

APPENDIX

Calculations and Conversions

Water Balance Adjustment Guide

Troubleshooting Common Pool or Spa Problems

Calibrating a Thermometer

VGB Compliance Diagram

Public Health Concerns

Columbus Contact Information

Rules

**Columbus Public Health does not promote any product seen in this book or presentation.*

Pictures are used for visual reference only.

CALCULATING SURFACE AREA (IN FT²) AND POOL CAPACITY (IN GALLONS)

Surface Area = Length x Width

Capacity = Surface Area x Average Depth x 7.5

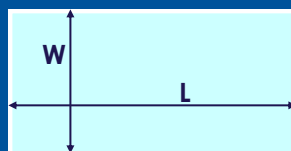
Calculating surface area in square feet is a process of, generally speaking, taking the length multiplied by the width of the pool or spa. However, some pools and spas are not perfect rectangles and need special equations to determine this figure.

To calculate pool capacity, you must first know the surface area and the average depth. In a pool with a constant slope, you determine the average depth by adding the depth of the shallow end to the depth of the deep end, then divide that by 2. However, if a pool does not have a constant slope, you need to calculate the capacity by dividing the pool into sections, provided that each of the sections has its own constant slope. You can then calculate the surface area and average depth for each section, determine the capacity, and add the numbers for all sections together for a total capacity.

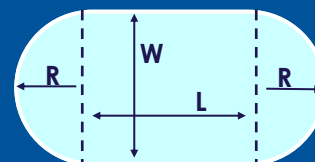
See the calculation below for an example of this type of situation.

SURFACE AREA (SA) CALCULATIONS

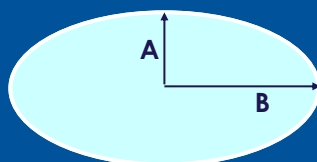
Surface area is calculated differently for different shapes. Use these equations to determine your pool or spa's surface area.



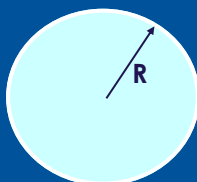
$$SA = L \times W$$



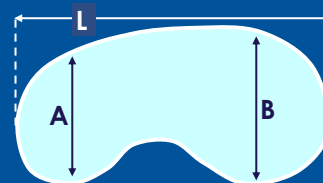
$$SA = R \times R \times 3.14 + (L \times W)$$



$$SA = A \times B \times 3.14$$

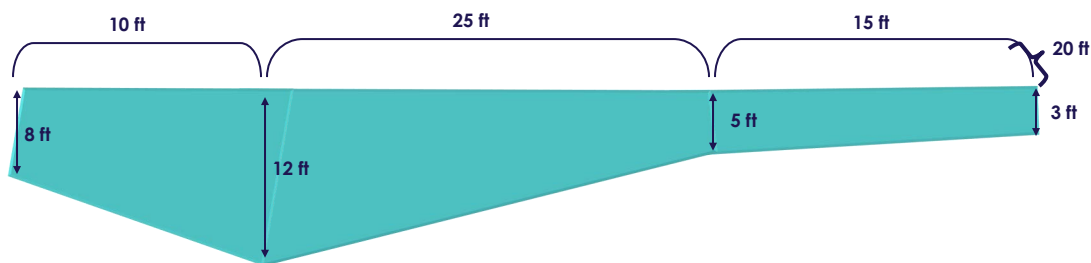


$$SA = R \times R \times 3.14$$



$$SA \text{ (approximate)} = (A + B) \times L \times 0.45$$

POOL CAPACITY CALCULATION



SECTION 1

Surface Area = $L \times W =$
 $10 \times 20 = 200 \text{ ft}^2$
 Average Depth =
 $(8 + 12) \div 2 = 10 \text{ ft}$
 Capacity = Surface Area x
 Average Depth x 7.5 =
 $200 \text{ ft}^2 \times 10 \text{ ft} \times 7.5 =$
15,000 gallons

SECTION 2

Surface Area = $L \times W =$
 $25 \times 20 = 500 \text{ ft}^2$
 Average Depth =
 $(12 + 5) \div 2 = 8.5 \text{ ft}$
 Capacity = Surface Area x
 Average Depth x 7.5 =
 $500 \text{ ft}^2 \times 8.5 \text{ ft} \times 7.5 =$
31,875 gallons

