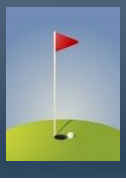

LEGIONNAIRES DISEASE

Peter Roberts, Hydroscape Ltd, wrote a recent report on the issue concerning the spread of Legionnaires disease from ponds and water storage tanks.

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It is a little known fact that water storage units and irrigation facilities can spread Legionnaires disease on golf courses. Peter Roberts' report on the issue showed that keeping ponds and tanks clean was the only way to guard against any potential problems.

The recent outbreak of Legionnaires disease in Barrow-in-Furness, which had 131 confirmed cases and had claimed the lives of six people at the time of going to press, may not at first glance seem to be highly relevant to most golf clubs, but a little carelessness with an irrigation system could be an unlikely breeding ground for the deadly bacteria.

Earlier in the year, a major hotel and golf course complex was worried about the possibility of this occurring through its automatic sprinkler system which feeds both the course and the landscape areas around the buildings, and contacted Peter Roberts to look into the situation.

"My initial reaction to their enquiry was that there was next to no chance of this possibly happening, and to be quite honest, found the whole idea slightly amusing," said Peter, who is not a qualified biochemist, but has over 30 years' experience in the turfgrass irrigation and amenity water industry.

However, due to the importance of the customer, I agreed to do some investigative work for them and through a series of discussions and the acquisition of various articles on the subject, a picture began to emerge that not only showed that their concerns were well founded, but also that there could be a potential hazard that up until now had been completely overlooked.

As increased pressure is brought to bear on the traditionally available sources of irrigation water, it is now becoming the norm to farm or collect water from varying sources including winter rainfall and surface runoff, and store this in large quantities for seasonal use.

This means that we need to be far more conscious of the unseen potential hazards surrounding stored water and the methods that can be employed in keeping stored water healthy."

Peter contacted many sources when compiling the report for the hotel and golf course, including the Health and Safety Executive, the STRI, the Department of Health, the Environment Agency, marine biologists and various publications writing by experts, and unveiled some interesting information.

What Is Legionnaires Disease?

The major manifestation of Legionnaires disease is pneumonia. Patients typically develop a fever and cough, usually feel lethargic and can become disorientated. Unlike other forms of pneumonia, patients with Legionnaires often have severe gastrointestinal symptoms, including diarrhoea, nausea and vomiting.

The disease rarely occurs in people with good health but tends to afflict patients with pre-existing illnesses, especially chronic lung disease. Smoking also seems to be an important risk factor, as is heavy alcohol intake. A second clinical syndrome associated with Legionnella infections is Pontiac fever. Patients with this do not have the respiratory problems, but do have a fever, headache, muscle aches and general malaise. Unlike Legionnaires, these individuals often have no underlying illness and recover completely without any treatment.

It is considered that the instances of both Legionnaires disease and Pontiac fever are under-reported, but in case studies in the UK using 25 hospitals over a one-year period, two per cent of all cases of pneumonia were discovered to be Legionnaires disease.

The Habitat

The natural habitat for Legionalla pneumophila appears to be aquatic habitats, including rivers and lakes. Legionalla pneumophila can survive in a wide range of environmental conditions and temperatures from 5.7°C to 63°C, and can also lie dormant in bodies of water that may be covered in ice for up to six months. Legionalla pneumophila has been discovered in as diverse places as freshwater streams and lakes in North America and Europe, tropical lakes in Puerto Rico, river banks in Japan, and wastewater effluent in Israel.

Different studies from around the world suggest that the concentration of the bacteria is directly related to water temperature. Although temperatures in the UK may not be in the ideal growth range for Legionalla, it should be noted that the bacteria can survive at low temperatures, and should temperatures rise over the summer months, conditions could be encountered where a bacteria colony can grow and multiply.

It also becomes possible to transfer the bacterium into an above-ground irrigation water storage tank, especially where the initial water is being taken from a non-potable surface water supply such as a river, stream, lake or pond.

As water held in an above-ground tank could be more susceptible to a rise in temperature, then the possibility could arise where the temperature range could be met where Legionalla pneumophila bacteria will freely multiply.

Mode of Transmission

The prevailing thesis in the mode of infection is airborne transmission and inhalation of contaminated aerosols or small water droplets containing the bacteria. Many potential sources of aerosolisation have been investigated, including evaporative condensers, humidifiers, nebulisers and shower heads, however it appears that in most reported cases it has been necessary for a victim to come into direct contact with and directly inhale the aerosol effect of contaminated sources.

Treatments

Several methods of bacteria elimination have been tested, showing various levels of success.

These are:

- Disinfection
  Currently, biocides appear to be ineffective in eradicating Legionalla pneumophila from tested sites, and only marginally successful in reducing organism numbers. Chlorination and hyperchlorination have both proved ineffective as it appears that the bacteria are relatively chlorine tolerant. Additional problems with the use of chlorine in the natural water environment, together with potential turf cultural issues if using chlorinated water for irrigation, would occur.
  For ponds to be free of Legionalla pneumophila, a lot of care needs to be taken to ensure they are clean and healthy, and not nature's dumping ground

- Thermal eradication
  Heat eradication is the most widely used method for Legionalla disinfection as it has been shown that temperatures of over 60°C were sufficient to kill the bacteria. However, although this may be a practical approach when dealing with an enclosed or portable water supply, it is not practical to consider it for the treatment of an open body of natural water or a continuous changeover of water held within an irrigation tank.

