March 2026

CSTE
COUNCIL OF STATE AND TERRITORIAL EPIDEMIOLOGISTS

# *Legionella* Remediation Options for Building Water Systems

# *Table of Contents*

# *Legionella* Remediation Options for Building Water Systems

## Purpose

This document is intended to provide an overview of common methods of *Legionella* remediation for public health or facility staff. Because remediation methods are system specific, it is critical that facilities collaborate with those knowledgeable about plumbing system components and technical implementation strategies for remediation approaches.

Healthcare facilities should ensure that any remediation activities are consistent with the facility's water management program and all-hazard risk management practices in accordance with ASHRAE Standard 514.

## Background

The growth of *Legionella* within a building water system is influenced by several factors, including but not limited to:

- Presence of biofilm, scale, and/or sediment
- Water temperatures between 68-120° F
- Low or absent disinfectant residual
- Stagnant or low water movement/flow

Even if a risk management approach (e.g., a water management program) has been implemented to control these factors, there may still be instances when remediation activities are needed to mitigate *Legionella* growth. Within this context, remediation involves specific actions, above and beyond routine control measures, designed to eliminate or minimize *Legionella* colonization within a building water system.

**Remediation is considered a short-term measure** intended to reduce the burden or colonization of *Legionella* within the building water system and to quickly minimize the risk of exposure to building occupants. However, *Legionella* may rebound if long-term control measures are not implemented.

**Flushing is not described as a remediation option in this document**.
Flushing is a commonly used strategy to prevent *Legionella* growth as part of water management programs or as a corrective action in building plumbing systems. It can improve water quality by reducing water age and preventing stagnation, which are conditions that promote *Legionella* growth. In buildings supplied with disinfected water, flushing also helps maintain disinfectant residuals throughout the building plumbing system. However, because flushing alone is not expected to address *Legionella* growth in biofilm, it is technically not considered a method of remediation. Only chemical and mechanical (e.g., scrubbing to physically remove biofilm) remedial methods would be expected to impact biofilm. In the context of remediation, "flushing" is used in a supportive role to move the chemical disinfectant uniformly throughout the building water system so that it can achieve inactivation of the colonized *Legionella.*

Building water systems can be complex and diverse, presenting unique challenges for controlling the growth of *Legionella*. Therefore, remediation activities should be tailored to the structural characteristics of the facility and specific circumstances of the *Legionella* colonization.

A determination of which remediation action is most appropriate for a particular building water system is situation specific. The optimal methods and techniques to remediate *Legionella* vary depending on the level of *Legionella* colonization; the size, makeup and complexity of the building water system; and other facility-specific factors, such as if there are associated cases of disease.

## When *Legionella* Remediation May Be Needed

*Legionella* remediation actions, beyond routine control measures, may be warranted when one or more of the following events occurs:

**Legionellosis Outbreak Investigation**: An investigation of a legionellosis outbreak that is potentially associated with a potable water system is an indication that remediation activities may be necessary to eliminate *Legionella* bacteria from the system.

**Failure of Routine Control Measures**: Based on the severity and duration of a failure of routine *Legionella* control measures specified by a water management program, remediation activities may be warranted to re-establish control of the water system.

***Legionella* Growth Appears Poorly Controlled or Uncontrolled**: Routine *Legionella* environmental sampling that shows an increase in the percentage of samples that are positive, or an increase in the concentration of *Legionella,* can also indicate the need for remediation activities.

**Disruption to the Water System**: Unexpected events, such as equipment failure, water service interruption, a low-pressure event, a boil water notice, or a water main break in the system serving the facility may require remediation to prevent the colonization of *Legionella*.

## *Legionella* Remediation Methods

Building level treatment, above and beyond routine control measures, can be instituted as an emergency corrective measure to remediate a water system colonized with *Legionella*. This section describes most remediation methods that may be marketed to building owners/operators. N**on-chemical options, including ultraviolet radiation and thermal remediation (superheat and flushing), are less effective and NOT recommended for *Legionella* response.** Table 1 compares the advantages and disadvantages of each of the chemical remediation methods, and Table 2 summarizes the non-chemical remediation methods.

