. Because of health department requirements, these products are effective in reducing but will not eliminate the use of a chlorine-based sanitizer.

There are several other alternatives to chlorine or bromine, but they are usually expensive, harder to maintain and not as effective. Biguanides (Baquacil®, Revacil®, Soft Swim® and so on) are the most widely used, but more and more products are offered each year.

Chloramines

To disinfect the pool, most owners use chlorine. Sometimes, however, chlorine can combine with ammonia and nitrogen-based organics (coming primarily from swimmer waste) and form chloramines.

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. FAC is the effective killer of bacteria that we rely on to disinfect pools. When the CAC is higher than the level of FAC, the pool water will become cloudy and unsafe for swimming. To maintain clear and clean water, the free

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available chlorine must be maintained between 2.0 and 4.0 ppm 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.

There are two ways to reduce the level of chloramines in a pool:

- Using 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 10. For example, if the CAC is 2.0 ppm, the FAC level should be raised to 20 ppm. For more information about superchlorination, see page 7.
- Using a chlorine-free shock oxidizer such as SeaKlear Chlorine-Free Shock Oxidizer at a rate of 1 pound per 10,000 gallons. Oxidizing is discussed in more detail below.

It is important to note that the above methods are only effective at breaking up inorganic chloramines. These types are chlorine attached to ammonia. There can also be a buildup of organic chloramines in swimming pools. These are chlorine molecules attached to organic nitrogen. Organic chloramines cannot be destroyed by superchlorination or by chlorine-free shock oxidizer. Draining and dilution are the only ways to lower the level of organic chloramines.

Sanitizers vs. Oxidizers

There is a distinct difference between a sanitizer and an oxidizer. A sanitizer destroys disease-causing germs; sanitizing water means the removal of bacteria from pool or spa 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, such as chemical by-products, microscopic dirt, dead algae and swimmer waste.

Oxidizing is a common practice in the industry, but many people do not fully understand when it is necessary. The key reason for oxidizing is to convert the chloramines in the water back into free available chlorine. This assures that all available chlorine is active to sanitize.

Chlorine and bromine are two sanitizers that also act as oxidizers, which means 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, the chemical is 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.

There are four ways of oxidizing waste in pools: superchlorination, hyperchlorination, extreme oxidizing (ozone) and chlorine-free oxidizing.

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 *breakpoint chlorination*.

Based on the theory that it takes seven molecules of chlorine to effectively oxidize one molecule of combined chlorine, superchlorination adds an amount of chlorine that is 10 times the combined chlorine level (total chlorine minus free available chlorine). This generally requires a fairly large dose of granular or liquid chlorine.

In theory, the excessive amount of chlorine is enough to burn up waste materials, such as chloramines, and still have some residual free chlorine left over for sanitizing.

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

- Success is hard to determine. For example, there could be such a large buildup of 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, which cannot be removed by superchlorination.
- Dumping high amounts of chlorine into pools is hard on equipment and pool surfaces.
- The pool must be closed for an extended period of time to allow the chlorine level to return to safe levels.

Hyperchlorination

In August 2008, the Centers for Disease Control and Prevention (CDC) recommended that the process of *hyperchlorination* be used in pools suspected of contamination, in an effort to destroy harmful cysts and bacteria otherwise resistant to traditional sanitizing and oxidizing methods (“Hyperchlorination to kill *Cryptosporidium*,” August 1, 2008). The costly hyperchlorination process, however, requires maintaining a minimum of 10 ppm of chlorine for 25.5 hours with a pH of 7.5 or lower and at a water temperature of 77°F or higher. Alternatively, a minimum of 20 ppm of chlorine can be maintained for 12.75 hours with a pH of 7.5 or lower and at a water temperature of 77°F or higher.

Extreme Oxidizing

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

Chlorine-Free Oxidizing

A better way to oxidize and remove nonbacterial waste and chloramines is to use a chlorine-free shock oxidizer in addition to a sanitizer. The chlorine-free shock oxidizer oxidizes combined chlorine, thereby ensuring that the sanitizer, specifically available chlorine, is used to sanitize.

Organic impurities are oxidized by using as little as 1 pound of chlorine-free shock oxidizer per 10,000 gallons of water. Using a chlorine-free shock oxidizer also has the advantage that it works quickly—swimming can resume after just 15 minutes. In pools over 50,000 gallons, it is recommended to wait 45 minutes before allowing swimmers to return to the pool.

One such oxidizer is SeaKlear Chlorine-Free Shock Oxidizer. It is one of the strongest blends of potassium monopersulfate (MPS) on the market, containing 4.75 percent oxygen. Because SeaKlear Chlorine-Free Shock Oxidizer is so effective at oxidizing waste and even stubborn organic chloramines, it can be used along with chlorine to help keep water both clear and sanitized.



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An Overview of Water Clarity

Beyond water balance, water clarity is another key to safe, enjoyable, appealing water. Water clarity in a swimming pool is something that is taken for granted. Pool owners don't spend much time thinking about clear water—until the pool becomes cloudy. That's when they go to their dealer or pool professional, demanding an immediate solution to the problem of their cloudy pool. In this situation, knowledge of the causes of water cloudiness and their effects, along with a good grasp of the proper standards, can help professionals offer their customers real solutions.

The 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.

- **Appearance.** Unsightly, cloudy or discolored water makes swimming undesirable.
- **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.
- **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 underwater 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. When the boy was discovered missing, the boy's parents called the police, and

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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.

Standards for Water Clarity

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

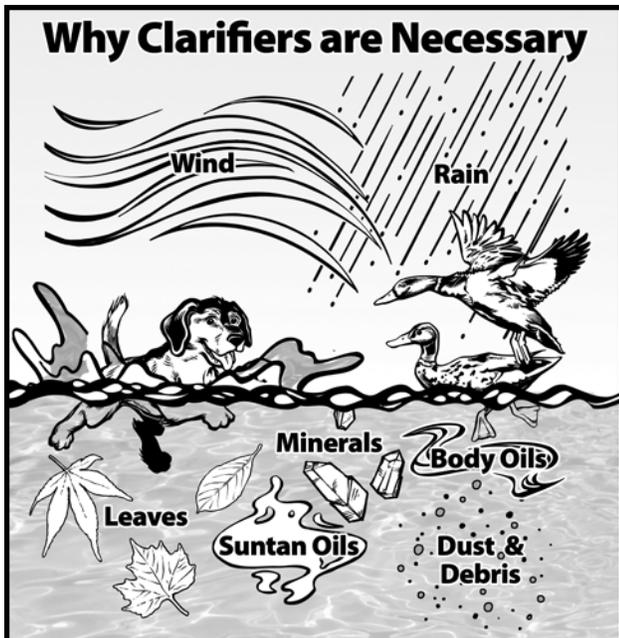
Formal standards for water clarity in public pools are based on drinking water standards determined by the National Sanitation Foundation (NSF). The NSF standard for water clarity is 0.5 nephelometric turbidity units (NTUs). At times of peak bather loads, the turbidity is allowed to increase to 1.0 NTU, but it must return to 0.5 NTUs within six hours following peak use (National Swimming Pool Foundation, *Certified Pool-Spa Operator Handbook*, 2005).

NTUs are 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.

Particulate matter in swimming pools comes from bather waste and organic debris. This debris is primarily negatively charged ions that when in suspension repel off one another, contributing to the turbidity of the water. The more turbidity, the cloudier the water will be.

Causes of Cloudiness

Oftentimes, cloudy pool, spa or hot tub water may be caused by a lack of sanitizers such as chlorine. If that has been ruled out, the underlying problem may be suspended particulate matter in the water. Suspended particulate matter is a fancy way of saying:



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

These issues are dealt with through a combination of filtration and chemical treatment, which are described in more detail in the following pages. The “Algae and Phosphates” chapter and the “Metals, Minerals and Stains” chapter provide specific instructions for dealing with those problems.

Water Clarification

Proper filtration and a good chemical treatment system are the keys to clear water in a swimming pool or spa. 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. This chapter details the role that filtration and chemicals play in helping to clear cloudy water.

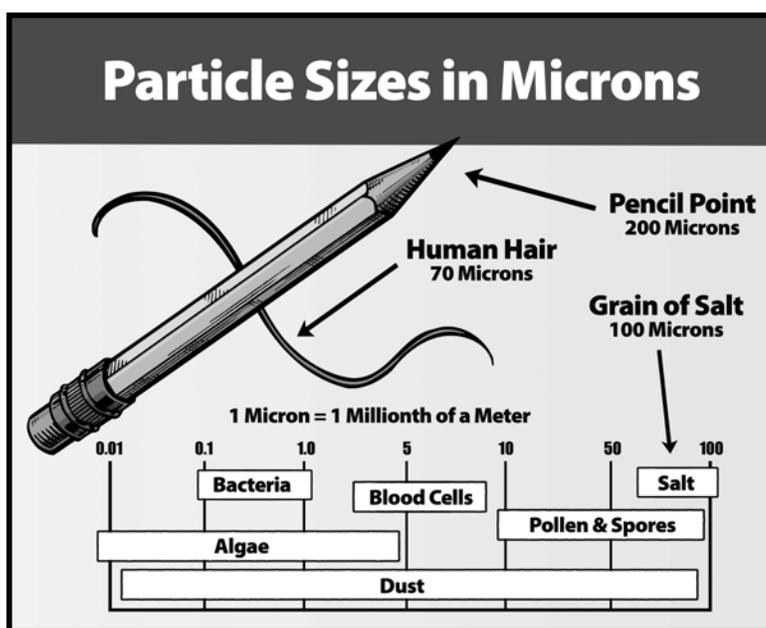
Filtration

Filters clarify water by removing particulate matter suspended in 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.

