

## **Model Aquatic Health Code**

- 1.0 Preface**
- 2.0 User Guide**
- 3.0 Definitions**

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## Table of Contents

### 1.0 Preface

- 1.1 Recreational Water Illness Estimates, Risk Factors, and Interventions
- 1.2 Model Aquatic Health Code (MAHC) Background, Vision, Path, and Authority
- 1.3 Public Health and Consumer Expectations
- 1.4 Uniform Standards
- 1.5 Modification and Improvements in this Edition
- 1.6 Code Adoption/Certified Copies
- 1.7 The Code Revision Process
- 1.8 Acknowledgements

### 2.0 User Guide

- 2.1 Overview
- 2.2 MAHC Structure and Format
- 2.3 MAHC Grading System
- 2.4 Annexes

### 3.0 Definitions

- 3.1 Title, Intent, Scope
- 3.2 Definitions

### 4.0 Design Standards and Construction

- 4.1 Plan Submittal
- 4.2 Materials
- 4.3 Equipment Standards
- 4.4 Pool Operation and Facility Maintenance [N/A]
- 4.5 Pool Structure (Shell)
- 4.6 Indoor/Outdoor Environment
- 4.7 Recirculation and Water Treatment
- 4.8 Decks and Equipment
- 4.9 Filter/Equipment Room
- 4.10 Hygiene Facilities (Bathhouse)
- 4.11 Water Supply/Wastewater Disposal

4.12 Specific Venues - Special Requirements

## **5.0 Operation and Maintenance**

- 5.1 Plan Submittal [N/A]
- 5.2 Materials [N/A]
- 5.3 Equipment Standards [N/A]
- 5.4 Pool Operation and Facility Maintenance
- 5.5 Pool Structure (Shell)
- 5.6 Indoor/Outdoor Environment
- 5.7 Recirculation and Water Treatment
- 5.8 Decks and Equipment
- 5.9 Filter/Equipment Room
- 5.10 Hygiene Facilities (Bathhouse)
- 5.11 Water Supply/Wastewater Disposal
- 5.12 Specific Venues - Special Requirements

## **6.0 Policies and Management**

- 6.1 Operator Training
- 6.2 Lifeguard Training
- 6.3 Facility Staffing
- 6.4 Facility Management
- 6.5 Fecal/Blood/Vomit Contamination Response
- 6.6 Inspections

## **7.0 Index**

## **8.0 Annexes**

## **9.0 Summary of Changes**

## 1.0 Preface

- 1.1 Recreational Water Illness Estimates, Risk Factors, and Interventions
- 1.2 Model Aquatic Health Code (MAHC) Background, Vision, Path, and Authority
- 1.3 Public Health and Consumer Expectations
- 1.4 Uniform Standards
- 1.5 Modification and Improvements in this Edition
- 1.6 Code Adoption/Certified Copies
- 1.7 The Code Revision Process
- 1.8 Acknowledgements

### 1.1 Recreational Water Illness Estimates, Risk Factors, and Interventions

#### 1.1.1 Introduction

##### *Introduction*

1.1.1.1 Swimming is a popular activity in the United States with over 368 million person-visits annually to swimming pools, beaches, and lakes in the United States. This high level of exposure makes it imperative to ensure public health and safety at swimming venues. Multiple challenges exist to providing adequate disinfection at swimming pools, spray grounds, and other disinfected swimming venues. Sunlight, urine, aeration, and organic matter can rapidly deplete free chlorine, which is the primary disinfectant used in pools. Swimming venues also provide an opportunity for exposure to fecal contamination from fellow bathers. Fecal incidents are a common occurrence in swimming pools, especially when patrons include diapered and toddler-aged children not yet toilet trained. The fecal-orally transmitted pathogen *Cryptosporidium* may survive for days in chlorinated swimming venues as a result of its environmental stability and extreme chlorine resistance. Some waterborne pathogens have a low infectious dose and can be shed for weeks after diarrhea ends. These factors increase the potential for a waterborne disease outbreak. Waterborne disease and outbreaks can include 1) gastrointestinal illness resulting from exposure to pathogens such as *Escherichia coli* 0157:H7 or *Cryptosporidium*, 2) infections of the brain, skin, ear, eye, and lungs, 3) wounds, and 4) exposure to chemicals.