## Overview

- Before implementing remediation actions or modifying a building water system, facility owners and operators should consult with their oversight or regulatory agency to determine whether specific considerations or requirements apply, including plumbing code requirements.
- An environmental assessment should be conducted (See CDC's *Legionella* Environmental Assessment Form), and remediation activities should take into consideration the building-specific characteristics of the water system (e.g., facility population being served, water quality, water usage, type and age of material used for pipes, and whether there are any dead legs within the system). The remediation actions should be tailored to those characteristics and circumstances leading to the need for remediation.
- The choice of remediation technology will depend on several factors including cost, operator training, plumbing material composition, water quality parameters, system configuration, and water use patterns.
- Facilities should consider hiring a consultant with *Legionella*-specific environmental expertise to help inform decisions about the type of remediation needed and/or to perform the remediation activities. The CDC provides information for building owners/managers to consider when hiring a vendor for *Legionella* control.
- If remediation requires any adjustment or alteration to the plumbing system, it should be performed by a qualified contractor and/or a professional engineer in accordance with local regulatory requirements.

## Remediation Approaches:

### Chemical Shock Hyperdisinfection

Chemical shock hyperdisinfection is used as a short-term remedial treatment to inactivate *Legionella* in hot or cold potable water systems. Chemical shock hyperdisinfection treatment involves applying a chemical disinfectant such as chlorine or chlorine dioxide for a relatively short period (e.g., up to 24 hours), frequently at concentrations well above maximum residual disinfectant levels permitted for potable water. Selection of the concentration level and contact time should be made in consultation with a professional water treatment consultant. Facilities may opt to turn off the water heater system prior to the remediation to reduce chemical demand. Adequate precautions should be taken to prevent occupants from consuming or being exposed to water with chemical concentrations exceeding allowable maximum residual disinfectant levels. Following completion of treatment, the potable water system should be thoroughly flushed until disinfectant residual levels are within regulatory limits before resuming water use.

### Continuous Hyperdisinfection

Continuous hyperdisinfection involves adding chemical disinfectants to increase the residual while maintaining levels within regulatory limits so that water can continue to be used. Both shock and continuous hyperdisinfection involve the addition of a chemical disinfectant to the water for a fixed period of time (i.e., not indefinitely as with supplemental disinfection). While chemical shock hyperdisinfection treatment involves a higher disinfectant concentration for a shorter contact time (e.g., 50 ppm for several hours), continuous hyperdisinfection involves longer contact time with a disinfectant concentration within regulatory limits (e.g., 2.0 ppm for a few days to a few weeks for free chlorine or monochloramine).

In situations where water restrictions cannot be implemented or enforced (e.g., correctional or psychiatric facility), lower concentrations of a chemical disinfectant applied within regulatory limits might be recommended. Continuous hyperdisinfection with lower concentrations (e.g., at or below 4 mg/L of free chlorine) is performed over a period of days or weeks. **Note that this is a short-term remediation activity not to be confused with ongoing supplemental disinfection.**

Supplemental disinfection involves the installation of permanent chemical injection equipment at the facility. For both shock hyperdisinfection and continuous hyperdisinfection, the injection equipment is removed after treatment. While supplemental disinfection often triggers the need for a certified water operator and other regulatory requirements, chemical shock hyperdisinfection and continuous hyperdisinfection treatment typically do not.

### Operational Considerations for Chemical Remediation

For all chemical disinfectant technologies, establishing and maintaining a disinfectant residual throughout the system is critical. To be effective against *Legionella*, the chosen disinfectant must be present in sufficient concentration with adequate time to react. These disinfection strategies are evaluated in terms of “CT” - the concentration (“C”) of disinfection (measured in mg/L) multiplied by time (“T”) of exposure (measured in minutes). The water pH and temperature also need to be considered.

- To the extent possible, remediation treatment should be performed when the fewest building occupants are present (e.g., nights and weekends).
- If remediation is performed by facility staff, ensure they are trained and use appropriate personal protective equipment in accordance with occupational health and safety regulations when handling chemicals.
- For shock hyperdisinfection, signs and warning labels should be posted at sinks and other outlets to warn building occupants not to use the water when remedial hyperdisinfection is taking place. Facilities with a vulnerable population should take extra precautions to prevent exposure to water during remediation activities.