Different types of filters are designed to remove materials of varying sizes, measured in microns. For example, sand filters work by passing water through a bed of specialized sand media, which is capable of removing matter larger than 25 microns. Any smaller particulate matter cannot be caught by a sand filter. The most common filters and their micron-removal capabilities are shown in the illustration on page 12.

No matter what type it is, the filter must be in proper working condition to ensure clean and sparkling water. If, for example, the sand in a sand filter wears out, the filter will 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 or spa. This will lead to a buildup of small-micron materials in the water and result in cloudy water.

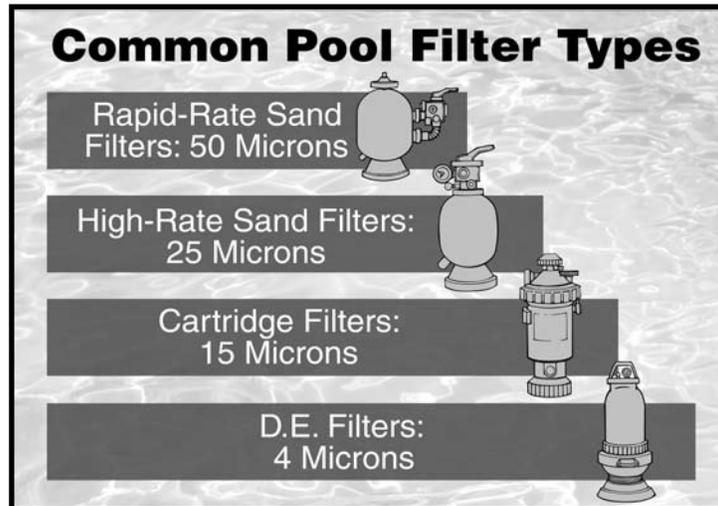
Therefore, to maximize their effectiveness, filters of all types should be cleaned regularly according to the manufacturer’s specifications.



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
- Eroded 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:

- A dirty, oil-clogged cartridge
- Holes or tears between the pleats
- A cartridge that is improperly seated in the filter bottom fitting
- A worn cartridge that needs replacement
- Improper sizing of the cartridge filter

D.E. filters:

- Uneven D.E. coating of the filter grids
- Torn filter grids, a cracked manifold or a worn backwash gasket, allowing D.E. to pass into the pool
- Leaks in the equipment system that allow air to enter the filter tank

Clarifiers

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 takes 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.

Clarifiers vs. Alum

In contrast to clarifiers, alum 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 a proper pH balance and will not work if pH is above 7.8.

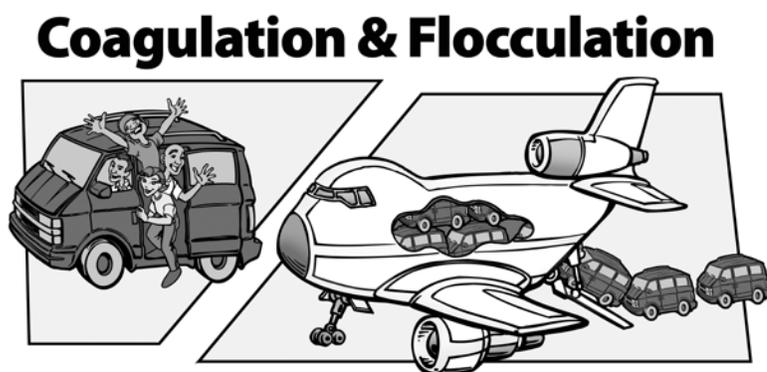
Enzymes

When used with clarifiers, filter enhancers and oxidizers, enzymes can reliably deliver clean, clear water. An enzyme works to digest the organic waste, specifically oils, in the water much like the enzymes in your stomach help you digest your food. In situations where oil and oily scum are a severe problem, SeaKlear Enzyme Klear can be used to boost the effectiveness of SeaKlear Natural Clarifier or SeaKlear PRS®. SeaKlear Enzyme Klear is an effective way to eliminate an existing oily scum line, maintain filter efficiency and assist in keeping water clear.

Coagulation vs. Flocculation

Most clarifiers used in swimming pools are coagulants. Be wary of some synthetic clarifiers that claim to be flocculants when in fact they are not true flocculants, but rather strictly coagulants.

- **Coagulation.** When a positive ion enters the water, it attracts negatively charged ions, and the process of coagulation begins. Much of what is coagulated is caught in the filter. However, even some coagulated material can be small enough that it continues to pass through filters (particularly sand filters).



- **Flocculation.** Flocculation is a step up from coagulation because flocs are made up of “bridged” coagulated ions. Thus, flocs are bigger and more able to be trapped by filters. One way to illustrate the difference between coagulation and flocculation is to compare a minivan 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) and transport them.

Clarifiers are used for removing small particulate matter from water using coagulation and flocculation. Many clarifiers coagulate, but not all completely flocculate.

Natural Water Clarification Solutions

SeaKlear Natural Clarifier both coagulates and flocculates small particles for superior water clarity. The patented SeaKlear Natural Clarifier is the only nonsynthetic, nonpetroleum clarifier

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on the market. The all-natural formula of SeaKlear Natural Clarifier is based on chitosan, a substance derived from shrimp and crab shells that are a by-product of the seafood industry.

SeaKlear PRS is a patented, two-stage, all-natural clarifier with the ability to rapidly remove particles as small as 0.5 microns to the filter. SeaKlear PRS has been reviewed by the Environmental Protection Agency (EPA) for the trapping of *Cryptosporidium*, *E. coli*, *Giardia* and algae in a pool's filter. The germs are effectively trapped in a complete, stable floc and removed from the water by filtration. SeaKlear PRS is approved to NSF 60 standards.

SeaKlear PRS has the unique ability to first coagulate and then flocculate the contaminants, especially the cysts and bacteria, in the water in stage one. Then stage two binds the flocculated material into stable flocs that can be held in the filter until they are backwashed or rinsed away. SeaKlear PRS is highly effective in high-pressure commercial filter systems where normal clarifiers would break down under the pressure and allow the contaminants to return to the pool or spa.

SeaKlear PRS has the ability to gather particles as small as 0.5 microns into stable flocs as large as 70 microns. This unique ability is why it is able to trap and hold diseased cysts and bacteria in the filter. This is also why SeaKlear PRS is outstanding for clearing up a swampy pool. A program for opening and clearing a swampy pool is available in the "Routine Maintenance and Troubleshooting" chapter.

Chapter 3



Algae and Phosphates

The most common, and sometimes most frustrating, problem for the average pool owner is algae. Algae is an unsightly problem that can significantly detract from the enjoyment of a swimming pool.

The types of algae found in pools include:

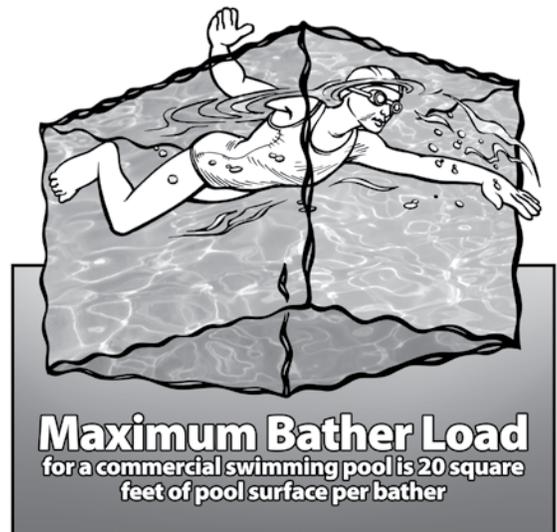
- **Green**, which can be free floating or on pool walls
- **Yellow (mustard)**, powderlike algae that cling to walls, steps and corners
- **Blue-green (*Cyanobacteria*)**, often mistaken for green algae but are actually bacteria that thrive on phosphates
- **Black**, which appear as small to quarter-size algae patches embedded into a surface

Some algae are more resistant to chemical treatment than others. SeaKlear offers several products that are proven to be reliable and effective at removing and preventing algae in swimming pools.

Algae Growth Factors

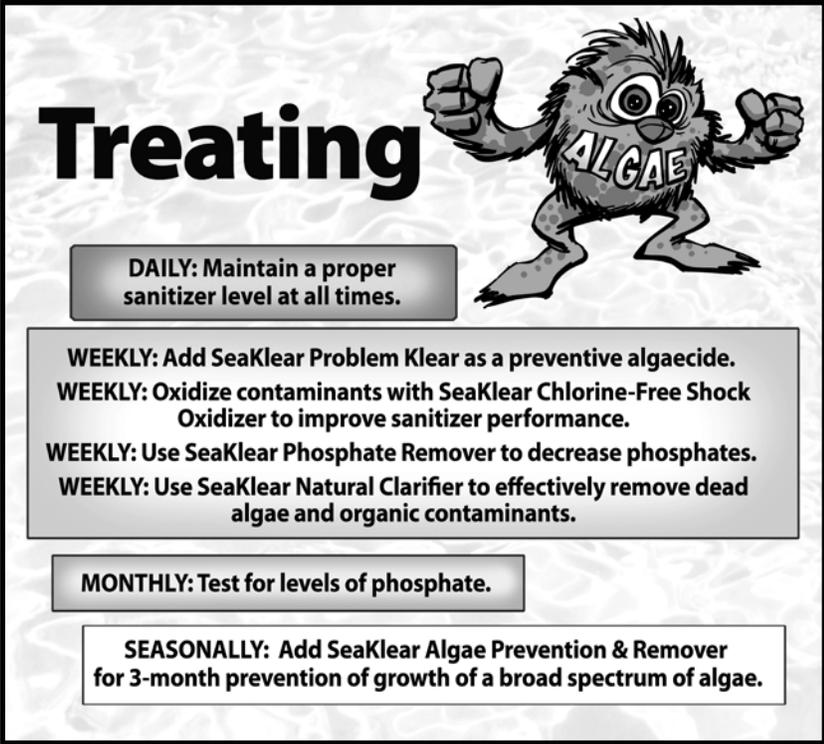
Algae need the following conditions in order to thrive:

- **Sunlight.**
- **Lack of sanitizer.** High bather load or an excess of organic debris in the pool causes a



demand on the chlorine. If the chlorine demand is not met and there is an insufficient residual of chlorine, algae can grow. It is important to be sure that the chlorine is maintained between 1.0 ppm to 4.0 ppm at all times. Excess nitrogen ammonia uses chlorine very rapidly. Chlorine levels should be carefully monitored at times of peak bather load.