#### 1.1.2 Recreational Water-Associated Illness Outbreaks

##### *Statistics for recreational water-*

1.1.2.1 The number of reported recreational water-associated waterborne disease outbreaks (WBDOs) reported annually

*associated illness outbreaks*

have increased substantially since 1978, when CDC first began receiving surveillance data for these WBDOs. The increase is likely due to a combination of factors, such as the emergence of pathogens, especially the chlorine-resistant parasite *Cryptosporidium*, increased participation in aquatic activities, and increases in the number of aquatic venues. Increased recognition, investigation, and reporting of recreational water-associated outbreaks also might be contributing factors. A total of 78 recreational water-associated WBDOs affecting 4,412 persons were reported to CDC during 2005-2006, which is the largest number of outbreaks ever reported in a 2-year period. CDC documented that 58 (74.4%) of these outbreaks and 4,167 (94.4%) of the cases were associated with disinfected water venues. (Yoder J, Roberts V, Craun GF, Hill V, Hicks LA, Alexander NT, Radke V, Calderon RL, Hlavsa ML, Beach MJ, Roy SL. (2008) Surveillance for waterborne disease and outbreaks associated with drinking water and water not intended for drinking — United States, 2005–2006. MMWR Surveill Summ 57:39-69).

*Significance of Cryptosporidium*

1.1.2.2 There were 31 recreational water-associated outbreaks reported in 2005-2006 that were caused by *Cryptosporidium*, a substantial increase from the 9 reported in 1997-1998. In addition, during 1997-2006 *Cryptosporidium* was identified as the etiologic agent in 68.3% of gastroenteritis outbreaks at disinfected recreational water venues. (Yoder J, Roberts V, Craun GF, Hill V, Hicks LA, Alexander NT, Radke V, Calderon RL, Hlavsa ML, Beach MJ, Roy SL. (2008) Surveillance for waterborne disease and outbreaks associated with drinking water and water not intended for drinking — United States, 2005–2006. MMWR Surveill Summ 57:39-69).

## **1.2 Model Aquatic Health Code (MAHC) Background, Vision, Path, and Authority**

### **1.2.1 Background**

*Lack of uniform standards*

1.2.1.1 In the United States, all pool codes are reviewed and approved by state and/or local public health officials. There are no uniform national standards governing design, construction, operation, and maintenance of swimming pools and other recreational water venues. Thus, the code requirements for preventing and responding to recreational water illnesses can vary significantly among local and state agencies. A model national code would ensure that the best available standards

and practices for protecting public health are available for adoption by state and local agencies.

## **1.2.2 Path**

*MAHC process*

1.2.2.1 The MAHC process will develop a comprehensive, national consensus, risk reduction plan for the design, construction, alteration, replacement, operation, management, and regulatory oversight of aquatic facilities in the United States. This will be accomplished through development of a model aquatic health code and risk reduction plan that is data and best practices based, national in scope, can be implemented across the U.S., is updated on a continuous basis, and includes input from all sectors and levels of public health, all segments of the aquatics industry, and the general public.

## **1.2.3 Authority**

*MAHC host*

1.2.3.1 The Model Aquatic Health Code is hosted by the Centers for Disease Control and Prevention (CDC), a Federal agency whose mission is “To promote health and quality of life by preventing and controlling disease, injury, and disability.” CDC is “the primary Federal agency for conducting and supporting public health activities in the United States” (CDC Fact Sheet); however, they are not a regulatory agency. As such, the Model Aquatic Health Code is intended, as its name suggests, as a model aquatic code that state and local health agencies can adopt in part or in full as code regulations for their jurisdiction. CDC has taken on this role because, as of 2008, no U.S. federal agency has oversight over disinfected public swimming venues.

## **1.3 Public Health and Consumer Expectations**

### **1.3.1 Shared Responsibility**

*Shared responsibility*

1.3.1.1 It is a shared responsibility of the aquatics industry and the government to ensure that aquatic facilities provide consumers with safe and healthy recreational water experiences and do not become vehicles for transmission of communicable disease or outbreaks. This shared responsibility extends to ensuring that consumer expectations are met and that aquatic facilities are properly designed, constructed, operated, and maintained.

### **1.3.2 Mission Statement**

*MAHC vision*

1.3.2.1 The vision for the MAHC process is to develop a Model Aquatic Health Code that is user-friendly, knowledge-based, and scientifically supported in an effort to reduce risk and promote healthy recreational water experiences. The objective is to transform varied swimming pool regulations used by health departments into a uniform model national code to ensure the health and safety of the swimming public.

