

Watersprint Residential UVC LED Applications

1. Define and educate the customer regarding the problem with “regular” water for residential applications (wells, showers, faucets)

Most consumers draw their drinking water from one of two sources. Either surface freshwater sources (lakes, reservoirs, rivers) or groundwater sources (private wells, springs, boreholes). Many large municipal drinking water plants in urbanized areas utilize surface water, while smaller towns/villages and private dwellings often use a groundwater source. Many consumers also use private wells in their summer homes.

Private dwellings in rural areas often rely on groundwater as drinking water sources. Historically, most homeowners have used simple water treatment processes such as filtration and ultraviolet disinfection to purify their water as they sourced it from pristine sources. Ultraviolet disinfection has been used as primary disinfection to protect against several waterborne pathogens such as viruses (e.g., *Norovirus*), bacteria (e.g., *Escherichia Coli.*), and oocysts (e.g., *Cryptosporidium*). Ultraviolet “Point of Entry” (POE) systems are often employed, which allows users to treat water flowing to all sinks, showers, and appliances throughout the home. These systems tie into the main water line coming into the dwelling.

The fight against COVID-19 over the past couple of years has led to an increased awareness of microbial issues and the importance of disinfection. While water sources have not proven to be a vector of infection for COVID-19, many homeowners are looking for additional ways to protect themselves from pathogens and the impacts of recurrent COVID-19 infections. This is especially important for immune-compromised persons, the elderly, and healthcare institutions. Aside from the COVID pandemic, other factors also increased consumer interest in drinking water treatment within the home.

For rural homeowners, factors such as climate change and land use intensification are leading to reductions in raw water quality for private wells. Urban dwellers are also at risk due to aging pipe infrastructure which makes distribution systems vulnerable to microbial contamination. In addition, both rural and urban dwellers are also vulnerable to “plumbing pathogens” (e.g., *Legionella*) which can build up within residential plumbing systems after “Point of Entry” (POE) treatment. These concerns have caused homeowners to search for additional barriers and treatment processes to solve these problems.

Watersprint’s innovative UVC LED systems enable more comprehensive protection for homeowners. Systems can be applied in traditional Point of Use (POU) and Point of Entry (POE) applications. Additionally, these systems can be installed as close as possible to the Point of Dispense (POD), typically a faucet or showerhead. This provides another layer of protection as primary or secondary disinfection and protection against plumbing pathogens. Watersprint enables truly distributed disinfection providing homeowners with various installation options and applications. You can add an additional hygienic barrier where you need it.