- For maximum efficacy, any dead legs in the building plumbing system should be removed prior to remediation, although this may not be immediately achievable because it may be complex and take more time and funding.
- Water storage tanks should be drained and flushed to remove any accumulated sediment.
- Immediately following this section, **Best Practices for Flushing during Hyperdisinfection** provides a bulleted list for facilities to use. It is important to move disinfectants through the building water system sequentially starting with the tap closest to where treatment is being performed. Disinfectant levels should be monitored during the remediation to ensure target levels are maintained.
- Remove aerators, shower heads and other flow restrictors (e.g.,inline filters) from faucets before flushing. Flushing should be performed in a manner that reduces the risk of aerosolization.
- High concentrations of disinfectants may corrode metal pipes and other plumbing fixtures. Chemicals used for remediation should be NSF/ANSI/CAN 60 certified for use in drinking water.
- If a resident cannot be moved during a flushing procedure, additional measures should be taken to protect against exposure to aerosolized water, such as closing any doors where the outlet is located during flushing and turning on any exhaust fans.

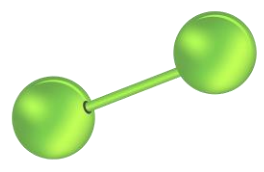
**Best Practices for Flushing during Hyperdisinfection**

- Flushing should move sequentially through the building, typically starting with outlets closest to where water enters the facility or where treatment is being performed. Proceed systematically to flush each outlet, in each room on each floor, to cover the entire facility, including outlets behind all locked doors.
- If flushing both hot and cold potable water systems, ensure the target disinfectant is reached in both systems. This may involve flushing hot and cold water systems separately.
- Duration of flushing should be determined by measuring disinfectant residuals to ensure remediation targets are achieved at all outlets. Flushing times may need to be longer for low-use outlets or based on the configuration of the plumbing system.
- Remove aerators and showerheads before flushing to allow for better flow and cleaning.
- Take care to prevent splashing and avoid generating aerosols during flushing.
- Consider replacing any fixtures or outlets that are inoperable or with biofilm that cannot be sufficiently cleaned and disinfected.
- A post-remediation flush will be needed to bring water quality back to pre-remediation levels throughout the plumbing of the facility.

## Chemical Options:

### Chlorine-Based Disinfectants for Short Term Remediation

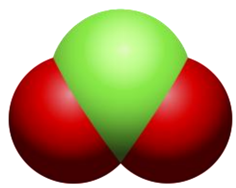
### Chlorine



$Cl_2$

Chlorine is the most commonly used chemical option for *Legionella* remediation. Chlorine is widely used as a disinfectant in drinking water treatment due to its effectiveness, affordability and ease of use. It can be added in the form of gas, sodium hypochlorite or calcium hypochlorite. When added to water, it forms hypochlorous acid which is the active disinfectant. The amount of hypochlorous acid that is formed is dependent upon both the pH and temperature of the water. Elevated levels of chlorine, greater than what is provided by the utility (i.e., hyperchlorination), are added and maintained for a period of time to achieve the desired contact time throughout the water distribution system.

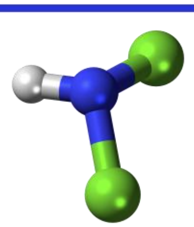
### Chlorine Dioxide



$ClO_2$

The water-soluble gas chlorine dioxide is an effective disinfectant to control *Legionella* and biofilm in both hot and cold building water systems. For water treatment, chlorine dioxide generally needs to be generated on site by a qualified operator. Chlorine dioxide has greater potential than other chemical treatment options to promote corrosion and pitting of pipe surfaces and can degrade rubber and plastic components in the plumbing system. For remediation purposes, the disinfectant needs to be applied at an adequate dose and maintained consistently throughout the building water system for a sufficient contact time. Required contact time will vary based on water quality, temperature, and other site-specific factors. It maintains its effectiveness over a much wider pH range than chlorine.

### Monochloramine

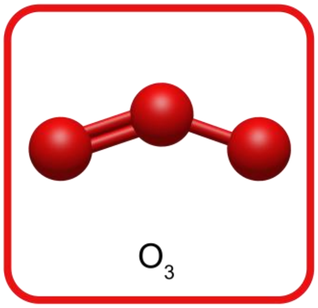


$NH_2Cl$

Monochloramine treatment can be effective in controlling bacterial regrowth and penetrating biofilms more effectively than chlorine, and it does not degrade as readily as chlorine. **Monochloramine has primarily been used for long-term permanent control rather than a short-term remedial option and may not be appropriate for remediation.** Precise dosing of chlorine and ammonia to form monochloramine is also necessary to prevent nitrification. In addition, monochloramine systems have been associated with other health hazards, such as disinfectant byproducts or emergence of other opportunistic pathogens.