SECTION 3

Surface Area = $L \times W =$
 $15 \times 20 = 300 \text{ ft}^2$
 Average Depth =
 $(5 + 3) \div 2 = 4 \text{ ft}$
 Capacity = Surface Area x
 Average Depth x 7.5 =
 $300 \text{ ft}^2 \times 4 \text{ ft} \times 7.5 =$
9,000 gallons

TOTAL VOLUME = 15,000 + 31,875 + 9,000 = 55,875 gallons

HELPFUL UNIT CONVERSIONS AND CONSTANT VARIABLES

Ounces to Pounds

Ounces \div 16 = # Pounds

Fluid Ounces to Gallons

Fluid Ounces \div 128 = # Gallons

Liters to Gallons

Liters \times 3.875 = # Gallons

Cups to Fluid Ounces

Cups \times 8 = # Fluid Ounces

Cubic Feet to Gallons

Cubic Feet \times 7.5 = # Gallons

Square Inches to Square Feet

Inches² \div 144 = Feet²

Pints to Quarts

Pints \times 2 = # Gallons

Quarts to Gallons

Quarts \times 4 = # Gallons

Gallons to Pounds

Gallons \times 8.33 = # Pounds

Meters to Feet

Meters \times 3.28 = # Feet

Yards to Feet

Yards \times 3 = # Feet

Parts per Million to Milligrams per Liter

1 ppm = 1 mg/L

Fahrenheit to Celsius

$^{\circ}\text{C} = 5/9 \times (^{\circ}\text{F} - 32)$

Celsius to Fahrenheit

$^{\circ}\text{F} = (9/5 \times ^{\circ}\text{C}) + 32$

1 ppm = 8.33 pounds of chemical in one million gallons of water

1 Pound per Square Inch (psi) is the pressure created by a column of water 2.31 feet high

1 Micron = 1 Millionth of one Meter

POOL OR SPA BASIC CALCULATION GUIDE

Pool Name: _____

Surface Area (SA)* = L X W = _____

Average Depth* = _____

*For a pool or spa with multiple sections, calculate surface area and average depth for each section separately.

Total Capacity = SA x Average Depth x 7.5 = _____

Minimum Turnover Rate = _____ Hours

Turnover rates are: 8 hrs for pools, 2 hours for wading pools and spray grounds, .5 hours for spas

Flow Rate = Capacity \div (Turnover Rate x 60 min/hr) = _____

Filter Area Needed = Flow Rate x Filter Media Rate** = _____

**See page 11 in the workbook for filter media rates.

Your facility should maintain records that contain information such as pool capacity or volume as well as pool dimensions to help you calculate these items. If you are having problems finding information or need help with calculations, contact Columbus Public Health and we will schedule an appointment to help you determine these parameters.

| | 10,000 GALLONS | | | 40,000 LITERS | | |
|----------------------------------|----------------|----------|---------|----------------|---------|---------|
| | DESIRED CHANGE | | | DESIRED CHANGE | | |
| | 1 PPM | 5 PPM | 10 PPM | 1 mg/L | 5 mg/L | 10 mg/L |
| INCREASE CHLORINE | | | | | | |
| Calcium Hypochlorite (67%) | 2.0 oz | 10 oz | 1.3 lb | 63 g | 315 g | 630 g |
| Sodium Hypochlorite (12%) | 10.7 floz | 1.7 qts | 3.3 qts | 330 mL | 1.36 L | 3.3 L |
| Lithium Hypochlorite | 3.8 oz | 1.2 lb | 2.4 lb | 110 g | 570 g | 1.1 kg |
| Dichlor (62%) | 2.1 oz | 10.75 oz | 1.3 lb | 65 g | 320 g | 650 g |
| Dichlor (56%) | 2.4 oz | 12 oz | 1.4 lb | 72 g | 360 g | 720 g |
| Trichlor | 1.5 oz | 7.5 oz | 14 oz | 44 g | 220 g | 440 g |
| INCREASE TOTAL ALKALINITY | | | | | | |
| | 10 PPM | 30 PPM | 50 PPM | 10 mg/L | 30 mg/L | 50 mg/L |
| Sodium Bicarbonate | 1.4 lb | 4.2 lb | 7.0 lb | 670 g | 2.0 kg | 3.4 kg |
| Sodium Carbonate | 14 oz | 2.6 lb | 4.4 lb | 400 g | 1.2 kg | 2.0 kg |
| Sodium Sesquicarbonate | 1.25 lb | 3.75 lb | 6.25 lb | 600 g | 1.8 kg | 3.0 kg |
| DECREASE TOTAL ALKALINITY | | | | | | |
| | 10 PPM | 30 PPM | 50 PPM | 10 mg/L | 30 mg/L | 50 mg/L |
| Muriatic Acid (31.4 %) | 13 floz | 2.4 qts | 1 gal | 800 mL | 2.4 L | 4.0 L |
| Sodium Bisulfate | 2.1 lb | 6.4 lb | 10.5 lb | 1.03 kg | 3.1 kg | 5.15 kg |
| INCREASE CALCIUM HARDNESS | | | | | | |
| | 10 PPM | 30 PPM | 50 PPM | 10 mg/L | 30 mg/L | 50 mg/L |
| Calcium Chloride (100%) | 0.9 lb | 2.8 lb | 4.6 lb | 402 g | 1.2 kg | 2.0 kg |
| Calcium Chloride (77%) | 1.2 lb | 3.6 lb | 6.0 lb | 575 g | 1.7 kg | 2.9 kg |
| INCREASE STABALIZER | | | | | | |
| | 10 PPM | 30 PPM | 50 PPM | 10 mg/L | 30 mg/L | 50 mg/L |
| Cyanuric Acid | 13 oz | 2.5 lb | 4.1 lb | 400 g | 1.2 kg | 2 kg |
| NEUTRALIZE CHLORINE | | | | | | |
| | 1 PPM | 5 PPM | 10 PPM | 1 mg/L | 5 mg/L | 10 mg/L |
| Sodium Thiosulfate | 1.4 oz | 7 oz | 14 oz | 42 g | 210 g | 419 g |
| Sodium Sulfite | 2.4 oz | 12 oz | 1.5 lb | 71 g | 356 g | 711 g |

