Hagensborg Water District Water Treatment Project

Point-of-Entry Ultraviolet (UV) Disinfection Proposal

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Prepared by:

Grant Robertson, B.B.A.
Home Water Purifiers & Filters,
A division of MediaWave Communications Corp.
2-1335 Dalhousie Drive, Kamloops, B.C. V2C 5P6
Toll Free: 1-866-376-2690
Phone: (250) 374-2690
Fax: (250) 374-2692

Prepared for:
Brian Mowry AScT
David Nairne & Associates Limited

Background and Purpose

The Hagensborg Water District currently obtains its water supply from an untreated supply – a mountain creek near the community. In anticipation that the Vancouver Coastal Health Authority will soon require the District to install a suitable water treatment system to ensure that the District meets all applicable standards outlined in the Drinking Water Protection Act, David Nairne & Associates Limited has been retained to investigate water treatment options.

Initial meetings between the engineering firm and the District and its community members has revealed a strong desire within the community to find a non-chemical (no chlorine / chloramine) solution that will meet regulatory requirements under the Drinking Water Protection Act and Regulations.

The purpose of this report is to propose a point-of-entry water treatment system capable of meeting or exceeding relevant regulatory drinking water standards, and that meets Hagensborg Water District users' desire for a non-chemical (non-chlorine) solution. Specifically, this report addresses the use of ultraviolet (UV) light sterilization with accompanying pre-treatment on a point-of-entry basis in each home and business within the District.

Hagensborg Water District Water Sample Test Results

This proposal and the recommendations contained herein are based on the results of a water test performed by ALS Laboratory Group of Vancouver, BC. The date of the water sample was October 31, 2008, and the date of the report was November 13, 2008. Our proposal recommends that an analysis of long-term historical test data or additional water testing to consider potential changes in turbidity that could result from seasonal or weather-related events within the source creek's watershed, including spring freshet, drought, and excessive rainfall.

Based on the ALS Laboratory Group report, it can generally be concluded that the Water District's water supply is generally of excellent quality with all measured attributes within the acceptable range under the province's Drinking Water Protection Act and Regulations. The test results demonstrated a low level of mineralization, neutral pH, low color and turbidity, very high UV Transmittance, very low dissolved metals, and low organics. Most notable to this proposal, these characteristics suggest that the water is very amenable to ultraviolet (UV) sterilization with only basic pre-filtration required.

Background on Water Sterilization with UV Light

Ultraviolet (UV) water purification systems use specialized lamps to produce UV-C or "germicidal UV," radiation of much greater intensity than sunlight. Almost all of a UV lamp's output is concentrated in the 254 nanometers (nm) region in order to take full advantage of the germicidal properties of this wavelength.

The lamp is enclosed in a clear quartz-glass sleeve and suspended in a stainless steel chamber through which the water to be treated flows from one end to the other. When harmful microorganisms in the water are exposed to the UV rays, their nucleic acid absorbs the UV energy. This energy damages the DNA structure of the organism and the microbe is rendered sterile and incapable of reproducing or causing illness. This process is generally referred to as "inactivation." UV is known to be highly effective at inactivating bacteria, viruses, molds and yeasts, and disease causing cysts and protozoa like cryptosporidium and Giardia, including those responsible for most major waterborne pathogenic diseases.

UV water treatment offers many advantages over other forms of water treatment for microbiological contaminants. Most notably, it does not introduce any chemicals to the water, it produces no harmful bi-

products, and it does not alter the taste, pH, or other properties of the water (does not remove minerals). Accordingly, in addition to producing safe drinking water, it is not harmful to plumbing or septic systems. Further, it is generally easy and cost-effective to install and maintain.

UV water sterilization is widely accepted as a residential, municipal, and industrial/commercial water treatment method. It is recognized by regulatory bodies all over the world, including Canada, as an accepted and effective treatment method for many types of water treatment systems.

NSF International is responsible for the independent certification of UV sterilizers within the water treatment industry. Most regulatory bodies, including the majority, if not all, regional health authorities in B.C. require that UV sterilization systems meet NSF/ANSI Standard 55, Class A.