- Ultra violet light
  Destruction of bacterial cells occurs at a light wavelength within the ultra violet range. Ultra violet light causes damage to nucleic acids within bacteria cells which hampers DNA replication. Continuous ultra violet irradiation was found to be effective in eradicating water-born Legionalla pneumophila in an enclosed or portable supply, but the drawback again comes when treating an open natural water source. In this instance, Legionalla pneumophila would not be found as free-swimming bacteria, but would be cloaked within water- http://www.hydroscape.co.uk/main.html born particles, particularly organic matter, algae and so on. In this case it would be completely ineffective.

- Ozonation
  Ozone is an unstable gas comprising three oxygen atoms. The gas will readily degrade back into oxygen and during this change a free oxygen atom, or radical, is formed.
  The free oxygen radical is highly reactive and short-lived. Under normal conditions it will only survive for milliseconds and during this time will oxidise virtually any chemical species. Ozone will crack the carbon bond of organic molecules and will oxidise the

proteins in the cell walls of bacteria. It has seven times the oxidising capacity of chlorine but does not produce any toxic chemicals. When ozone degrades back to oxygen and free radicals, the potential of the water to oxidise is measured as redox potential, or ORP. The higher the level of redox potential, the higher the concentration of free radicals, and the greater the oxidising and disinfecting potential.

In a healthy freshwater environment, the redox level would be measured at between 300 and 330mv. If the redox level is increased above 400mv, then physical oxidisation starts to occur and a higher percentage of bacteria are removed from the water.
At levels above 500mv, a high percentage will be disinfected, while at levels of 750mv there is complete disinfection of the water of all organisms. This is the level used to keep swimming pools sterile.

Storage Lakes or Ponds

There is much that can be done to generally maintain or improve the quality of the water held in lakes or ponds. We must recognise that an open body of water becomes nature's dumping ground, collecting all types of undesirable materials, from grass clippings through to leaf fall and nutrient run-off.

Over a period of time nature will try to fill in an open water area through the process of eutriphication, where decaying organic matter will gradually silt up a pond, reducing the water depth and quality. Much of this process is brought about by the growth of algae. Each algae cell has a short life span, as little as 24 hours. As each of these single plant cells die, more nutrient is produced to continue the life cycle, hence the bloom becomes self-sustaining.

During this process of growth and decomposition, high levels of oxygen are being used, which if left unchecked can reduce the levels of healthy aerobic bacterial activity within the water, which needs oxygen to survive. It is this bacterium which, in a healthy body of water, will out-compete algae for a food source and stop algae development.

The water's natural ability to keep itself clean is therefore slowly diminished and in the worst cases oxygen levels can become so low that aerobic bacteria cease to function completely, leaving only anaerobic bacteria to digest the waste products. Not only is anaerobic bacteria a much slower process, but one of the by-products given off is methane gas, together with other obnoxious gases, which is why some ponds and lakes have an unpleasant odour.

An increase in oxygen to a pond will stimulate the growth of aerobic bacterial activity which would out-compete plant life in the digestion of free nutrient. This would have the effect of reducing the development of undesirable single cell aquatic plants such as algae, reducing the nutrient levels available to fertilise undesirable bottom-rooted aquatic plants, reducing the levels of anaerobic or anoxic bacteria, reducing the build-up of decaying matter, and improving the quality of aquatic life, therefore creating a much healthier pond.

The method of introducing oxygen into a body of water is through the use of surface or subsurface aerators. Firstly they will break down thermal stratification within the water by drawing up cold water from the bottom of the pond - which is capable of holding far more oxygen than the warmer surface layers - and mixing the water to produce a consistent temperature. Furthermore, aerators will also inject high levels of oxygen to promote healthy aerobic bacterial activity.
Additional remedies to maintain water quality and clarity include encouraging wind action across the surface water by managing surrounding trees, and reducing the amount of vegetation entering a pond from items such as grass clippings and falling leaves.

Storage Tanks

To ensure water quality is high in storage tanks there are a number of steps that can be taken. Firstly, consideration should be given to the initial siting of a tank. It is preferable to position a tank away from direct sunlight to keep the water as cool as possible.

Secondly, a suitable well-fitting lid should always be used to stop the entry of unwanted materials and stop the entry of sunlight. Finally, old brittle tank liners should be replaced.

Irrigation Water

To treat and disinfect the water being taken from ponds or storage tanks for irrigation purposes, there are several alternatives. The first idea should be to treat the water at source within the ponds or tanks. However, this presents certain difficulties. The levels of disinfection needed to eliminate Legionalla were very high so any operation within the water would eliminate all pond life. It is therefore apparent that any disinfection process must take place only with the water being drawn for irrigation or spray purposes. Ultra violet light, as previously discovered, is also both impractical and potentially ineffective.

After much consideration, Peter concluded that his company's recommendations would be to actually treat the water at a common position after the discharge from the irrigation pump units through the process of filtration and ozone injection.

This would entail the addition of a five micron cartridge filter unit to remove any water-born solids that may be cloaking bacteria, together with an automatically controlled ozone generator and injection system.

This would need to inject ozone at a rate of four litres per minute to give a redox potential of 700mv, sufficient to provide complete disinfection and the eradication of the Lenionalla pneumophila bacteria.

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See: http://www.hydroscape.co.uk/main.html