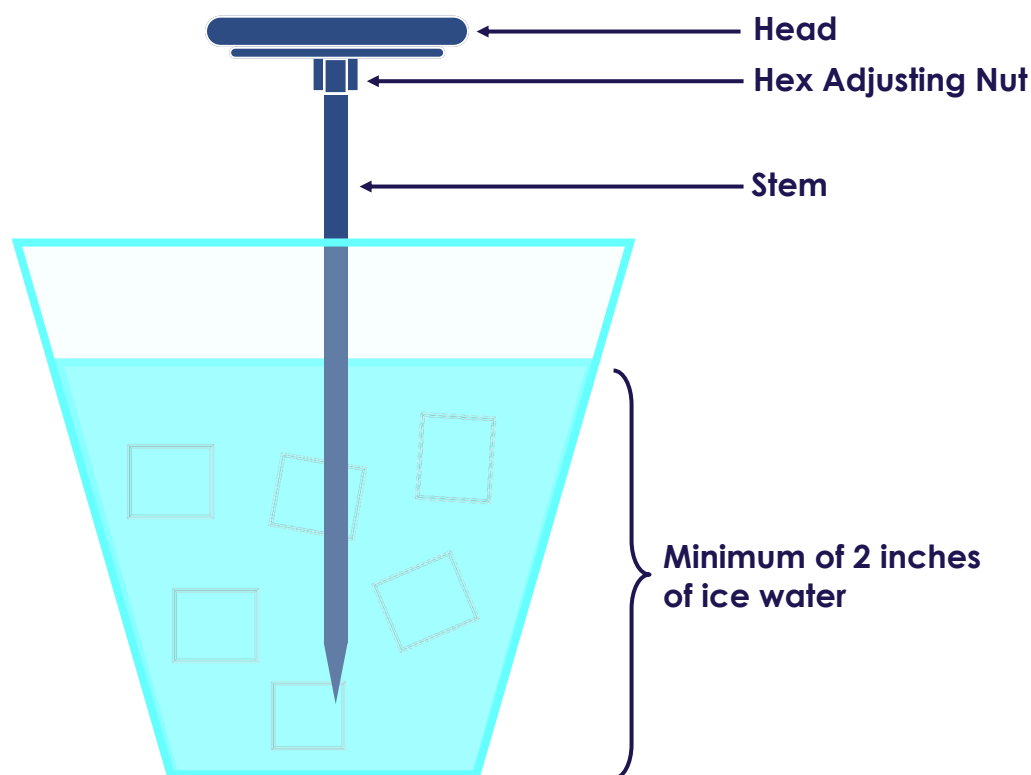
**Always follow the instructions on the manufacturer's label for exact dosage amounts*