## **1.4 Uniform Standards**

### **1.4.1 Advantages**

*Advantages to uniform standards*

1.4.1.1 The advantages of well-written, scientifically sound, and up-to-date model codes have long been recognized by industry and government officials. Industry conformance with acceptable procedures and practices is far more likely where regulatory officials "speak with one voice" about what is required to protect the public health, why it is important, and which alternatives for compliance may be accepted. Model codes provide a guide for use in establishing what is required. They are useful to business in that they provide accepted standards that can be applied in training and quality assurance programs. They are helpful to local, state, and federal governmental bodies that are developing or updating their own codes. The MAHC provides guidance on aquatic facility design standards & construction, operation & maintenance, and policies & management that can be uniformly adopted for the retail segment of the aquatics industry. The document is the cumulative result of the efforts and recommendations of many contributing individuals, agencies, and organizations. It embraces the concept that safe and healthy recreational water experiences by the public are directly affected by how we collectively design, operate, and maintain our aquatic facilities. Model performance standards in effect define public aquatic safety expectations, usually in terms of lethality to a pathogenic microorganism of particular concern. Use of performance standards as the measure of regulatory compliance means aquatic facilities are free to use innovative approaches in providing safe experiences, in lieu of adherence to traditional prescriptive approaches in design and operation, that achieve the same end. However, to show compliance with the model performance standard, the facility must demonstrate that control measures are in place to ensure that the standard is being met. Thus, a request for a variance based on a federal

performance standard must be approved by a licensed engineer with documented verification made available to the regulatory authority.

## **1.5 Modifications and Improvements in this Edition**

### **1.5.1 (reserved)**

## **1.6 Code Adoption**

### **1.6.1 Code Adoption**

*Adoption of MAHC at the state or local level*

1.6.1.1 The MAHC is provided for use by aquatic facility regulatory jurisdictions at all levels of government. At the state and local levels the MAHC may be:

(a) Enacted into statute as an act of the state legislative body;

(b) Promulgated as a regulation, if the state legislative body has delegated rulemaking authority to a governmental administrative agency; or

(c) Adopted as an ordinance, if the local legislative body has been delegated rulemaking authority or regulatory powers.

Typically, code adoption bodies publish a notice of their intent to adopt a code, make copies available for public inspection, and provide an opportunity for public input prior to adoption. This is usually done in one of two ways. The recommended method is the "short form" or "adoption by reference" approach where a simple statement is published stating that certified copies of the proposed code are on file for public review. This approach may be used by governmental bodies located in states that have enabling laws authorizing the adoption of codes by reference. An advantage to this approach is a substantial reduction in the cost of publishing and printing. The alternative method is the "long form" or "section-by-section" approach where the proposed code is published in its entirety. Both methods of adoption allow for the modification of specific provisions to accommodate existing law, administrative procedure, or regulatory policy.



## **1.7 The Code Revision Process**

### **1.7.1 Model Aquatic Health Code Revision and Publication Cycles**

*MAHC revision timeline*

1.7.1.1 CDC intends to issue a new edition of the MAHC every 2 years. During the 2-year span of time between editions, supplements may be issued to an existing edition. Each new edition will incorporate the changes made in the supplement as well as any new revisions.

### **1.7.2 Submission of Model Aquatic Health Code Change Suggestions**

*Submission of comments and suggestions*

1.7.2.1 CDC will continue to receive concerns and recommendations for modification of the MAHC from any individual or organization via the email address MAHC@cdc.gov. Given the purpose of the document as discussed in item 1.2 of this Preface, the Agency will be especially interested in addressing problems identified by those in government and industry who are responsible for implementing the MAHC. CDC will also be especially responsive to those needed policy and technical changes raised by an organization that uses a democratic process for addressing problems and concerns. Included are organizations that provide a process that encourages representative participation in deliberations by government, industry, and academic and consumer interests, followed by public health ratification such as a state-by-state vote by officially designated delegates. These organizations receive problems submitted by any interested individual, but specify the forms on which the issues must be detailed and provide specific time frames during which they may be submitted. CDC encourages interested individuals to consider raising issues and suggesting solutions involving the federal-state cooperative programs based on the MAHC through these organizations.