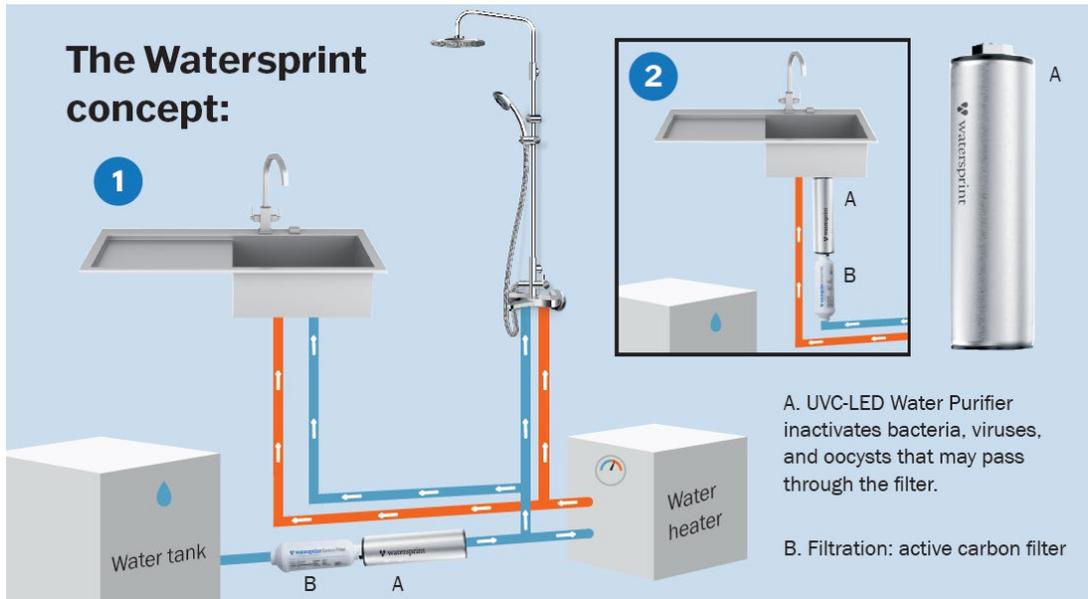


Figure 1.1 - Ultraviolet Water Disinfection Applications Within the Home - UV disinfection applications were historically confined to Point of Entry (POE) in a home as it was difficult to scale down the technology (conventional UV lamps) and engineering issues prevented more widespread use (e.g., lamp warm-up times). Watersprint's Next-Generation Water Purifiers allow for the addition of hygienic barriers throughout the home.



Figure 1.2- Faucet Application - Watersprint purifier installed to eliminate microbial contamination at the tap by providing an additional hygienic barrier to protect against waterborne (e.g., *Norovirus*) and plumbing pathogens (e.g., *Legionella*) at the point of dispense.



Figure 1.3 - Shower Application - Watersprint purifier installed to add an additional hygienic barrier to protect against plumbing pathogens (e.g., *Legionella*) at the point of dispense in a shower. One infection pathway for *Legionella* is the inhalation of aerosols during showering.

2. Agitate the problem (give examples and results on how you can see these problems in real life).

The overall risk to the homeowner is a waterborne disease outbreak resulting from microbiological contamination of water sources, distribution pipes, and plumbing within the home. Microbial pathogens may be transmitted to the home via water or may be airborne due to the aerosolization of pathogens (e.g., *Legionella*) in showers and faucets.

Two examples of waterborne pathogens include *Cryptosporidium* and *Norovirus*. *Cryptosporidium* is a parasite that can cause cryptosporidiosis. Transmission occurs mainly through contact with contaminated water. *Norovirus* is the most common nonbacterial causative agent of waterborne outbreaks in Scandinavia.

Waterborne disease outbreaks often occur in private dwellings or small groundwater systems. The Swedish Geological Survey and the Swedish National Board of Health and Welfare surveyed the microbial quality of well water from private wells in 2008 (Socialstyrelsen, 2008). Out of 4250 analyses, 46% (1946) either did not comply (694) or complied with remarks on necessary improvements (1252). Many of these systems have minimal water treatment processes and are often not regulated by a government authority. Historically pristine aquifers are now more likely to be contaminated by surface runoff. Climate change is creating more extreme rainfall events, which results in an increased concentration of disease-causing microorganisms.

Waterborne disease outbreaks are not confined to private dwellings or small groundwater systems. Larger urban areas with more comprehensive water treatment facilities also have experienced issues. Two of the most significant outbreaks in the Nordic countries occurred in Sweden and were caused by the microorganism *Cryptosporidium hominis*. One occurred in Östersund, Sweden, in 2010, and the other in Skellefteå, Sweden, in 2011. The event in Östersund was the largest *Cryptosporidium* outbreak seen in Europe.

Another issue causing concern for public health officials is the risk of contamination in the drinking water distribution system due to aging pipe infrastructure. Aging distribution pipes are vulnerable to contamination when pipes leak and create a loss of pressure. This results in a backflow of contaminants in the distribution system. These contaminants often include pathogenic viruses, bacteria, and parasites which can cause waterborne disease outbreaks.

An emerging health concern is “Opportunistic Plumbing Pathogens” found in premise plumbing which includes water pipes, tap components, and showerheads within the home. These pathogens naturally occur in water, grow in biofilm, and are often transmitted by inhalation of aerosols. They often infect individuals who are immunosuppressed, older and have pre-existing chronic diseases. The most well-known opportunistic plumbing pathogen is *Legionella pneumophila*. Transmission of *L. pneumophila* occurs via aerosols (e.g., showers) and causes life-threatening pneumonia, Legionnaires' disease. Other pathogens in this category include *Mycobacterium avium* and *Pseudomonas aeruginosa*. *M. avium* is found in showerheads and household plumbing and causes pulmonary infection. *P. aeruginosa* is relatively resistant to disinfectants such as chlorine and is often found in water taps.