UV Dosage

The amount of UV light transmitted to the contaminants in the water is referred to as the "dose," and it is typically measured in µWs/cm2 (microwatt seconds per square centimeter). UV dose is often also expressed in mJ/cm2 (milliJoules per square centimeter). 1,000 µWs/cm2 = 1 mJ/cm2. The UV dose is a function of the intensity and size of the UV lamp and the length of time that the water is exposed to the UV rays. Accordingly, systems with larger UV lamps will provide a higher UV dose than systems with smaller lamps, and the slower the water runs through the sterilizer, the greater the UV dose will be.

The UV dose is also affected by the UV transmittance properties of the water. For instance,

- sediment particles in the water may block some of the UV light (create a "UV shadow")
- water that is discoloured due to mineral or organic staining may reduce UV transmittance
- water containing high levels of certain organics may absorb UV light

UV transmittance (UVT) is normally expressed as a % of the UV light that will pass through the water. A minimum UVT of 75% is generally required for UV sterilization to be considered safe and effective. Where the UVT of feed water is less than 75%, additional pre-treatment is required to improve UVT prior to UV sterilization. Where UVT is greater than 75%, pre-treatment may still be recommended to increase the effective UV dose.

The UV dose can also be negatively impacted by the accumulation of minerals, most notably hard water scale and iron deposits on the clear quartz glass sleeve that surrounds and protects the UV lamp. The mineral deposits / stains inhibit UV transmittance to the water in the sterilization chamber. This potential problem can easily be avoided through appropriate pre-treatment where water conditions dictate it.

It should be noted that the UV dose delivered by a UV lamp is not constant over the course of its effective lamp life. Much like with a traditional light bulb, the UV intensity and dose provided by a UV lamp will decline over time. For this reason, UV lamps require periodic replacement on a scheduled time interval regardless of the quantity of water treated or if the lamp is still illuminated (not burned out). UV dose also declines as the water temperature increases. Dose specifications provided by UV system manufacturers are based on the dose provided at the end of the specified lamp life and based on a relatively warm assumed water temperature. Accordingly, the dose provided during the majority of the lamp life cycle and in most real-life conditions is actually higher than that specified by the manufacturer. This approach to dose calculation is done out of an abundance of conservatism.

NSF certification (Standard 55, Class A) requires that a sterilizer be capable of providing a minimum UV dose of 40,000 µWs/cm2 at a 75% UVT, at the end of the recommended lamp life, and at the system's maximum rated flow capacity. The effective UV dose will be correspondingly higher when water is flowing at a rate lower than the maximum rated capacity, which will be the vast majority of the time in most residential settings. The 75% UVT suggests that 25% of the UV output does not reach the contaminants due to impurities in the water blocking or absorbing some of the UV light or due to fouling/staining of the

quartz sleeve that protects and surrounds the lamp. Through proper pre-filtration and maintenance, UVT can generally be maintained well above 90%. Furthermore, the NSF dose of 40,000 µWs/cm2 is many times greater than that required to kill most microorganisms, so combined with the facts that UVT is likely higher and the flow rate lower than the rated capacity, there is a considerable margin of safety built in to the NSF certification dosage.

Vancouver Coastal Health Authority Requirements

Health authorities in British Columbia have adopted the 4-3-2-1-0 drinking water objective to provide a performance target for water suppliers to ensure microbiologically-safe drinking water.

4 log inactivation of viruses
3 log removal or inactivation of Giardia Lamblia and Cryptosporidium
2 refers to two treatment processes for all surface drinking water systems
1 for less than 1 NTU of turbidity with a target of 0.1 NTU
0 total and fecal coliforms and E. Coli

We propose the use of ultraviolet (UV) sterilization, combined with 1 micron absolute pre-filtration, to achieve a multi-barrier approach that will enable the district to meet the 4-3-2-1-0 drinking water objective on an economical basis and in harmony with community resident's desire for a chemical-free solution.