| PROBLEM | SYMPTOMS | CAUSES (most to least likely) |
|-------------------------------------|---|---|
| CLOUDY WATER | Hazy or milky appearance to water. Lack of sparkle. | Disinfection; Circulation; Filtration; Cyanuric Acid; Ph; Calcium Hardness; Total Dissolved Solids |
| ALGAE GROWTH | Green or almost black spots on the pool/spa walls and bottom or pasty green tint to water. | Disinfection Circulation Cyanuric Acid pH Filtration |
| DIRT ACCUMULATION or SCUM LINE | Debris on pool/spa bottom or on water surface, dark oily film on pool/spa sides. | Circulation |
| EYE IRRITATION or CHLORINE SMELL | Dry or itchy eyes. Chlorine smell on skin and in hair. | pH Circulation Disinfection |
| STAIN FORMATION or DISCOLORED WATER | Brown, red or gray discoloration on pool/spa walls and bottom, rust red or clear green tint to water. | pH |
| UNSTABLE pH or HARD TO CHANGE pH | Problem keeping pH within ideal range. | Total Alkalinity pH |
| CALCIFIED FILTER or SCALED HEATER | Excessive flow restriction in filter or heater not caused by oils. | pH Calcium Hardness |
| WATER TASTES SALTY | Salt or brackish taste to water. | Total Dissolved Solids |
| GROUT EROSION or PLASTER EROSION | Grout between tiles missing or plaster surface rough and possibly trapping dirt. | pH Calcium Hardness |

| CAUSES | SOLUTIONS |
|------------------------|--|
| CIRCULATION | Run pump continuously. Maintain turnover rates: Pools-8 hrs, Spas-30 min Clean hair and lint trap. Backwash filter. Set valves to minimize restriction. If filter oily, clean with degreaser (tri sodium phosphate) If filter calcified, treat with decalcifier. Use sequestrant thereafter. If heater calcified, have heater repaired. Use sequestrant thereafter. Adjust inlet fittings to cause water to rotate slowly in one direction. Equip skimmers with all necessary parts (weirs, equalizers). If pool has gutters, inspect and repair modulation valve on main drain line. |
| FILTRATION | If DE filter, properly coat with DE. Repair any damaged elements. If cartridge filter, replace torn elements. Reseat elements properly. If sand filter, add clarifier to pool/spa water. Inspect and clean sand. Eliminate air leaks on suction side of pump. Check filter air vent. |
| DISINFECTION | Maintain proper disinfection level throughout pool/spa. Adjust circulation to assure uniform distribution of disinfectant. If algae visible, superchlorinate and brush pool/spa surface. Use algicide. If eye irritation, superchlorinate. If disinfectant level too high, lower with sodium thiosulphate. |
| CYANURIC ACID | If cyanuric acid level too high, drain and refill or dilute with fresh water. |
| PH | If pH below 6.8, add sequestrant, adjust total alkalinity, add soda ash. If pH below 7.2, add soda ash. If pH above 8.0, add acid. If metal discoloration or staining, use sequestrant. Maintain constant pH. |
| TOTAL ALKALINITY | If total alkalinity below 80 ppm, add sodium bicarbonate. If total alkalinity above 120 ppm, add acid to maintain pH of 7.4-7.6. |
| CALCIUM HARDNESS | If calcium hardness below 200 ppm, add calcium chloride. If calcium hardness above 500 ppm, add sequestrant. |
| TOTAL DISSOLVED SOLIDS | If water tastes salty, drain and refill or dilute with fresh water. |

Because temperature is an important factor in your pool or spa, you need to monitor it carefully. Doing so requires a calibrated thermometer. Calibrating is the process of ensuring that the measurements you are reading are accurate. A simple way to do this is by using the ice water method as illustrated below.

ICE WATER METHOD



INSTRUCTIONS

1. Fill a glass with ice and add cold water
 - This will make the water 32°F.
2. Place the thermometer in ice water and adjust to 32°F.
 - You should see the thermometer's manufacturer's instructions on how to adjust the reading. On a stem thermometer like the one shown in the picture above, you can do this by rotating the hex adjusting nut.
3. After adjusting, place in water again to ensure that the thermometer reads 32°F.