- **Warm water.** Most common pool algae love warm water. Care should be taken to keep the water temperature below 80°F if possible. Algae become a problem for many pools in the spring.
- **Rough surfaces.** Cracks and crevices attract algae growth. Regular brushing of the pool surface is a preventive measure.
- **Poor circulation.** Algae thrive in still waters. If a pool has areas where the water does not move well, algae can settle in those “dead spots.” Good, strong circulation and filtration help keep algae from taking hold.
- **Carbon.** Algae breathe carbon dioxide and therefore need CO₂ to survive.



Treating

DAILY: Maintain a proper sanitizer level at all times.

WEEKLY: Add SeaKlear Problem Klear as a preventive algacide.
WEEKLY: Oxidize contaminants with SeaKlear Chlorine-Free Shock Oxidizer to improve sanitizer performance.
WEEKLY: Use SeaKlear Phosphate Remover to decrease phosphates.
WEEKLY: Use SeaKlear Natural Clarifier to effectively remove dead algae and organic contaminants.

MONTHLY: Test for levels of phosphate.

SEASONALLY: Add SeaKlear Algae Prevention & Remover for 3-month prevention of growth of a broad spectrum of algae.

- **Nutrients.** Nitrates and phosphates are necessary for algae to survive.

Phosphates

Phosphates are biological building blocks that are formed when phosphoric acid comes in contact with certain metals. It is important to understand that phosphates exist in many different forms. Most of these come from natural sources such as rivers, lakes and oceans or mined rock. (The United States is one of the largest producers of phosphate rock.)

Phosphate is termed a “pollutant” and is primarily used in soaps, detergents, shampoos and even soda pop. Other phosphate sources include fertilizers, organic debris such as leaves and bark, and some pool chemicals. Phosphate pollution in lakes and streams is due mainly to overdevelopment, which causes extreme amounts of by-product waste to end up in natural water systems.

Most of the phosphates in pool water enter in the form of a compound such as trisodium phosphate. Algae cannot use these combined phosphates as a nutrient for growth. It is not until

the phosphate compounds are broken down into free orthophosphates, by oxidation, hydrolysis or enzymatic digestion, that algae can begin to thrive.

Benefits of Phosphate Removal

Removing phosphates and maintaining proper levels can be very beneficial to the health of a pool or spa. First, these practices will improve the overall quality of the water. In addition, they will keep phosphates at the correct level; high phosphates will interfere with chlorine generators and prevent proper levels of free chlorine from being produced.

SeaKlear Phosphate Remover is proven to remove high levels of phosphate from swimming pools safely and effectively. SeaKlear Phosphate Remover is fast acting and concentrated, removing more than 9,000 parts per billion (ppb) of orthophosphate in 10,000 gallons of water. Quick, easy and cost-effective, SeaKlear Phosphate Remover is proven reliable and effective at removing the phosphates that come from fertilizers, rainwater, soaps, decaying vegetation and other pollutants. SeaKlear Phosphate Remover is 100 percent nontoxic and safe for swimmers and the environment. It is easy to use and in most cases does not leave a messy residue on the pool floor.

Killing Algae

The best way to fight algae growth in pools is to avoid a pool environment that is conducive to the growth of algae. A program for preventing algae growth is available in the “Routine Maintenance and Troubleshooting” chapter.

Chlorine is the chemical used most often to fight algae. While chlorine may be sufficient for some algae, residual algae can still remain in places, such as the filter, where the chlorine may not effectively kill it. A good choice for supplementing chlorine is a superior 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. SeaKlear Problem Klear is an effective preventer of green, black and yellow (mustard) algae. SeaKlear Yellow Klear is an effective killer of green and yellow (mustard) algae.



SeaKlear Algae Product Comparison Chart

Algae Type	SeaKlear Algae Prevention & Remover	SeaKlear Problem Klear	SeaKlear Yellow Klear
Yellow or Mustard Algae	Better	Prevention	Best
Green Algae	Better	Prevention	Best
Black Algae	Best	Prevention	-
White Water Mold	Best	-	-
Brushing Required	Wire brush daily for black algae	Weekly	-
Oxidizing Required	Yes, after 1 hour	Yes	Yes
Recommended Oxidizer	SeaKlear Chlorine-Free Shock Oxidizer or chlorinating compound	SeaKlear Chlorine-Free Shock Oxidizer or chlorinating compound	SeaKlear Chlorine-Free Shock Oxidizer or chlorinating compound
Approximate Kill Time	24 hours	Prevention	Starts immediately
Compatible with Salt Pools	No	Yes	Yes
Duration of Protection	3 months	1 week	1 week
Dose (per 10,000 gallons)	16 ounces	6 ounces	4 ounces



Chapter 4

Metals, Minerals and Stains

A pool can be a beautiful addition to any backyard environment. There are a variety of pool surface types and a multitude of designs, patterns and features available. Many pools also have decorative tile along the waterline that gives the pool a high-end look. Unfortunately, this can all be ruined by the formation of stains on the pool surface or scale on the tile.

Surface stains are typically caused by metals in the pool water or tannins from organic material left in the pool. Metals can come from several sources.

In many areas, groundwater contains dissolved metals or minerals. Iron, copper and manganese are the most prevalent metals found in municipal and well water. These metals can be introduced to the pool anytime water is added, and if preventive measures are not taken, the surface can become stained. The other primary cause of the introduction of metals into pool water is improper water balance. Low pH or total alkalinity can cause corrosion of the metal components of the equipment or pool—most commonly the heaters, ladders and pool lights—and that corrosion can result in a buildup of metals such as copper or iron in the pool water. This buildup not only will cause staining, but also can cause serious and expensive damage to the equipment.

The minerals calcium and magnesium can cause hard water in swimming pools, and hard water can lead to the formation of scale on the pool surface and tile. This scale can be very unsightly and difficult to remove.

As with other common pool and spa problems, the best way to fight the problems caused by metals and minerals is to prevent them. Therefore, a stain prevention program is a key part of any regular pool maintenance program. A simple program for preventing the problems caused by high metal content is available in the “Routine Maintenance and Troubleshooting” chapter.

The symptoms of high metal and mineral content include:

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

When treating for metal in the water, it is best to use a phosphate-free product such as SeaKlear Metal Klear. In areas of very high metal content, SeaKlear Metal Stain Control is suggested. In situations where high metals and/or metal stains exist, especially in plaster or Pebble Tec® pools, SeaKlear Stain Prevention & Remover—Professional Strength is recommended.



The rule of thumb for treating stains is, the milder the better. Stain lifters and metal removers are acids and corrosive by nature. Using SeaKlear Natural Stain Remover is recommended for lifting most stains without damaging the vessel or equipment, especially in vinyl or fiberglass pools.

For the lifting of tough stains, especially in older gunite pools, SeaKlear Stain Klear is recommended. It is highly effective on older stains on steps or on tannin stains from leaves or organic debris. For copper stains in gunite, marcite, Pebble Tec or Diamond Brite™ pools, SeaKlear Stain Prevention & Remover—Professional Strength is recommended.

Anytime SeaKlear Natural Stain Remover or SeaKlear Stain Klear is used to lift a stain, the application should be followed up with SeaKlear Metal Klear to capture the metals or tannins and take them to the filter. SeaKlear Metal Klear can be added 15 minutes after SeaKlear Natural Stain Remover or SeaKlear Stain Klear.

The filter should be backwashed or cleaned 24 hours after the stains lift, to give SeaKlear Metal Klear time to remove the stain particles to the filter. Once the stains have been lifted and the containment has been removed by the filter, promptly backwash or rinse out the filter to prevent the stain from returning to the pool.

The SeaKlear Metal & Stain Product Comparison Chart on page 21 explains which surfaces each product works best on and the issue the product will resolve. It also provides proper dosage information.

Tip: To test whether SeaKlear Natural Stain Remover will work on a stain, rub a vitamin C tablet on the stain. If the tablet lifts or lightens the stain, SeaKlear Natural Stain Remover will work.