4 log inactivation of viruses
Most viruses are easily inactivated by the application of ultraviolet light. Various species of viruses and bacteria are inactivated at a different UV dose (some microorganisms are more resistant to UV inactivation than others due to their more complex cell wall or opacity). While it appears that health authorities in the province have discretion regarding the selection of a surrogate virus for the determination of what dose is deemed necessary for 4-log inactivation of viruses to meet the 4-3-2-1-0 objective, it is widely accepted that the NSF-certified dose of 40,000 µWs/cm2 is sufficient. This is also supported by an extensive body of scientific research into bacteria and virus inactivation by UV light. For instance, a summary of more than 20 research papers examining the inactivation of e.coli (various species) using UV light indicate that a dose of as little as 1,100 µWs/cm2, and no more than 12,800 µWs/cm2, is required to inactivate e.coli. See the report entitled *UV Dose Required to Achieve Incremental Log Inactivation of Bacteria, Protozoa and Viruses* attached to this report for additional details. Given the high UVT of the District's water supply, our proposed system will provide a UV dose significantly higher than 40,000 µWs/cm2 using an NSF-validated UV sterilizer to achieve this objective. In the event that a higher dosage level is desired by the Health Authority, this can be accomplished by selecting a larger UV system or restricting the water flow rate to a lower level. This would not change the principal of our recommended treatment, just the specific equipment that we would select for the purpose.

3 log removal or inactivation of Giardia Lamblia and cryptosporidium protozoa
While cryptosporidium has proven to be resistant to chlorination, especially where high turbidity levels are present, UV disinfection has proven extremely effective at inactivating both cryptosporidium and Giardia protozoa. Most health authorities provide a credit for 3 log reduction if the dose is a minimum of 40,000 µWs/cm2. A summary of research data by Trojan Technologies, a world leader in UV-based water treatment indicates that Cryptosporidium requires at most a dose of 10,000 µWs/cm2 for 3-log reduction. Giardia Lamblia requires a dose of less than 20,000 µWs/cm2 for 3-log reduction. In addition to using UV light, our proposal includes the use of a Harmsco 1 micron absolute filter which is sufficient to provide a physical barrier through which these protozoa cannot pass due to their size being significantly larger than the filter pore size. Cryptosporidium ranges in size from about 3 to 7 microns in diameter. Giardia are slightly larger, typically 8 to 12 microns. This Harmsco filter alone has been independently tested to achieve greater than 99.92% reduction of 3 micron styrene beads (surrogate for protozoa). Combined with UV sterilization, greater than 3-log reduction is assured through this 2 step process.

2 treatment barriers are a minimum for all surface water sources. A multiple barrier approach to water treatment is associated with providing potable water:
Our proposal includes both mechanical filtration down to a level of 1 micron (absolute) and UV sterilization to achieve a multiple barrier approach to meet this objective.

<1 NTU of turbidity (target of 0.1 NTU)
Based on the test results provided, the District's water supply already meets this objective. The turbidity level tested on October 31, 2008, was only 0.17 NTU. By using a series of mechanical filters ultimately filtering down to a level of 1 micron (absolute), our proposed system will ensure turbidity levels are maintained below 0.1 NTU, even during periods where the water supply is impacted by the spring freshet or heavy rain which could cause a seasonal or temporary increase in raw water turbidity.

0 Fecal coliform or E. coli bacteria
As discussed above, UV light is highly effective at inactivating e.coli. It is equally effective at inactivating fecal coliform.

Recommendations

We propose the use of a three-stage system to meet the 4-3-2-1-0 water treatment objectives on a point-of-entry basis in each building within the Hagensborg Water District. Based on the water test results for the District, it is our opinion that the recommended system will significantly exceed the minimum required parameters.

The first two stages are designed to provide a very high level of mechanical filtration. Filtration will occur in two stages to reduce maintenance requirements (filter replacement interval) and maintain strong water pressure so as to ensure satisfaction with the system among community residents. The first stage will include a multi-gradient sediment filter which gradually increases in density and filtration effectiveness as the water progresses towards the core or the filter. The inner core has a final rating of 1 micron (nominal). The purpose of this filter is to trap the majority of suspended sediment and other particulate to reduce turbidity and improve the esthetic qualities of the water, and most importantly, to reduce the contaminant load on the second, more costly filter. The second stage is composed of a 1 micron (absolute) pleated filter for reduction of cryptosporidium, Giardia, and turbidity. This filter will ensure an extremely low turbidity level and a very high UVT level are maintained so as to promote maximum UV dose.