### Other Disinfectants

#### Ozone




Ozone is used in drinking water treatment for disinfection and oxidation. It is generated onsite as a gas using either air or liquid oxygen and is then dissolved into the water. Ozone **should not** be used alone as a premise plumbing disinfectant because it decays quickly and cannot maintain a residual in the distribution system. Ozone disinfection is a relatively complex process, and the operational and maintenance demands are significantly greater than chlorine and monochloramine.

#### Copper-Silver Ionization

Copper-silver (Cu-Ag) ionization (CSI) is a common approach to controlling *Legionella*. Copper (Cu) and silver (Ag) have biocidal activity, especially when used in combination. CSI systems can be plumbed into the cold-water entry pipe or into the hot water line. **CSI has primarily been used for long-term permanent control rather than a short-term remedial option and may not be appropriate for remediation.** CSI systems require installation and careful monitoring for accurate levels of copper and silver, which cannot be readily performed onsite. In buildings receiving water from a public water system using phosphates for corrosion control, CSI will have reduced treatment effectiveness due to copper and silver ions binding to the phosphate.

### Non-Chemical Methods (Not Recommended):

#### Ultraviolet Light

Ultraviolet (UV) light disinfection is a well-established treatment technology for inactivating pathogens present in drinking water. However, UV is only effective at inactivating *Legionella* in the water that flows through the UV reactor. For facilities with existing *Legionella* colonization or biofilm in the building water system, UV treatment **is not effective** as a remedial option and other controls such as chemical disinfection or flushing will be necessary. (EPA) 2016. Technologies for *Legionella* Control in Premise Plumbing Systems: Scientific Literature Review.)

#### Superheating

Superheating water, or "thermal shock" (>158°F) can be effective in killing *Legionella*, but has several limitations, including potential scalding hazards, insufficient hot water generating capacity to provide sufficient temperature for an extended period, and the risk of damaging pipes, fittings, fixtures, and equipment. It is also not very effective in removing biofilm, which can harbor *Legionella*, leading to a rebound of *Legionella* following treatment. Because of the limitations and high rate of failure, **thermal shock is not recommended for remediation of building water systems.** However, it may be an appropriate remediation tool for specific water-using devices as specified in ASHRAE Guideline 12, *Managing the Risk of Legionellosis Associated with Building Water Systems*.

**Table 1: Advantages and Disadvantages of Different Remediation Chemicals**

| **Chemical Methods** | | | |
|---|---|---|---|
| **Chemical Type** | **Description** | **Advantages** | **Disadvantages** |
| Chlorine | Uses higher concentrations of chlorine to kill *Legionella* bacteria. | • Easier for facilities receiving water treated with chlorine by the utility.<br>• May be cheaper than other methods.<br>• Effective at penetrating biofilm. | • Effectiveness influenced by water temperature, pH and presence of biofilm<br>• Can lead to temporary taste and odor concerns even after treatment stopped.<br>• Can cause corrosion of pipes and damage to rubber and plastic components in system.<br>• Can result in formation of disinfection byproducts. |
| Chlorine Dioxide | A water-soluble gas with strong oxidizing potential to eliminate *Legionella* bacteria. | • Can be more effective at eliminating biofilm.<br>• Effective over wider pH range than chlorine. | • Can cause corrosion of pipes and damage to rubber and plastic components in system.<br>• Can result in formation of disinfection byproducts. |
| Monochloramine | Introduction of chlorine and ammonia to form monochloramine for *Legionella* inactivation. | • More effectively penetrates biofilm than hyperchlorination and can provide more thorough eradication of bacteria.<br>• May be a better option for hot water systems.<br>• May be a better option when long-term permanent control is needed, rather than short-term remediation. | • Requires precise dosing of chlorine and ammonia to prevent nitrification.<br>• May be associated with emergence of other opportunistic pathogens.<br>• Can result in formation of disinfection byproducts. |