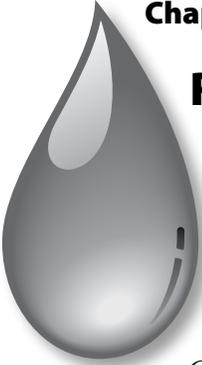
SeaKlear Metal & Stain Product Comparison Chart

	SeaKlear Natural Stain Remover	SeaKlear Stain Klear	SeaKlear Stain Prevention & Remover– Professional Strength	SeaKlear Metal Stain Control	SeaKlear Metal Klear
Stain Type					
Copper	Best	Good	Better	-	-
Other Metals	Best	Better	Good	-	-
Organic	Best	Better	-	-	-
Cobalt	Best	Better	-	-	-
Scale	-	-	Best	Better	-
Metals in Solution					
	--	--	--	Better	Best
Surface Type					
Vinyl	Best	-	-	-	Not a stain remover
Fiberglass	Best	-	-	-	
Plaster/Gunite	Best	Better	Good	Good	
Pebble Tec	Best	Better	Good	Good	
Other					
Sequester	-	-	-	Better	Best
Phosphate-Free	Yes	Yes	-	-	Yes
Requires Metal Klear	Yes	Yes	-	-	-
Test for Phosphates	-	-	Yes	Yes	-
Dose					
Stain Removal	2 lb per 20,000 gallons	2 lb per 20,000 gallons	1 qt per 20,000 gallons	1 qt per 10,000 gallons	2 qt per 10,000 gallons
Sequester	-	-	1 qt per 20,000 gallons	1 qt per 10,000 gallons	1 qt per 10,000 gallons
Maintenance	-	-	Better (6–8 oz per 10,000 gallons)	Good (6–8 oz per 10,000 gallons)	Best (6–8 oz per 10,000 gallons)

SeaKlear Metal & Stain Product Comparison Chart (cont.)

SeaKlear Natural Stain Remover	SeaKlear Stain Klear	SeaKlear Stain Prevention & Remover—Professional Strength	SeaKlear Metal Stain Control	SeaKlear Metal Klear
Features & Benefits				
<ul style="list-style-type: none"> • All-natural citric acid formula • More cost-effective and less caustic than ascorbic acid • Effectively removes organic, tannin, copper, iron and manganese stains • Excellent for spot treatment • Excellent for all surfaces • MUST be followed by SeaKlear Metal Klear 	<ul style="list-style-type: none"> • Excellent for tough, old stains on gunite, plaster and hard surfaces • Effectively removes copper, iron and manganese stains • Can be used as a spot treatment • MUST be followed by SeaKlear Metal Klear 	<ul style="list-style-type: none"> • Removes and prevents metal stains from iron, copper and other metals • Removes scale and controls scale buildup • Effectively removes stains in gunite, plaster, and Pebble Tec pools 	<ul style="list-style-type: none"> • Effective for removing the metals that cause stains • Prevents staining, controls scale 	<ul style="list-style-type: none"> • Phosphate-free formula prevents metal stains and is excellent for use in high-phosphate areas • Ideal for pools with salt systems • Excellent for preventing stains on all pool surfaces • MUST be used after SeaKlear Natural Stain Remover or SeaKlear Stain Klear





Chapter 5

Recreational Water Illness

Even clear water can have potential problems lurking in it. Without proper maintenance, pool and spa water can be contaminated with bacteria and parasitic pathogens. These are commonly known as recreational water illnesses (RWIs) and are increasingly becoming a concern. RWIs are caused by pool water contaminated with bacteria or parasitic pathogens that are released by swimmers.

Cryptosporidium, *E. coli*, *Giardia*, *Shigella* and *Pseudomonas* are just some of the contaminants present in pool water that can lead to an RWI outbreak. Most of these germs are killed by the proper use of chlorine and correct water balance, but some, such as *Cryptosporidium*, are highly chlorine resistant and require other means of treatment and prevention.

***Cryptosporidium* Defined**

Cryptosporidium, commonly referred to as Crypto, is a parasite that is very difficult to detect and destroy in pool water. Crypto can be introduced into swimming pool water from swimmers who release fecal material. Although chlorine and bromine are effective at killing most pathogenic bacteria, Crypto is highly resistant to standard sanitizers such as chlorine. In its oocyst stage, Crypto is protected by a thick outer shell, so it can remain viable in properly chlorinated water for six to seven days. When swallowed by swimmers, Crypto can cause severe symptoms such as diarrhea, stomach cramps, fever, nausea and vomiting. Crypto cysts are approximately 4 to 6 microns in size and can pass through most sand filters. Even in D.E. filters, which pick up material down to 4 microns, Crypto can elongate and pass through the media.

Risk of Crypto to Swimmers

- On average, adult swimmers swallow 1 ounce of pool water per swim, and children typically swallow twice that amount.
- Even clean, showered swimmers introduce fecal matter, which can contain Crypto.

Crypto can cause severe symptoms, such as diarrhea, stomach cramps, fever, nausea and vomiting, that usually last for a week and a half but can last for several weeks. In some people, a trickle of parasites continues to be shed in feces for months after an episode of disease.

- Crypto is present in 1 to 4 percent of the total population. This equates to between 3 and 12 million people in the United States shedding oocysts.
- Since chlorine doesn't effectively kill Crypto oocysts, and sand beds don't efficiently remove them, cyst numbers can continuously build up in the pool's water throughout the season.

Risk of *Cryptosporidium* Infection

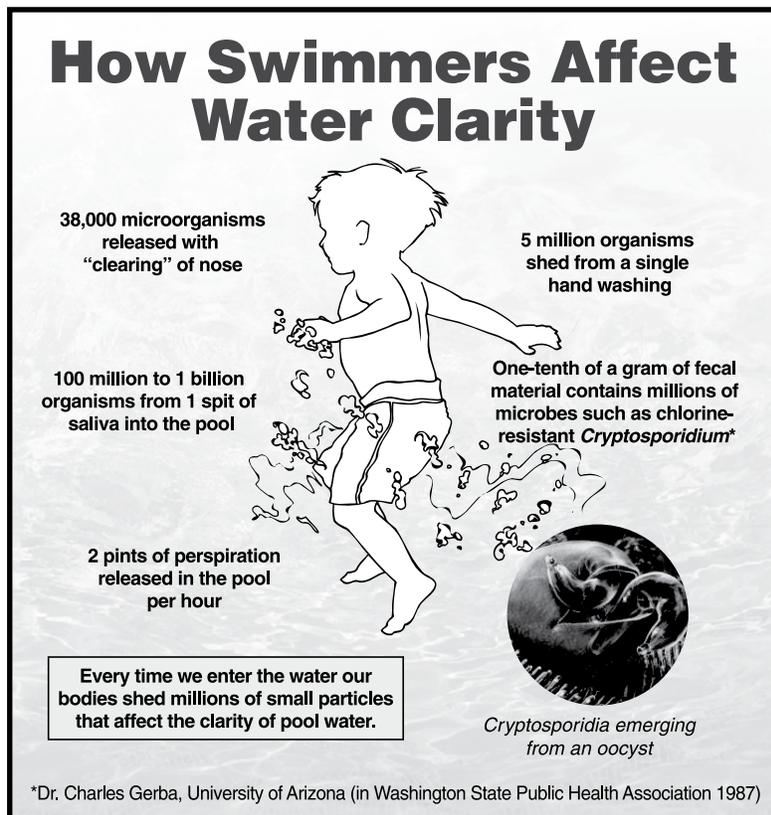
Crypto is present in from 1 to 4 percent of the total population of North America (San Francisco Public Utilities Commission, "*Cryptosporidium*," Part 1, September 26, 2006). This means that more than 12 million people in the United States alone could be carriers of Crypto. And according to microbiology studies at Arizona State University (Charles Gerba, PhD, "Preventing Waterborne Disease in Hot Water," audio presentation, APSP 1999), even a clean, showered swimmer can introduce 0.1 gram of fecal material into pool water.

Studies conducted by the EPA have shown that the average adult swimmer swallows up to 1 ounce of water when swimming ("Water Ingestion During Swimming Activities in a Pool: A Pilot Study," *Journal of Water and Health*, April 4, 2006). Children usually swallow twice that amount. Given the following statistics:

- One Crypto diarrhea "release" puts five oocysts per milliliter into pool water.
- For a 55,000-gallon pool, there would be about 20,000 oocysts per gallon.
- An infectious dose is probably in the range of 10 to 30 oocysts for adults (volunteer studies).

It is easy to see how an adult may take in about five infectious doses per swim.

With the possibility of billions of chlorine-resistant Crypto cysts present in pool water, it is easy to see how swimmers can become



infected: one serious fecal accident can lead to almost every mouthful of water containing a fully infectious dose of the parasite.

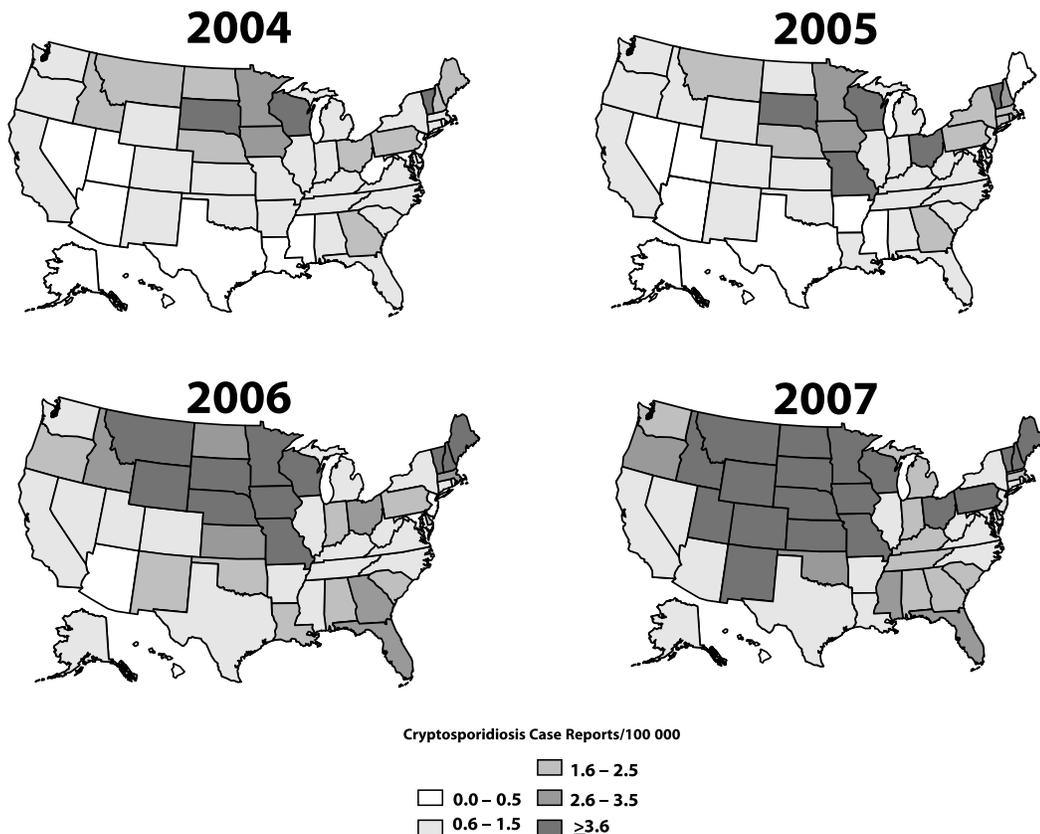
What’s more, since the Crypto oocyst remains infectious in the water for six to seven days, pools with a high bather load always present a risk for potential outbreak, especially after the season is in full swing and the numbers of Crypto cysts in the water have risen to dangerous levels.