The filter housings selected to house the two stages of mechanical filtration have been chosen on the basis of ensuring optimal flexibility to adjust pre-filtration selection if deemed appropriate in the future due to changes in pre-treatment needs as dictated by changes in the District's water supply quality.

The third stage of the recommended system is an NSF-validated UV sterilizer.

All UV sterilizers required sediment pre-filtration to reduce or eliminate the possibility that a targeted contaminant could "hide" behind a sediment particle in the "shadow" of the UV light and therefore not receive a full dose of UV light. Accordingly, the manufacturer strongly recommends sediment pre-filtration down to a level of 5 microns or smaller. As noted above, our recommended pre-filters far exceed the manufacturer's sediment/turbidity pre-treatment requirements.

Water exceeding 120 ppm in hardness (7 grains per gallon) should be softened to reduce the risk that hard water mineral scale will build-up on the UV sleeve thereby reducing UV light distribution into the UV chamber. Similarly, iron levels exceeding 0.3 ppm should also be treated to prevent staining of the UV sleeve. No additional pre-treatment for hardness or iron is required to ensure adequate UV disinfection for the District. Water test results indicate that the District's water supply is already "soft" and therefore lacking sufficient minerals to precipitate on the UV sleeve and cause a reduction in UV dose within the sterilization chamber. The negative Langelier Index figure confirms this. Similarly, iron and manganese levels are well

below the levels normally associated with a risk of sleeve staining. Furthermore, UVT testing indicates that the UVT of the water as at October 31, 2008, was 95.0% which suggests minimal absorption of UV light by organics. Accordingly, no pre-treatment to reduce organics is required.

Selecting the appropriate model for a given sterilization task is largely a function of flow rate – how many gallons or liters per minute the peak water demand in the home or business will be. We propose that for residential applications in the District, the UV sterilizer be sized to treat a flow rate of 10 gallons per minute (GPM). For commercial applications, we recommend that larger units with a capacity of either 20 GPM or 30 GPM be implemented.

We have selected the Trojan UVMax Pro Series as the recommended sterilization equipment for the system. The Pro Series offers three NSF-validated models with capacities of 10, 20 and 30 gallons per minute, respectively. Each model is identical in features and differs only in lamp size and accordingly, its flow capacity.

The Trojan UVMax Pro10 is recommended for the majority of the residential applications in the District. The Trojan UVMax Pro10 is the smallest member of Trojan's revolutionary new Pro Series product line. The Pro10 is a full featured unit offering convenient color-coded plug & play connections, a sophisticated UV intensity monitor with self diagnostic test, innovative high-output lamps with 2-year service life, dynamic flow restrictor, and a host of other performance and convenience features designed to make installation, operation, and maintenance as simple as possible. The Pro10 is well suited to typical residential and light commercial water treatment applications where a Class A NSF certified (NSF / ANSI Standard 55) model is desired or required. It has also proven to be a very popular choice for bed and breakfast facilities, rural resorts and lodges, etc. The Trojan UVMax Pro10 is certified to 10 gallons per minute at a UV dose of at least 40,000µWs/cm2 based on a UVT of 75%. Given the District's feed water UVT of 95%, the effective dose provided by the Pro10 will be significantly higher than 40,000 µWs/cm2 at a flow rate of 10 gallons per minute (roughly 50,650 µWs/cm2). Furthermore, it is important to recognize that the vast majority of residential water demands require flow rates of only 1 to 3 gallons per minute. At a flow rate of 3 gallons per minute, and at 95% UVT, the effective UV dose would be greater than 165,000 µWs/cm2.