| Remediation Type | Description | Advantages | Disadvantages |
|---|---|---|---|
| Copper – Silver Ionization | Introduces copper and silver ions into the water which kill *Legionella* by disrupting their cell walls. | • Can be used in both cold and hot water.<br>• May be a better option when long-term permanent control is needed, rather than short-term remediation.<br>• Can be effective in penetrating and destabilizing biofilm in building water systems. | • Typically the most expensive option.<br>• Complexity of installation and monitoring likely not appropriate for short-term remediation.<br>• May not be effective when building receives water from a public water system that uses phosphates for corrosion control. |
| Ozone | Generated onsite by passing dry air or oxygen through a high-voltage electrical field or UV light. | • Molecular ozone and its hydroxyl radical decomposition product are very strong oxidizers. | **Not recommended for *Legionella* remediation.**<br>• Decays very rapidly and cannot maintain a residual in the plumbing system.<br>• The decay timescale is short relative to chlorine-based disinfectants.<br>• Ozonation byproducts may increase levels of organic carbon leading to biological growth in the water system. |

**Table 2: Non-Chemical *Legionella* Remediation Methods (NOT RECOMMENDED)**

| Non-Chemical Methods | | |
|---|---|---|
| **Remediation Type** | **Description** | **Disadvantages** |
| Ultraviolet (UV) | Uses UV light waves to damage DNA of bacteria rendering them unable to reproduce. | **Not recommended for *Legionella* remediation.**<br>• Only inactivates *Legionella* in the water that flows through the UV reactor, not effective for *Legionella* colonization in building water system. |
| Superheating | Raise the water temperature in the hot water heater and then flush through all outlets. | **Not recommended for *Legionella* remediation.**<br>• Can create scald hazards and damage pipes and equipment. |

*NOTE: All remediation methods should be conducted by trained and experienced personnel.*

## Post-Remediation

To determine the efficacy of the remediation treatment, samples for *Legionella* culture are often collected two to seven days after remediation activities have concluded. . The delay is intended to allow the system to return to normal operating conditions. Follow-up testing, over a longer timeframe (weeks to months), should take place to validate that subsequent long-term control measures are effective at preventing recurrence.

To prevent recolonization after the remedial treatment is completed, it is important that the factor(s) leading to the *Legionella* growth (e.g., water stagnation and water temperatures in optimal growth range) be identified and corrected. A water management program for the system should be developed or amended accordingly.

No single control strategy should be relied upon to control *Legionella* in building water systems. To the extent possible, multiple approaches for preventing *Legionella* growth and spread should be implemented.. Recommendations for Success with Remediation provides a list of some recommendations that will increase the likelihood that *Legionella* remediation efforts are successful.

**Recommendations for Success with Remediation**

- Move sequentially through the building water system and conduct flushing at every single fixture or outlet.
- Drain, clean, and disinfect water storage tanks and ensure that no sediment remains at the bottom of the tanks.
- Remove aerators, showerheads, and point of use filters before flushing an outlet.
- Identify and safely eliminate dead legs (e.g., capped pipes) in the building water system and repair any non-functional fixtures to eliminate functional dead ends.
- Ensure that an adequate residual concentration of the chosen disinfectant (e.g., chlorine, chlorine dioxide, or monochloramine) has been attained at all distal points of the system.
- Maintain familiarity with the building's water system, including addressing fluctuating pressures throughout the system that can arise from plumbing design and/or water usage patterns.
- Conduct monitoring consistently throughout and post-remediation.

*NOTE: These recommendations address common issues with remediation efforts. They do not guarantee that remediation will be successful.*

## Glossary

**Aerators** are fixtures on faucets that mix air with the water stream to reduce flow and splashing.

**Aerosolization** is the process where water droplets, which can contain bacteria such as *Legionella*, are dispersed into the air. For example, the process of evaporating water in cooling towers creates a fine mist which is then aerosolized into the air.

**Biofilm** is a slime layer that adheres to surfaces, like the inside of pipes, and which acts as a protective shield and a nurturing environment for bacteria such as *Legionella*.

**Corrosion control** is the implementation of measures to minimize the deterioration of pipes and other components within a water system.

**Dead legs** are pipes or pipe segments subject to low or no flow because of design or decreased water use, such as old sections of piping that have been capped off or unused faucets.

**Disinfectant residual (or residual concentration)** refers to the amount of disinfectant that remains in water throughout the distribution system, even at the points of use (e.g., taps or showerheads).