History of *Cryptosporidium*

The first human cases of *Cryptosporidium* infection were reported in 1976. The first reported outbreak of waterborne Crypto was in Texas in 1984. The most recent large outbreak occurred in the summer of 2005 at a spray park in New York. The outbreak infected as many as 4,000 people and spread to 36 New York counties, 26 states and two countries.

**Cryptosporidiosis Case Reports
United States, 2004–2007**

(reported by the Centers for Disease Control and Prevention)



Note: These numbers are largely dependent on reporting and surveillance activities in individual states and do not necessarily indicate the true incidence in a given state.

In two separate presentations at the 2004 World Aquatic Health Conference, the Centers for Disease Control (CDC) recommended enhanced filtration using clarifiers as a viable means of reducing the risk of Crypto outbreaks (“Recreational Water Outbreaks and Lessons Learned,” Dr. Michael Beach; “Research Advances on the Inactivation of Chlorine-Resistant Pathogens Like *Cryptosporidium*,” Dr. Joan M. Shields). At the 2006 World Aquatic Health Conference, evidence was presented that showed the enhanced filter trapping of Crypto in sand filters using a two-part polymer system (“*Cryptosporidium* Removal from Swimming Pools by Sand Filters,” James Amburgey, PhD).

Fighting Crypto

Part of what makes Crypto such a serious problem in pools and spas is that the cysts through which the parasite is distributed are a small micron size and capable of passing through most filters. SeaKlear PRS effectively enhances filtration by trapping pathogens such as *Cryptosporidium*, *E. coli* and *Giardia* in the pool filter. Independent studies indicate that SeaKlear PRS reduces the presence of *Cryptosporidium* in pool water by 99.9 percent. SeaKlear PRS studies show a 99 percent reduction of *E. coli* in pool water. The EPA has reviewed and determined that SeaKlear PRS traps *Cryptosporidium* in the pool filter. In addition, SeaKlear PRS is patented for entrapment of Crypto cysts by pool filters.

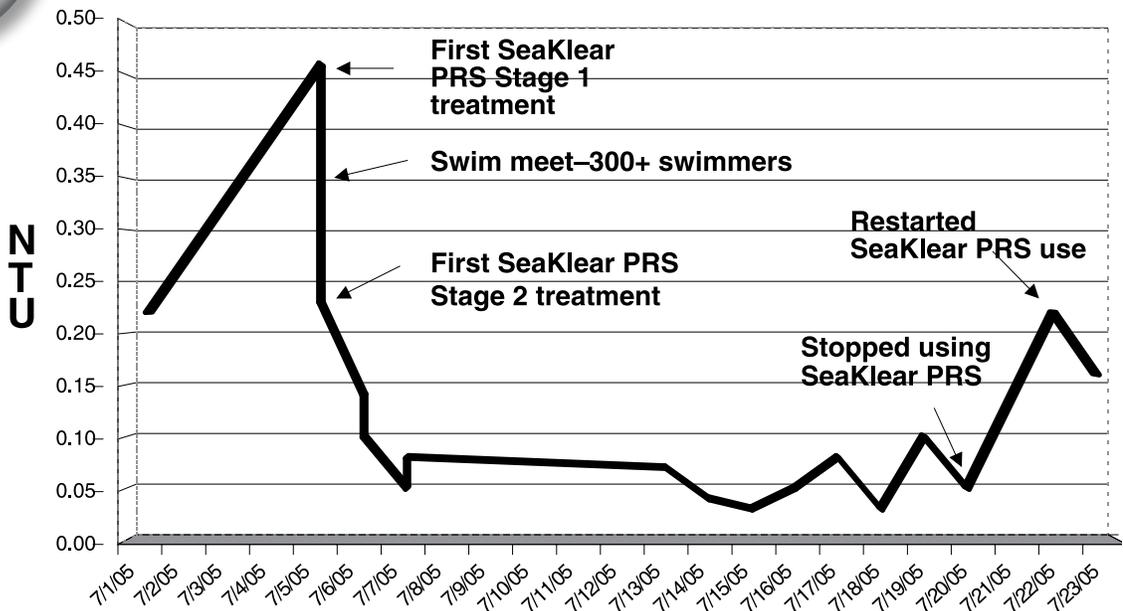
Note: SeaKlear PRS is a filter-enhancement product and not a sanitizer. Regulated levels of an approved sanitizer must be maintained. For information about the proper sanitizing of pool water, see page 4.

Chapter 6

Field Tests and Testimonials

Fairwood Golf & Country Club

Fairwood Golf & Country Club is located outside Seattle, Washington. The chart below shows turbidity levels in Fairwood's 155,000-gallon pool during a three-week period in July 2005.



Regular dosages of SeaKlear PRS lower turbidity and keep it down even during peak bather loads.

First, Fairwood treated its pool with SeaKlear PRS Stage 1. A swim meet was held six hours after the initial SeaKlear PRS Stage 1 treatment. The bather load during the swim meet was

approximately 300 swimmers over a three-hour period. After the swim meet, the pool was treated with SeaKlear PRS Stage 2. The pool was treated daily with SeaKlear PRS for eight days and then treated twice a week for two weeks.

“We have seen remarkable results with SeaKlear PRS. Not only with water clarity, but with the overall function of our sand filters. We are backwashing less, and the pool has never looked so good,” said Aaron Whittecar, Facility Maintenance Manager at Fairwood Golf & Country Club.

A Texas Facility Field Study

A large facility in Texas started using SeaKlear PRS in 2007 as part of a closely monitored field study. During the study, the pool was initially dosed with SeaKlear PRS Stage 1 and SeaKlear PRS Stage 2 on a daily basis for a two-week period and then once per week for six months. Data collected from this study showed a particle shift from smaller to larger particles during the initial daily treatment. The shift became more dramatic with long-term use. This shift in particle size demonstrates the capabilities of SeaKlear PRS to floc small, submicron-sized particles into larger clumps that can then be removed by the filter.

Not only did the scientific findings support the product’s claims of enhanced filtration, but the facility also noticed the difference. Prior to using SeaKlear PRS, the facility had been using chlorine and filtration. Facility management was interested in adding SeaKlear PRS to enhance the filtration of Crypto and other RWIs. SeaKlear PRS was appealing because, unlike other options, it uses the filter to naturally remove contaminants from the pool instead of circulating them back in. The facility continued to use SeaKlear PRS to trap Crypto, *E. coli* and *Giardia* but noted improved water quality as an added benefit. Since starting the treatment, the facility, along with its patrons, has noticed a difference in water clarity. The facility quickly did the math on adding SeaKlear PRS to its weekly maintenance. Factoring in the added drop in clarifier cost, the facility decided it couldn’t afford not to. Patrons commented on the cleanliness of the pool and its appearance. Although improved water clarity is important to any public pool facility, the facility’s primary concern is always for the health and safety of its swimmers.

Keys to Defeating RWIs

There is no doubt that the war against RWIs is far from over, but at least advances in the recreational water industry are combating this ever-elusive enemy. Whether a facility uses SeaKlear PRS or any other system, the best approach is to incorporate these key elements: prevention, awareness and layered protection, such as UV, ozone, filtration and enhanced filtration.

As the Texas facility study shows, SeaKlear PRS is best used as an added layer to improve a facility’s current methods. For more information on the results of this study or other testimonials please contact SeaKlear directly.

Chapter 7



Routine Maintenance and Troubleshooting

Regardless of the type of sanitizer used, the quality and serviceability of the circulation system, or the ancillary equipment used, routine maintenance is an important part of maintaining a pool or spa and protecting it as an investment. A routine maintenance regimen includes regular testing of the water chemistry, brushing and vacuuming, and cleaning and servicing the filter. It is also recommended that the equipment be physically inspected on a regular basis. Nevertheless, even the best-maintained pool will develop a hard-to-treat problem.

The following pages outline detailed procedures for many basic kinds of pool and spa maintenance, as well as a troubleshooting guide and tips for solving some problems.