VGB COMPLIANCE DIAGRAM FOR POOL & SPA DRAINS

VGB = Virginia Graeme Baker Pool & Spa Safety Act

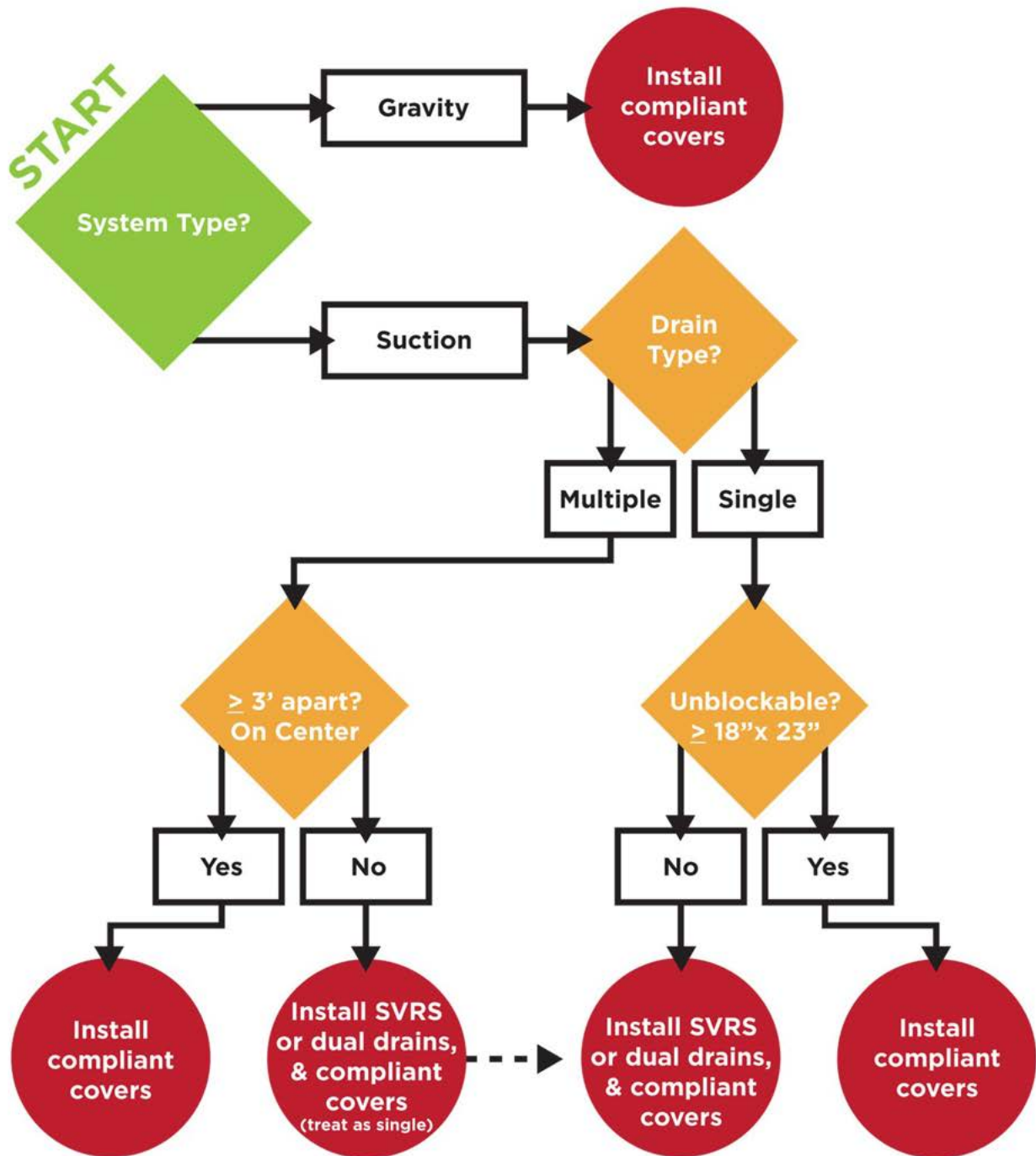


Diagram developed in accordance with the Ohio Administrative Code, with support from the Ohio Department of Health Environmental Engineering Section; Created 5/2011; Updated 2/2015.

HOW ARE ILLNESSES SPREAD AT AQUATIC FACILITIES?

Communicable illnesses can be spread by swallowing, breathing, or having contact with contaminated water from swimming pools, spas, lakes, rivers, or oceans. These illnesses can cause a wide variety of symptoms, including skin, ear, respiratory, eye, and wound infections. The most commonly reported illness caused by exposure during swimming is diarrhea. Diarrheal illnesses can be caused by germs such as Crypto, short for *Cryptosporidium*, *Giardia*, *Shigella*, and *E. coli* O157:H7.