## **1.8 Acknowledgements**

### **1.8.1 Volunteer Effort**

*MAHC project volunteers*

1.8.1.1 Many individuals devoted considerable time and effort in addressing concerns and developing recommendations that are now reflected in the Model Aquatic Health Code. These

individuals represent a wide diversity of regulators, educators, industry leaders, and consumer representatives acting through their agencies, companies, professional groups, or trade organizations. It is only through the dedicated efforts and contributions of experienced professionals that a scientifically sound, well focused, and up- to-date model code is possible. CDC acknowledges with gratitude the substantial assistance of those who contributed to public health and aquatic safety in the development of the Model Aquatic Health Code.

## **2.0 User Guide**

### **2.1 Overview**

### **2.2 MAHC Structure and Format**

### **2.3 MAHC Grading System**

### **2.4 Annexes**

## **2.1 Overview**

### **2.1.1 New Users**

*MAHC scope*

2.1.1.1 A new user will find it helpful to review the Table of Contents in order to quickly gain an understanding of the scope and sequence of subjects included in the MAHC.

### **2.1.2 Topic Presentation**

*Presentation of topics*

2.1.2.1 MAHC provisions address essentially three areas: Design & Construction (Chapter 4), Operation & Maintenance (Chapter 5), Policies & Management (Chapter 6). In addition, an overarching Risk Reduction Plan is provided in the Annex.

## **2.2 MAHC Structure and Format**

### **2.2.1 Numbering System**

*MAHC numbering system*

2.2.1.1 The MAHC follows a numeric outline format. The structural nomenclature of the document is as follows:

Chapter	1.0
Part	1.1
Subpart	1.1.1
Section	1.1.1.1
Paragraph	1.1.1.1.1

Recommended code requirement wording is shown to the right side of the numbering system. These requirements usually appear in sentence or paragraph format.

	<b>2.2.2</b>	<b>Left Column Text</b>
<i>Left column keywords</i>	2.2.2.1	On the left portion of each page is a two or three word keyword summary showing the information contained in the corresponding code wording.
	<b>2.2.3</b>	<b>Critical Items</b>
<i>Critical items</i>	2.2.3.1	Critical items have their number in red font and have an asterisk next to their number.
	<b>2.2.4</b>	<b>Italicized Words</b>
<i>Italicized words</i>	2.2.4.1	Italicized words indicate that the content is further discussed in the Annex.
	<b>2.2.5</b>	<b>Illustrations</b>
<i>Illustrations</i>	2.2.5.1	Appropriate charts, diagrams, and other illustrative material found in the Chapters will also appear in the Annex.
	<b>2.2.6</b>	<b>Consistency Between Chapters 4.0 and 5.0</b>
<i>Chapters 4.0 and 5.0</i>	2.2.6.1	Each Part or Sub-part is repeated throughout MAHC Chapters 4.0 Design Standards & Construction and 5.0 Operation & Maintenance. For example, for disinfection, the design standards and construction aspects are addressed in Subpart 4.7.3 and the operation and maintenance aspects are addressed in Subpart 5.7.3. If a topic is not applicable then that section is marked with a N/A (e.g., the size or width of the decking is not really applicable for Operation & Maintenance versus Design Standards & Construction). This is designed to allow MAHC users to see how a topic of interest applies under both chapter headings.
	<b>2.2.7</b>	<b>Conventions</b>
<i>Conventional language</i>	2.2.7.1	The following conventions are used in the Model Aquatic Health Code. “Shall” means the act is imperative, i.e., “shall” constitutes a command. “May not” means absolute prohibition. “May” is permissive and means the act is allowed. The term

“means” is followed by a declared fact.

## **2.2.8 Definitions**

*Terms defined in Chapter 3*

2.2.8.1 Defined words and terms are in “small caps” in the text of the Model Aquatic Health Code chapters to alert the reader to the fact that there is a specific meaning assigned to those words and terms and that the meaning of a provision is to be interpreted in the defined context. A concerted effort was also made to place in “small caps” all forms and combinations of those defined words and terms that were intended to carry the weight of the definition.

## **2.3 MAHC Grading System**

### **2.3.1 Purpose**

*Purpose of grading system*

2.3.1.1 A grading system is provided for the recommended standards. It is based on the perceived reliability and accuracy of the material presented. This grading system is divided into three levels.

### **2.3.2 Grading System**

*Grading system*

2.3.2.1 The MAHC grading system is as follows:

Grade A: Practice supported by science/research/data.

Grade B: Generally accepted practice not supported by science/research/data.