Maintaining Pools

Pool Dosage Chart

Product	Dosage
Natural Clarifier	Standard dosage: 1 ounce/6,000 gallons weekly Cloudy water dosage: 2–3 ounces/6,000 gallons twice weekly
Natural Clarifier Tablets	One tablet/20,000 gallons weekly
Enzyme Klear	Initial application: 1 ounce/2,000 gallons Maintenance application: 1 ounce/4,000 gallons weekly
PRS Kit	Stage 1: 4 ounces/20,000 gallons Stage 2: Wait 4 hours after Stage 1, add 4 ounces/20,000 gallons High bather load: Use daily Medium bather load: Use 2–4 days/week Low bather load: Use weekly

Chapter 7

Chlorine-Free Shock Oxidizer	Light bather loads: 1 pound/10,000 gallons every 2 weeks Heavy bather loads: 1 pound/10,000 gallons every week
Algae Prevention & Remover	16 ounces/10,000 gallons every 3 months For severe algae: 1 quart/10,000 gallons every 3 months
Yellow Klear	4 ounces/10,000 gallons (8 ounces if severe accumulations) Activate with appropriate amount of sanitizer or oxidizer following label instructions
Problem Klear	Initial treatment: 6 ounces/10,000 gallons Maintenance treatment: Add twice a week per label directions in proportion with chlorinating sanitizer
Phosphate Remover	Initial high-phosphate treatment: 2 ounces/5,000 gallons Weekly: 1 ounce/5,000 gallons
Metal Stain Control	Initial pool filling: 1 quart/10,000 gallons Weekly: 6-8 ounces/10,000 gallons
Stain Prevention & Remover—Professional Strength	Initial pool filling: 1 quart/20,000 gallons Weekly: 6–8 ounces/10,000 gallons
Metal Klear	Initial pool filling: 1 quart/10,000 gallons Fresh stains, water discolored by metals: 2 quarts/10,000 gallons Weekly: 6–8 ounces/10,000 gallons
Natural Stain Remover	1 pound/10,000 gallons
Stain Klear	1 pound/10,000 gallons
Thick Tile & Vinyl Cleaner	Apply with brush, soft cloth or sponge weekly or as needed

Opening a Pool

Day 1

1. Do not add pool chemicals if they cannot be properly circulated. Make sure the pool circulation system is running properly.
2. Verify the skimmer baskets and pump strainer pot are clean and that the filter pressure is normal.
3. With the pump running, verify that the strainer pot is full of water, that there is no air in the pot and that there are no leaks in the plumbing lines.
4. If algae are present, use SeaKlear Yellow Klear along with SeaKlear Chlorine-Free Shock Oxidizer to kill the algae.
5. Add 1 quart of SeaKlear Natural Clarifier per 10,000 gallons, or, for severe cases, 1 quart of both SeaKlear PRS Stage 1 and 2.

Day 2

1. Run the filter for 24 hours during cleanup. Backwash or clean the filter as needed and empty the skimming baskets and strainer pot as needed.
2. If the filter pressure does not decrease after following normal cleaning procedures, you may have to use a filter cleaner.
3. Once the water is clear, set the filter to run six to eight hours a day. Filter cycles may vary.
4. Brush the pool (brushing aids the clarifying process). To maintain water clarity add 2 ounces of SeaKlear Natural Clarifier per 12,000 gallons every week.
5. Use SeaKlear Algae Prevention & Remover according to directions to prevent algae blooms.

Day 3

1. Test the water for phosphates using an approved kit that tests for free orthophosphates. Treat with SeaKlear Phosphate Remover, according to label instructions. Backwash or clean the filter after 24 hours. Reset the filter cycle to six to eight hours a day.

Closing a Pool

1. Vacuum and clean the pool thoroughly. Clean all debris from the skimmer and pump baskets.
2. Oxidize the pool with SeaKlear Chlorine-Free Shock Oxidizer to break down organic waste in the water. Use 1 pound per 10,000 gallons. Make sure the filter is running.
3. Balance the water: The pH should be 7.2–7.8; total alkalinity should be 80–120 ppm.
4. Add 16 ounces of SeaKlear Algae Prevention & Remover per 10,000 gallons of pool water. For concrete pools with salt systems, use SeaKlear Problem Klear at a rate of 13 ounces per 10,000 gallons.
5. Follow with 4 ounces of SeaKlear Natural Clarifier per 10,000 gallons. Run the filter for at least eight hours.
6. After 24 hours, add SeaKlear Phosphate Remover at a rate of 16 ounces per 10,000 gallons and let the filter run for another 24 hours.
7. Clean or backwash the filter according to the manufacturer's instructions.
8. Raise the chlorine level to 6–8 ppm. For alternative chlorine systems, make sure there is a good residual of sanitizer in the water.
9. Use SeaKlear Stain Prevention & Remover to control metals throughout the winter. For pools with salt systems, use SeaKlear Metal Klear.

10. Thoroughly clean and inspect your winter cover for debris and holes. In extremely cold areas, turn off all equipment and make sure all timers and lights are shut down.

Consult your professional dealer for more information about draining and preparing the system for freeze prevention.

This SeaKlear simple pool-closing system will assure there is clean, clear water for spring opening and less chance of algae problems next season.

Preventing Algae

The best way to fight algae growth in pools is to avoid a pool environment that is conducive to the growth of algae. A good prevention program for algae includes the following:

1. Maintain a proper sanitizer level at all times. For more information about sanitizing, see page 4.
2. Oxidize weekly with SeaKlear Chlorine-Free Shock Oxidizer. For more information about how oxidizing works, see page 6.
3. Regularly add a broad-spectrum, long-lasting copper algaecide such as SeaKlear Algae Prevention & Remover or an all-purpose algaecide like SeaKlear Problem Klear.
4. Test phosphate levels monthly and treat with SeaKlear Phosphate Remover as needed to maintain levels below 200 ppb.
5. Use a clarifier such as SeaKlear Natural Clarifier or an enhanced filtration product like SeaKlear PRS weekly to effectively remove dead algae and organic waste.

Preventing Metal Stains and Other Metal Problems

Stains, scale and metal problems can be dealt with easily if you adhere to the following simple programs:

- **To prevent stains in pools:** Use SeaKlear Metal Stain Control weekly at the rate of 6 to 8 ounces per 10,000 gallons or SeaKlear Metal Klear at the rate of 6 to 8 ounces per 10,000 gallons.
- **To prevent stains in pools where there are known metal issues:** Use SeaKlear Stain Prevention & Remover—Professional Strength at the rate of 6 to 8 ounces per 10,000 gallons.
- **To remove existing stains:** Use SeaKlear Stain Prevention & Remover—Professional Strength at the rate of 1 quart per 20,000 gallons.
- **To prevent stains in pools using a salt generator or where the buildup of phosphates is a concern:** Use SeaKlear Metal Klear at the rate of 6 to 8 ounces per 10,000 gallons.
- **To remove existing organic, cobalt or iron stains:** Use SeaKlear Natural Stain Remover (or SeaKlear Stain Klear) followed by SeaKlear Metal Klear according to directions on the label.

Maintaining Spas

Initial Filling or Refilling of a Spa

1. Upon filling the spa, add one bottle of SeaKlear Metal Control for spas to prevent staining from metals in the source water.
2. Test the water hardness and add SeaKlear Calcium Increaser for spas (not included in kits) if needed to prevent corrosion damage to spa equipment.
3. Balance the total alkalinity and pH of the water (see “Balancing Spa Water” below).
4. Once the water is properly balanced, do an initial oxidation with SeaKlear Chlorine-Free Shock Oxidizer for spas to burn out organics and other contaminants. Follow the label instructions.
5. After oxidizing, floc immediately with SeaKlear Natural Clarifier for spas, according to the label instructions.
6. Let the water circulate at least two hours and then add sanitizer according to the label instructions (see “Spa Weekly Maintenance Program” on page 34).

Balancing Spa Water

After filling the spa, there are two main adjustments to be made: total alkalinity and pH. Total alkalinity is the first and most important water balance adjustment. It acts as a control to pH, which cannot be properly adjusted if the total alkalinity is out of the suggested range of 80 to 140 ppm.

- **High total alkalinity.** If the total alkalinity is above 140 ppm, lower it with SeaKlear pH Reducer for spas according to label instructions.
- **Low total alkalinity.** If the total alkalinity is below 80 ppm, use SeaKlear Alkalinity Up for spas (not included in kits) according to label instructions.
- **High pH.** If the pH is above 7.8, lower it with SeaKlear pH Reducer for spas according to label instructions.
- **Low pH.** If the pH is below 7.2, raise it with SeaKlear pH Increaser for spas according to label instructions.

You can also easily adjust and stabilize the pH by using SeaKlear pH Steady for spas according to label instructions.

Note: SeaKlear pH Steady is not recommended for areas of hard water, where the calcium hardness is over 300 ppm.

Guidelines for Balancing Spa Water

Suggested Ranges

Total hardness (calcium) 200 to 400 ppm

Total alkalinity 80 to 140 ppm

pH 7.2 to 7.8 (ideal level is 7.4)

Chlorine 3 ppm

Bromine 3 to 5 ppm

Spa Weekly Maintenance Program

Test and Adjust

Always start each step by testing and adjusting the pH, total alkalinity and sanitizer levels with approved spa test strips.

- **pH and total alkalinity.** Using an approved test strip, check the water pH and total alkalinity and adjust if necessary.
- **Sanitizer.** Test to make sure the sanitizer level is correct. The ideal level of bromine is 3 to 5 ppm. The ideal level of chlorine is 3 ppm of free available chlorine (FAC). If sanitizer levels are low, add SeaKlear Sanitizing Granules for spas or SeaKlear Brominating Tablets for spas and adjust according to label instructions.

Monday: Oxidize

Test and adjust the water as needed. Once the water is properly balanced, oxidize with SeaKlear Chlorine-Free Shock Oxidizer for spas, using 2 ounces per 500 gallons of water. Add the product over the top of the water with the circulation jets on. Leave the cover off the tub for one hour after treatment.