**Disinfection byproducts** are chemicals that form when disinfectants, such as chlorine or chloramine, react with naturally occurring organic and inorganic matter in the water. These byproducts can potentially have harmful health effects.

**Flow restrictors** are devices designed to limit the amount of water flow to control water usage and improve water conservation efficiency.

**Hyperdisinfection** refers to the addition of high concentrations of disinfectant (e.g., chlorine, chlorine dioxide) to a building's water system to kill bacteria such as *Legionella*. Hyperdisinfection includes both shock and continuous hyperdisinfection with the amount of disinfectant and duration varying for each type of application. Hyperchlorination refers to hyperdisinfection with chlorine.

**Ionization** refers to the process of introducing positively charged ions such as copper and silver into the water supply. The ions bind to negatively charged ions on microorganisms such as *Legionella*, preventing replication and leading to cell death.

**Nitrification** occurs when ammonia in drinking water is converted into nitrite and then into nitrate by certain bacteria. Nitrification can compromise water quality creating taste and odor issues.

**Potability** refers to whether water is appropriate for human consumption, including drinking, bathing, showering, hand washing, and food preparation.

**Premise Plumbing** is the portion of a building’s water system located within the property lines. It is distinct from the larger water mains outside of the property.

**Stagnation** is when water stops flowing or flows slowly in pipes, creating an environment that is more conducive to bacterial growth.

## References

**ASHRAE**. 2023. ANSI/ASHRAE Standard 514, Risk Management for Building Water Systems: Physical, Chemical, and Microbial Hazards. Atlanta, GA: ASHRAE.

**ASHRAE**. 2023. ASHRAE Guideline 12-2023: Managing the Risk of Legionellosis Associated with Building Water Systems. Atlanta, GA: ASHRAE.

**Centers for Disease Control and Prevention (CDC).** 2021. Developing a Water Management Program to Reduce *Legionella* Growth & Spread in Buildings.

**Centers for Disease Control and Prevention (CDC).** 2022. *Legionella* Environmental Assessment Form.

**Centers for Disease Control and Prevention (CDC).** 2024. Implementing Remediation Plans.

**Centers for Disease Control and Prevention (CDC).** 2024. Working with Legionella Consultants.

**Council of State and Territorial Epidemiologists.** 2024. Water Management Program Evaluation Tool.

**Council of State and Territorial Epidemiologists.** 2019. Water Management Program Template.

**Council of State and Territorial Epidemiologists.** 2024. Recommendations for Review of Water Management Programs to Reduce Risk of *Legionella* in Healthcare and Community Facilities.

**Environmental Protection Agency (EPA).** 2016. Technologies for *Legionella* Control in Premise Plumbing Systems: Scientific Literature Review. (EPA 810-R-16-001).

## Acknowledgements

The Council of State and Territorial Epidemiologists (CSTE) thanks the members of the *Legionella* Resources Development Subgroup for their contributions to this project:

Sarah Rutschmann, California Department of Public Health
Geline Evangelista, Long Beach Department of Health and Human Services
Jacob Reece, Michigan Department of Health and Human Services
Salena Savarda, Nevada Department of Public and Behavior Health
Kathleen Ross, New Jersey Department of Health
Jane Yackley, Tennessee Department of Health
Olivia Smith, Texas Department of State Health Services
Anne Marie Charles, Washington State Department of Health
Gabriella LaBazzo, Washington State Department of Health
Frances Goglio, Wisconsin Department of Health Services
Elizabeth Hannapel, Centers for Disease Control and Prevention

CSTE staff members Akila Simmons, Lindsay Jordan Pierce, Beth Daly, and Jordan Peart also contributed to this project.

This project was prepared with the assistance of a consultant to CSTE, Hutton Health Consulting, LLC and supported by the Centers for Disease Control and Prevention of the U.S. Department of Health and Human Services (HHS) as part of a financial assistance award totaling $24,000 with 100 percent funded by CDC/HHS. The contents are those of the author(s) and do not necessarily represent the official views of, nor an endorsement, by CDC/HHS, or the U.S. Government.

For questions about this document, please contact:

Council of State and Territorial Epidemiologists
2635 Century Pkwy NE, Suite 700
Atlanta, GA 30345
Tel: 770.458.3811 | Fax: 770.458.8516
Email: idteam@cste.org | Website: www.cste.org