These illnesses are not spread by contact with blood. Most can be spread:

- By swallowing recreational water contaminated with the illness. Recreational water is water from swimming pools, hot tubs, jacuzzis, fountains, lakes, rivers, springs, ponds, or streams that can be contaminated with sewage or feces from humans or animals.
- Accidentally swallowing something that has come in contact with the stool of a person or animal infected with the germ.
- By swallowing the germ picked up from surfaces (such as lounge chairs, picnic tables, bathroom fixtures, changing tables) contaminated with stool from an infected person.

HOW DO I PROTECT MYSELF AND MY FAMILY?

Healthy Swimming behaviors are needed to protect you and your kids from recreational water illnesses and will help stop germs from getting in the pool in the first place. Here are six “P-L-E-As” that promote Healthy Swimming:

1. PLEASE don't swim when you have diarrhea.
2. PLEASE don't swallow the pool water.
3. PLEASE practice good hygiene. Take a shower before swimming and wash your hands after using the toilet or after changing diapers.
4. PLEASE take your kids on bathroom breaks or check diapers often.
5. PLEASE change diapers in a bathroom and not at poolside.
6. PLEASE wash your child thoroughly (especially the rear end) with soap and water before swimming.

CRYPTOSPORIDIUM - CRYPTO

Crypto is a germ that causes diarrhea. Crypto, short for *Cryptosporidium*, is found in infected people's stool and cannot be seen by the naked eye. This germ is protected by an outer shell that allows it to survive for long periods of time and makes it resistant to chlorine disinfection found in pools. During the past two decades, Crypto has become recognized as one of the most common causes of waterborne illness in the United States. The germ is found in every part of the United States and the world.

GIARDIA

Giardia is a germ that causes diarrhea. *Giardia* is found in infected people's stool and cannot be seen by the naked eye. This germ is protected by an outer shell that allows it to survive outside the body and in the environment for long periods of time. During the past two decades, *Giardia* has become recognized as one of the most common causes of waterborne illness (drinking water and recreational water) in the United States. The germ is found in every part of the United States and the world.

SHIGELLA

The *Shigella* bacteria pass from one infected person to the next. *Shigella* are present in the diarrheal stools of infected persons while they are sick and for a week or two afterwards. Most *Shigella* infections are the result of the bacterium passing from stools or soiled fingers of one person to the mouth of another person. *Shigella* infections can also be acquired by drinking or swimming in contaminated water. Water may become contaminated if sewage runs into it, or if someone with shigellosis swims in it.

E. COLI O157:H7

E. coli O157:H7 is one of hundreds of strains of the bacterium *Escherichia coli*. Although most strains are harmless and live in the intestines of healthy humans and animals, this strain produces a powerful toxin and can cause severe illness. Bacteria in diarrheal stools of infected persons can be passed from one person to another if hygiene or handwashing habits are inadequate. This is particularly likely among toddlers who are not toilet trained. Water contaminated with this germ could infect a healthy person who comes in contact with it.

COLUMBUS PUBLIC HEALTH

ENVIRONMENTAL HEALTH LICENSING PROGRAM

If you have questions about licensing fees or payments, call: 614-645-7005

POOL AND SPA SAFETY PROGRAM

If you have questions about inspections of your facility or need technical information, contact the Registered Sanitarian who inspects your facility: 614-645-7005

Certified Pool/Spa Operator® Certification (CPO®) is being offered at Columbus Public Health! The gold standard of swimming pool operator training, designed and accredited by the Pool & Hot Tub Alliance.

ASK US HOW TO BECOME A CERTIFIED POOL/SPA OPERATOR®



COMMUNICABLE DISEASE DIVISION

If you need to report an waterborne disease that you feel is affecting your facility's patrons, contact: 614-645-6466

OTHER IMPORTANT CONTACTS...

COLUMBUS DIVISION OF POLICE

In emergency situations, DIAL 9-11
For non-emergency calls, dial 614-645-4545
120 Marconi Blvd
Columbus, OH 43215

COLUMBUS DIVISION OF FIRE

In emergency situations, DIAL 9-11
For non-emergency calls, dial 614-645-8308
3675 Parsons Ave
Columbus, OH 43207

CENTRAL OHIO POISON CENTER

In emergency situations, DIAL 1-800-222-1222
700 Children's Drive, Room L032
Columbus, OH 43205

OHIO DEPARTMENT OF HEALTH

ODH's Swimming Pools, Spas and Public Use Pools Program focuses on pool and spa plan review and Ohio Administrative Code development. To contact ODH about this program, call 614-466-1390.

CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)

For information on disease listings and information on waterborne illnesses and how to prevent the spread of them, visit the CDC's website at: www.cdc.gov