Wednesday: Floc

Test and adjust the water as needed. After testing and adjusting, add 2 ounces of SeaKlear Natural Clarifier for spas per 500 gallons of water with the circulation jets on. Allow the circulation to run for 30 minutes after adding SeaKlear Natural Clarifier for spas. For heavily used spas, try SeaKlear PRS for spas according to label instructions.

Friday: Sanitize

Test and adjust the water as needed. Add product as follows to bring the sanitizer to the appropriate level:

- **If using a bromine system**, add SeaKlear Sodium Bromide for spas according to label instructions. Let the spa circulate for at least 30 minutes, then use SeaKlear Brominating Tablets for spas according to label instructions. Maintain the spa by adding three tablets per 300 gallons every five to seven days or as needed to maintain an active bromine residual at a minimum of at least 3 ppm at all times.
- **If using a chlorine system**, turn on the circulation system and ensure that it is operating properly. Add SeaKlear Sanitizing Granules for spas according to label instructions. Maintain 3 ppm of FAC while the spa or hot tub is in use. Test for FAC with a test strip and add additional product after each use or as needed.

Spa Dosage Chart

Product	Dosage
Brominating Tablets	3 tablets/300 gallons
Sodium Bromide	½ ounce (1 tablespoon)/100 gallons
Sanitizing Granules	Start-up: 6 teaspoons/500 gallons Maintenance: 3 teaspoons/500 gallons
Natural Clarifier	1 ounce/500 gallons
Enzyme Klear	2–4 ounces/500 gallons
PRS Kit	1 ounce (2 tablespoons)/500 gallons
Chlorine-Free Shock Oxidizer	2 ounces (4 tablespoons)/500 gallons
Phosphate Remover	1 ounce (2 tablespoons)/500 gallons
pH Reducer	1 ounce (2 tablespoons) at a time if pH is above 7.8
pH Steady	1 quart/500 gallons of freshly filled water
pH Increaser	1 ounce (2 tablespoons)/100 gallons
Calcium Increaser	1 ounce (2 tablespoons)/500 gallons
Alkalinity Up	1 ounce (2 tablespoons) at a time if pH is below 7.2
Metal Control	16 ounces upon fill or refill
Stain & Scale Control	2 ounces (4 tablespoons)/up to 800 gallons
Filter Cleaner Spray	See label instructions
Filter Cleaner & Degreaser	See label instructions
Self-Floccing Defoamer	2 ounces (4 tablespoons)/500 gallons
Leak Sealer	10 ounces/500 gallons

Troubleshooting for Pools

Pool Troubleshooting Chart

Problem	Cause	Solution
Cloudy water	Chloramines	SeaKlear Chlorine-Free Shock Oxidizer, SeaKlear Natural Clarifier, SeaKlear PRS.
	Organic waste	Skim, vacuum, SeaKlear Natural Clarifier, SeaKlear PRS, SeaKlear Chlorine-Free Shock Oxidizer.
	Mud and silt	SeaKlear PRS.
	High alkalinity	Muriatic acid.
	High pH	Muriatic acid.
	High total hardness	Drain the pool.
	High total dissolved solids	Drain or backwash the pool.
	Poor filtration	Check filters and clean or backwash per manufacturer’s guidelines.
	High phosphates	SeaKlear Phosphate Remover.
Discolored water	High metal content	For removal and prevention of metal stains use SeaKlear Stain Prevention & Remover—Professional Strength or SeaKlear Natural Stain Remover . For prevention of metal stains use SeaKlear Metal Stain Control . For pools with salt chlorine generators or high phosphate levels use SeaKlear Metal Klear .
	Low pH	Add sodium bicarbonate to raise the pH to the range of 7.2 to 7.6.
Green water	High copper	SeaKlear Stain Prevention & Remover—Professional Strength, SeaKlear Metal Stain Control or SeaKlear Metal Klear . Regular use of these products helps keep metals in check.
	Low alkalinity	Raise with sodium bicarbonate.
	Algae	Maintain correct levels of sanitizer and test for phosphates. Treat with SeaKlear Algae Prevention & Remover, SeaKlear Yellow Klear or SeaKlear Problem Klear .



Stains on the pool surfaces	Black (spots) or yellow algae	For existing yellow algae use SeaKlear Yellow Klear with SeaKlear Chlorine-Free Shock Oxidizer . To prevent yellow algae and treat for black algae, use SeaKlear Algae Prevention & Remover .
	Brown or blue-green stains that will not brush off on gunite or other hard surfaces	Use SeaKlear Stain Klear with SeaKlear Metal Klear , or use SeaKlear Stain Prevention & Remover—Professional Strength alone.
	Brown or blue-green stains that will not brush off on fiberglass, acrylic or vinyl surfaces	Use SeaKlear Natural Stain Remover with SeaKlear Metal Klear , or use SeaKlear Stain Prevention & Remover—Professional Strength (not for use on acrylic surfaces) alone.
Oils and oily scum lines	Body oils and dirt from swimmers	Use SeaKlear Natural Clarifier weekly to remove and prevent oil buildup on the filter and surfaces. For existing oil and visible oily scum on tile and waterlines use SeaKlear Enzyme Klear .

Transforming a Swamp

Turning a neglected pool from a “swamp” to a clear pool can be a troublesome and time-consuming process that can take days or even weeks to complete. With **SeaKlear PRS**, the process can be completed in about 24 hours and is a quick and easy alternative to the old method of cleaning and clearing a pool. It’s so easy and works so well that pool professionals across the country are using **SeaKlear PRS** to clean and clear pools.

The process, which is not significantly different from what has traditionally been done, includes these steps:

1. Remove as much of the debris from the water as you can.
2. Oxidize the pool with SeaKlear Chlorine-Free Shock Oxidizer (or a similar product). Double the amount of oxidizer used if the pool has been green more than one week.
3. Use 4 ounces of SeaKlear Yellow Klear (or a similar product) per 10,000 gallons of pool water to kill the algae.
4. Add 1 quart of SeaKlear PRS—Stage 1 per 10,000 gallons of pool water.
5. Continue to run the equipment for six hours.
6. After six hours, add 1 quart of SeaKlear PRS—Stage 2 per 10,000 gallons of pool water.
7. Continue to run the equipment and to clean the filter and baskets as necessary until the pool is clean and clear.
8. After the pool is clear, add 1 quart of SeaKlear Phosphate Remover per 20,000 gallons of

pool water. After 48 hours, test the phosphate level with a phosphate test kit approved for swimming pool use. If needed, reapply SeaKlear Phosphate Remover to achieve a phosphate level of less than 200 ppb.

9. Wait one week and then add 1 pint of SeaKlear Algae Prevention & Remover per 10,000 gallons of pool water, per label directions.

Troubleshooting for Spas and Hot Tubs

Spa & Hot Tub Troubleshooting Chart

Problem	Cause	Solution
Cloudy water	Lack of sanitizer	Test and add Brominating Tablets and Sodium Bromide or Sanitizing Granules as needed.
	Improper water balance	Test and adjust the pH and total alkalinity using Alkalinity Up, pH Increaser or pH Reducer . In areas where hardness is below 250 ppm, use pH Steady to lock in and hold total alkalinity and pH.
	High level of organics	Use Natural Clarifier or PRS .
	Dirty filter cartridge	Check the filter cartridge and then clean with Filter Cleaner Spray . If needed, soak the filter overnight in Filter Cleaner & Degreaser .
Brown, green or black water	Metals in water such as iron, copper or manganese	Add Metal Klear , then test the water balance and adjust as needed.
Foam	Soft water	Test, then adjust hardness using Calcium Increaser .
	Excess oils and dirt	Use Self-Floccing Defoamer or Enzyme Klear .
Musty odors	Lack of sanitizer	Test, and add Brominating Tablets and Sodium Bromide or Sanitizing Granules as needed.
	Buildup of organics	Oxidize with Chlorine-Free Shock Oxidizer .
	Water overdue for changing	Drain, clean and refill the tub.
Chemical odors	Combined chlorine too high—excess organics	Oxidize with Chlorine-Free Shock Oxidizer followed by Natural Clarifier .
Eye and skin irritation and irritating odors	Low pH	Test for metals, then test and adjust the pH as needed using pH Increaser .





Chapter 8

Merchandising

Pool and spa stores do not have a large retail space, so maximizing a store's impact on consumers is essential. Image is everything. A consumer visiting a store is like a reader flipping through a magazine; each area or display has only a second or two to catch the consumer's eye before he or she goes on to the next "page." This chapter discusses various aspects of effective merchandising—floor layout, shelving and displays—and how they can help increase a store's traffic and sales.

Layout

In analyzing sales, a retailer must break down the store's space into the various shopping areas: shelving, floor space, countertops and back room. Each area plays a significant role in the inventory management system, and effective management of the space determines profitability and sales velocity. Unfortunately, most pool and spa retailers do not have the time to set up a detailed layout of their retail space. Even those that have done so discover that over time, the floor can become a hodgepodge of products and shelving.

Effective layout requires understanding why consumers come to a store. The typical pool and spa consumer is "destination" shopping, coming into the store for a specific purpose. And the typical consumer is not very knowledgeable about the industry in general. Therefore, unlike many retail venues, which have innumerable products and categories, pool and spa stores must devote a large amount of business to problem solving and education. For this reason, both the register and the water-testing station should be hubs of profitability. Proper messaging is crucial to increasing sales volume because impulse sales can be tied into multiple categories of product solutions.

The chemical category is a good example. Chemicals can be broken down into:

- Sanitizers (chlorine, bromine, etc.)
- Water clarifiers

- Oxidizers
- Algae products
- Metals products
- Phosphate removers
- Cleaners
- Adjusters (pH, alkalinity, etc.)