3. Explain the various solutions that exist to mitigate the problem.

A variety of solutions exist to address microbial contamination of drinking water. The solutions often depend upon the water source (e.g., groundwater versus surface water) and situation (e.g., community water plants versus private wells). Urban dwellers are beginning to realize that their water utility is not responsible for water quality issues that develop in premise plumbing within the home. They are also concerned about aging pipe infrastructure delivering water to their homes. Rural homeowners now understand that climate change will require them to rethink water treatment within the home.

One emerging trend is that many homeowners recognize that they must rely on more than just the water industry and existing systems to maintain safe drinking water. Factors such as climate change, aging distribution systems, and a greater understanding of the health risks associated with opportunistic plumbing pathogens have increased interest in additional preventative measures and technologies to address this risk.

A lot of research has been undertaken to address this risk. For example, water temperature maintenance has been highlighted in global drinking water guidelines as a factor that can be manipulated to minimize pathogen growth. In addition, point-of-use (POU) treatment devices have been suggested to reduce exposure to pathogens from a contaminated water source.

Homeowners have now realized that devices that treat their water within the home closest to the "Point of Dispense" will provide them with the most significant amount of protection and "peace of mind."

4. Explain how we have decided to solve the problem

Watersprint has designed and engineered a range of Next-Generation Water Purifiers that are suitable for several applications within the home. While these systems are applicable and offer additional benefits for traditional Point of Entry (POE) (e.g., whole home) and Point of Use (POU) (e.g., sink) ultraviolet disinfection applications, the most exciting aspect of these systems is that they afford the homeowner the ability to add additional hygienic barriers also at the Point of Dispense (POD) (e.g.,

showers, faucets). Homeowners can now choose where to add extra protection, which enables truly distributed disinfection and enhanced health protection. This provides greater protection because plumbing pathogens (*e.g., Legionella*) can build up in plumbing systems leading to potential health concerns. These systems can also be coupled with an existing Point of Entry system to provide multi-barrier protection and additional “peace of mind” for vulnerable persons. This may be particularly important to the elderly, infants, and those with weakened immune systems.

Watersprint has designed and engineered several product platforms suitable for residential applications. Each platform has been designed with a range of models and unique features, providing the homeowner with many options to add an additional hygienic barrier within their home. These platforms include:

- **Purify Solo** is designed with high quality, versatility, a small footprint, and cost efficiency in mind.
- **Purify Solo FS** is a retrofit solution that enables the use of our Purify Solo as a stand-alone product.

Our UV LED-based systems have several unique benefits that make them well-suited for Residential Applications. UV disinfection systems incorporating conventional UV lamps have been available for many decades. Still, they have not been widely applied beyond Point of Entry or “Whole Home” residential applications due to their operational characteristics that limited their application (*e.g., UV lamp warm-up times*). The introduction of UV LED-based Water Disinfection systems eliminates these barriers and introduces several incremental benefits.



Benefits of Watersprint Next Generation Water Purifiers

Feature	Benefit
Ultra-Compact Footprint	<ul style="list-style-type: none"> ○ UVC LED-based systems have a substantially smaller footprint allowing them to be integrated as close as possible to the point of dispense (e.g., faucet, shower) and provide the highest level of protection without a chemical residual.
Environmentally Positive	<ul style="list-style-type: none"> ○ UV LEDs do not contain mercury making them a more environmentally positive solution. Homeowners do not need to worry about mercury spills, potential contamination, or disposal issues associated with conventional mercury-based lamp systems.
Lower Power Consumption	<ul style="list-style-type: none"> ○ UV LED-based systems can be powered by battery, solar, or mains supply. Allows for easy integration into the shower or faucet. This benefit is further enhanced when the system is incorporated with a flow meter enabling on-demand operation. On-demand or instantaneous start-up operation is unique to UV LED-based systems.
Easy to Retrofit	<ul style="list-style-type: none"> ○ Modular retrofit solutions are available.
Less Maintenance	<ul style="list-style-type: none"> ○ UV LED-based systems require less maintenance than conventional lamp UV systems. UV source replacement for UV LED systems is every five years compared to yearly lamp replacement requirements for traditional UV systems. UV LED-based systems are less prone to fouling which means less homeowner maintenance.