Grade C: No generally accepted practice. Proposed language not yet supported by science/research/data.

## **2.4 Annexes**

### **2.4.1 Rationale**

*Purpose of Annexes*

2.4.1.1 The annex is provided to:

(a) Give further explanations on why certain recommendations are made;

(b) Discuss rationale for making the code content

decisions;

(c) Provide a discussion of the scientific basis for selecting certain criteria, as well as discuss why other scientific data may not have been selected, e.g. due to data inconsistencies;

(d) State areas where additional research may be needed;

(e) Discuss and explain terminology used; and

(f) Provide additional material that may not have been appropriately placed in the main body of suggested recommendations. This would include summaries of scientific studies, charts, graphs, or other illustrative materials.

## **2.4.2 Content**

### *Annex content*

#### **2.4.2.1**

The annexes located at the back of the document can provide assistance to those charged with applying Model Aquatic Health Code provisions. No reference is made in the text of a provision to the annexes which support its requirements. This is necessary in order to keep future laws or other requirements based on the Model Aquatic Health Code simple. However, the annexes are provided specifically to assist users in understanding and applying the provisions uniformly and effectively.

It is, therefore, important for users to preview the subject and essence of each of the annexes before using the document. Some of the annexes (e.g., References, Public Health Reasons) are structured to present the information by the specific Model Aquatic Health Code item number to which they apply. Other annexes provide information and materials intended to be helpful to the user such as model forms that can be used, recreational water illness outbreak response, and guidelines for facility inspection.

## **2.4.3 Bibliography**

### *Bibliography*

#### **2.4.3.1**

The Annex includes a bibliography of the reference materials and scientific studies that form the basis for recommendations.

## 3.0 Definitions

### 3.1 Title, Intent, Scope

#### 3.2 Definitions

### 3.1 Title, Intent, Scope

#### 3.1.1 Title

*Title*

3.1.1.1 Model Aquatic Health Code.

3.1.1.1.1 These provisions shall be known as the Model Aquatic Health Code, hereinafter referred to as “this Code.”

#### 3.1.2 Intent

*Intent of MAHC*

3.1.2.1 Aquatic Safety and Illness Prevention.

3.1.2.1.1 The purpose of this Code is to safeguard public health and provide to patrons of disinfected water venues a safe and healthy experience.

#### 3.1.3 Scope

*Scope of MAHC*

3.1.3.1 Statement.

3.1.3.1.1 This Code establishes definitions, sets standards for management and personnel, disinfected water venue operations, and equipment and facilities, and provides for disinfected water venue plan review, permit issuance, inspection, employee restriction, and permit suspension.

### 3.2 Definitions

#### 3.2.1 Applicability and Terms Defined

*Terms*

3.2.1.1 Statement of Application and Listing of Terms.

3.2.1.1.1 The following definitions shall apply in the interpretation and application of this Code.

3.2.1.1.2 Terms Defined. As used in this Code, each of the terms listed in 3.2.1.2.2 shall have the meaning stated below.

**“Aquatic Venue”** means an artificially constructed or modified natural structure where the general public is exposed to water intended for recreational or therapeutic purpose. Such structures do not necessarily contain standing water so water exposure may occur via contact, ingestion, or aerosolization. Examples include swimming pools, water parks, water slides, spas (including spa pools and hot tubs), therapeutic pools, fountains, wet decks, spray pads, and interactive water features.

**“Best Practice”** means a technique or methodology that, through experience and research, has been proven to reliably lead to a desired result.

**“Breakpoint Chlorination”** means the conversion of inorganic chloramine compounds to nitrogen gas. When chlorine is added to water containing ammonia (from urine, sweat, or the environment, for example), it reacts with the ammonia to form chloramines. If more chlorine is added, the total residual chlorine continues to rise until the concentration reaches a point that forces the reaction with ammonia to go to rapid completion. In this reaction, the inorganic chloramines are converted to dichloramine, then to nitrogen trichloride, and then to nitrogen gas. Compounds of nitrogen and chlorine are released into the water, and the apparent residual chlorine decreases. The point at which the drop occurs is referred to as the “breakpoint”. The amount of free chlorine that must be added to the water to achieve breakpoint chlorination is approximately ten times the amount of combined chlorine in the water. As additional chlorine is added, all inorganic combined chlorine compounds disappear, resulting in a decrease in eye irritation potential and “chlorine odors.”