Where each of these chemicals is placed in the store is one of the keys to the category's success.

To a large extent, the layout of a store determines customer flow. Most locations display their spas or accessories at the front of the store and stock their chemicals in the back. The decision is based upon an attempt to encourage impulse sales or the purchase of large-ticket items. The fact of the matter is people are motivated to look for the chemicals, particularly sanitizers. The key is to build a center around that demand. Anyone who has tried to find bagged ice in a grocery store is familiar with this technique. If consumers must go to the end of the store to find the sanitizers, the layout should be designed so that they see the entire chemical category on their way. After all, there is a lot more profit margin from the specialty chemicals than there is from the sanitizers.

Ultimately, stores should be laid out in sections, with specific, theme-based displays near the front and near the back of the store. Items near the register should be either high impulse or solution based. Pool and spa parts should take up a minimum of space on the sales floor as they clutter up a store. What's more, store personnel can play a larger role in solving problems if parts are not shelved where consumers may access them without assistance.

Shelving

Once the section for the chemicals has been determined, there are several ideas to consider when setting a section. There are basically three types of sections:

- **Horizontal sets** are organized by brand and by shelf, with a specific brand on one shelf, and another brand on the next shelf. Typically, horizontal sets are based upon ring and profit—e.g., high-margin products at eye level, and low-margin or high-velocity products on lower shelves that have higher holding power. Horizontal sets tend to lack visual appeal, are difficult to maintain and do not stimulate multiple product purchases.
- **Type sets** are very popular with the larger chains, which set private labels next to the brand-name products to cannibalize the brand popularity. Type sets are based upon a specific category or product, such as clarifiers, phosphate removers, algaecides, metal products, etc. The bigger the category, the more space is allocated. Categories are placed next to related categories. For example, phosphate removers are placed next to algaecides and clarifiers, sanitizers are placed next to oxidizers, and so on.

- **Brand sets** have been shown in other industries to have the highest sales per section. Brand sets are the vertical blocking of specific brands into a banner of sorts. This method of setting uses the branding of each line to create color breaks. Ideally, the number one and number two brands should be at the opposite ends of the section. As with the other kinds of sets, the higher-volume products are placed on the lower shelves for more holding power and to stimulate impulse sales of the products on the upper shelves. The smaller, higher-profit or higher-ring items are placed at eye level and in between the two category leaders.

Consumers tend to buy items from manufacturers they trust or that have strong brand identity. And consumers are more likely to try new items carrying that brand. The sections also have a strong visual appeal, and consumers will spend more time looking at other products in that brand set.

Displays

Displays are known to lift product sales anywhere from 75 to 200 percent without any price reduction. The lift goes up exponentially when features and promotions are employed. The most effective displays deal with solutions. Water treatment solutions create the best excitement for multiple product sales. Similar to solution displays is cross-merchandising, which cross-promotes different areas of the store. This chapter gives an overview of displays first, then looks at cross-merchandising and theme-based or multiple-product displays.

There are several types of displays. Most small stores use end-caps, which are shelves at the end of the gondola that just hold product. End caps tend to waste air space. Big displays, as well as full displays, sell more product, and this is due to perceived appearance. The more of the product that can be shown, the more impact the display will have on the consumer. Displaying is a form of advertising. The objective is to get the word out, to convey a brand's presence. Displays should be large, clean and full.

Side stacks are great at adding incremental revenue. Side stacks, which are typically a single stack of three to five cases of a specific product, work great next to an end display and should be tied into a larger display—for example, algacide displayed next to chlorine. Diamond stacks are individual displays usually in the middle of an aisle in front of a specific category. Again, displays should somehow tie into the products around them—for example, rum can be stacked on the soda aisle, and chlorine-free shock oxidizer can be stacked in front of chlorine.

Island displays are just what they sound like—product displayed in the middle of an area by itself—and are very similar to end displays. Island displays work best when they incorporate multiple products or tie into another section that stimulates impulse purchases. Islands should be large and show a lot of product. Usually, islands should be placed near the entrance of a store. Again, size really makes an impact on a consumer.

The biggest mistake with any display is the lack of proper signage. Pricing on a display is absolutely essential. Point-of-sale, also called point-of-purchase, really helps to sell product. It is imperative to have something that communicates the benefit of the product on display. Signage comparing

the regular price to the reduced price or the competitor's price is very effective. Conversely, most people tend to walk away from a display without a price.

Cross-merchandising is another effective selling method because consumers want solutions. When a consumer comes into a store to purchase a chlorine shock or chlorine-free shock oxidizer, he or she is most likely trying to solve a bigger problem. Displaying six bottles of a clarifier or algaecide near a shock display will sell a lot more chemicals. Cross-merchandising can be added to the middle of an end-aisle display—for example, water features can display vinyl cleaner nearby. The trick is to avoid clutter; there needs to be a strategy or promotion driving the cross-merchandising.

The key to displaying product is to be creative. The featured product is the star. Offering specific solutions with complementary products makes it easier for a consumer to decide. Excitement sells! Currently, “green” sections are gaining popularity, much as organic produce sections did when they were introduced in grocery stores. “Algae prevention” is another theme that seems to have picked up in popularity. The number of possible themes is limited only by the imagination.

Merchandising should lead to increased growth and base volume levels. Like ads, displays and sections get tired and need to be revamped and redesigned, and their messages freshened up. Proper sections and displays will set a store above its competition and increase its margins as well. Stores should be exciting and inviting. Displaying will do just that.



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 Di-chlor are forms of acidic-based chlorine. Tri-chlor has a low pH of 2.9. Di-chlor 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 (mustard) 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.

Alkaline/alkalinity—Meaning the water is basic or a base.

Alum—Aluminum sulfate. Alum is a 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.

Ammonia—Two types can be found in pool water. Chemical ammonia is sometimes used as an algaecide. Ammonia, derived from urea in swimmers' 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.

APSP—Association of Pool & Spa Professionals.

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 by 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 or spa 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 cells burrow into plaster surfaces and protect themselves 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 10 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 algacide—An algacide 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.

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 debris.

Chlorine-free shock oxidizer—Commonly known as MPS (potassium monopersulfate), chlorine-free shock oxidizer 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—Resistant to or otherwise difficult to destroy by traditional sanitizing and oxidizing methods. Some harmful pathogens and bacteria are known to be chlorine resistant. For example, *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 (D. E.)—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.

Di-chlor—A form of chlorine that combines chlorine with cyanuric acid. Di-chlor comes in two strengths 56% and 62%. It is very soluble and has a near neutral pH of 6.0 to 6.8.

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.

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, *pH, Alkalinity, Water Testing and Water Balance*, 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* 25 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 floccules (or 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 that is 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.

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

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

Hyperchlorination— A method of sanitizing used in pools suspected of contamination, in an effort to destroy harmful cysts and bacteria otherwise resistant to traditional sanitizing and oxidizing methods. The CDC recommends a minimum of 10 ppm of chlorine be maintained for 25.5 hours with a pH of 7.5 or lower and at a water temperature of 77°F or higher. Alternatively, a minimum of 20 ppm of chlorine can be maintained for 12.75 hours with a pH of 7.5 or lower and at a water temperature of 77°F or higher.

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

—L—

Langelier Index—A method for determining whether the water is scale forming or corrosive by measuring the equilibrium of calcium carbonate.

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

Liquid chlorine—*See* “sodium hypochlorite.”

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

Logarithmic—The pH scale is called logarithmic because each number on it is raised or lowered exponentially by a power of 10. For example, a pH of 6 is 10 times more acidic than a pH of 7. Conversely, a pH of 8 is 10 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.

—M—

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

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—One of the by-products 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 of turbidity, as measured by a nephelometer.

Nutrient—Something that is able to nourish and give growth and strength. See “Essential nutrient” and “Growth-limiting nutrient.”

—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.

Oocyst—A protective shell that houses a parasitic protozoa such as *Cryptosporidium*.

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

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

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

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 the number of 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 of the oxidation of 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.

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.

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.

—P—

Particulate matter—Micron-sized particles that are suspended in pool water. These particles can possess the same electrical charge as one another, 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.

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

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

Petroleum-based—Chemicals that contain petroleum distillates.

pH—A measurement of the hydrogen present in a substance such as water, thereby in effect a term describing the relative acidity/alkalinity of a substance.

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 the 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.

ppb—See “Part per billion.”

ppm—See “Part per million.”

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.

Pseudomonas—Commonly referred to as “hot tub rash.” *Pseudomonas* is a gram-negative bacteria that can cause itchy skin and a bumpy, red rash. *Pseudomonas* can occur in spas, hot tubs, swimming pools and lakes.

—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 is 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 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.

Sequestration—To sequester or surround and hold captive. Most metal products surround metals to keep them from coming out of solution and staining surfaces.

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 bicarbonate—A base material for increasing alkalinity. Commonly referred to as baking soda.

Sodium bisulfate—A milder, granular form of acid. Used primarily in spas and hot tubs.

Sodium carbonate—Soda ash used primarily for raising pH in pool water.

Sodium hypochlorite—Also known as liquid chlorine, sodium hypochlorite is 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 that uses ten times the combined available chlorine reading 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, in addition to body oils, skin flakes, hair and bacteria.

—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, chemical and environmental material that enters the pool. Total dissolved solids are deposited and left behind in the process of evaporation. Total dissolved solids are considered high when they reach 1,500 ppm over the fresh, start-up water.

Total hardness—A measurement of minerals in the water, particularly calcium. Also known as calcium hardness. A high total hardness level indicates high levels of minerals in the water. Low total hardness refers to 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.

Tri-chlor—Trichloro-s-triazine-trione is 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, 1-inch tablets and 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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