**“Chlorine”** means an element that at room temperature and pressure is a heavy green gas with characteristic odor and is extremely toxic. It can be compressed in liquid form and stored in heavy steel tanks, but most pools now add other chlorine compounds (e.g. hypochlorite) that similar to the liquid form release hypochlorous acid when dissolved in water. Chlorinating agents are the most commonly used disinfectants for pools.

**“Code”** means a systematic statement of a body of law, especially one given statutory force.

**“Contamination Response Plan”** means a plan for handling contamination from formed-stool, diarrheal-stool, vomit, and contamination involving blood.

**“Contaminant”** means a substance that soils, stains, corrupts, or infects another substance by contact or association.

**“CT Value”** means a representation of the concentration of the disinfectant (C) multiplied by time in minutes (T) needed for inactivation of a particular contaminant. The concentration and time are inversely proportional; therefore, the higher the concentration of the disinfectant, the shorter the contact time required for inactivation.

**“Disinfection”** means the reduction of pathogens (disease causing organisms).

**“Free Chlorine Residual”** means the available disinfectant in the water. It is the portion of total chlorine that is not combined chlorine and is available as disinfectant. When chlorine is added to

water, hypochlorous acid is produced in either the molecular state (HOCl) or the ionized state (hypochlorite ion (OCl<sup>-</sup>) plus hydrogen ion (H<sup>+</sup>)), and a by-product specific to the type of chlorine is produced. The pH of the water determines the amount of hypochlorous acid in each state. HOCl is a very effective bactericide and is the active available chlorine disinfectant in the water. OCl<sup>-</sup> is also a bactericide, but acts more slowly than HOCl. Thus chlorine is a much less effective bactericide at high pH. The sum of HOCl and OCl<sup>-</sup> is referred to as “free chlorine” in pool water. The hypochlorous acid that remains in pool water uncombined with ammonia is called “free chlorine residual.” A free chlorine residual must be maintained for adequate disinfection.

**“Generally Accepted Practice”** means a technique or methodology that is widely used but may or may not be the “best practice.”

**“High-risk Venue”** means a venue which due to its intrinsic characteristics including intended users, has a greater likelihood of affecting the health and safety of the patrons of that venue. Examples of high-risk aquatic venues include wading pools, spas, and therapy pools.

**“mg/L”** means the equivalent metric measure to parts per million (ppm).

**“Oxidation”** means the process of changing the chemical structure of water contaminants by increasing the number of oxygen atoms or reducing the number of electrons of the contaminant, which allows the contaminant to be more readily removed from the water. It is the “chemical cleaning” of pool water. Oxidation can be achieved by common disinfectants (e.g., chlorine, bromine, ozone, potassium monopersulfate).

**“Performance measures/Performance-based design”** means an engineering approach to design elements of a facility based on agreed upon performance goals and objectives, engineering analysis and quantitative assessment of alternatives against the design goals and objectives using accepted engineering tools, methodologies, and performance criteria. It is different from the prescriptive approach, which identifies specific requirements for the design of a facility.

**“pH”** means a symbol that expresses the negative log of the concentration of hydrogen ions. When water ionizes, it produces hydrogen ions (H<sup>+</sup>) and hydroxide ions (OH<sup>-</sup>). If there is an excess of hydrogen ions the water is acidic. If there is an excess of hydroxide ions the water is basic. pH ranges from 0 to 14. Pure water has a pH of 7.0. If pH is higher than 7.0, the water is said to be basic, or alkaline. If the water’s pH is lower than 7.0, the water is acidic. As pH is raised, more ionization occurs and chlorine disinfectants decrease in effectiveness.

**“Pool”** means a subset of aquatic venue designed to have impounded/standing water for total or partial bather immersion.

**“Safety” (as it relates to construction items)** means a design standard intended to prevent inadvertent or hazardous operation or use (i.e., a passive engineering strategy).

**“Standard”** means something established by authority, custom, or general consent as a model or example.



**“Systems-based approach”** means a method based on the structure and function of how systems operate and interact with each other. The system is comprised of inputs, process, outputs, and feedback, and has general characteristics including complex underlying factors that drive how things work and why, and natural set points (outcomes) determined by these systems forces. The systems-based approach is an alternative to the traditional inspectional or code-based approach and includes system description, process evaluation, exploration of underlying cause and effect, and documentation and strengthening the system.

**“Water Feature”** means a feature designed for play and recreation that is used in an aquatic venue.