The Pro10 is equipped with a UV intensity monitor which continuously monitors the intensity of the UV rays to ensure that the water is receiving the NSF-certified dose level (based on the assumption that the water is always flowing at the maximum rated capacity of the unit). The UV intensity sensor is located on the outermost portion of the sterilization chamber and will detect all potential causes of a reduction in UV intensity, including a decline in the lamp's output of germicidal spectrum UV-C rays; a build-up of minerals, stains, or debris on the UV sleeve; a decline in the UVT of the water due to color, turbidity (failure of pre-treatment) or increase in UV-absorbing organics; or a decline in UV output due to excessive water temperature. In the event that the UV intensity monitor signals a decline in UV dose below the NSF-certified level, an alarm will sound and the water supply will be automatically shut-off by the emergency solenoid shut-off kit discussed below.

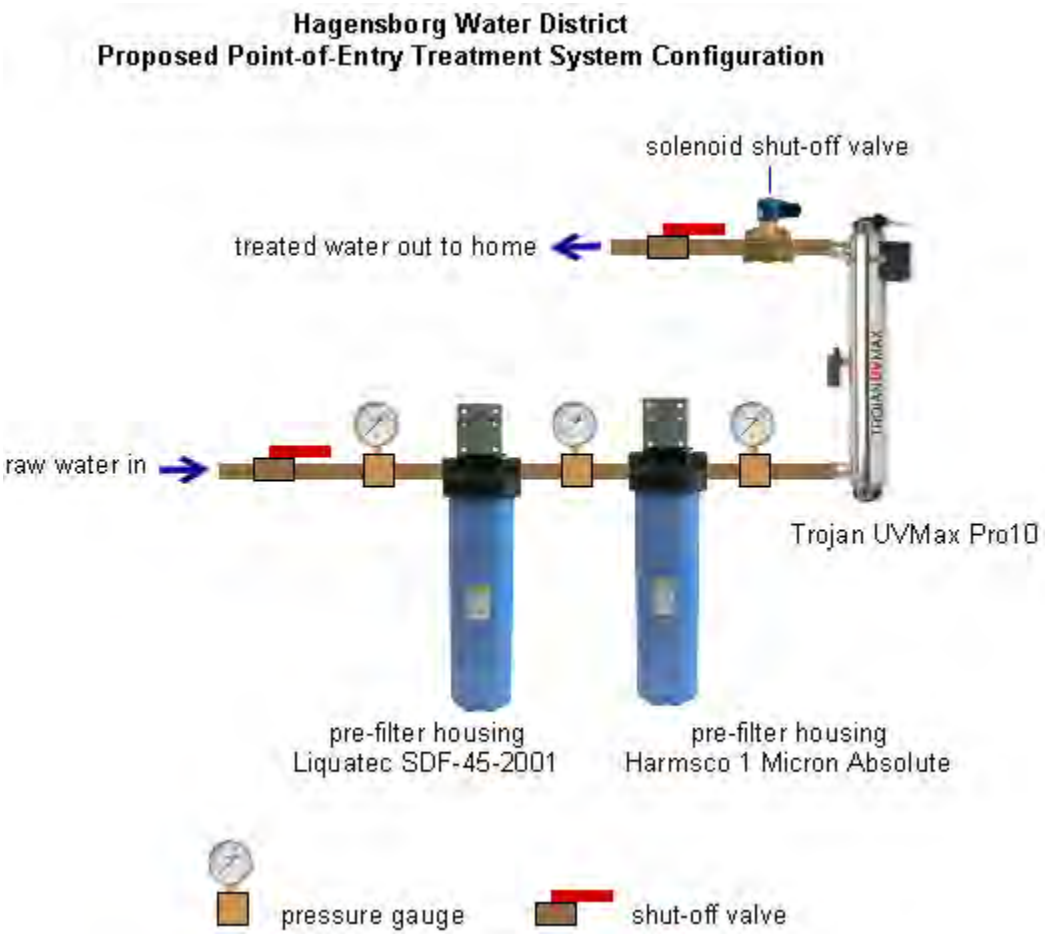
An integrated flow restrictor is also included with the unit to ensure that the maximum rated flow capacity is never exceeded.

The Pro 10 also includes an audible and visual lamp failure and low UV intensity alarm, lamp age indicator, and built-in chamber cooling system (prevents decline in lamp output and false UV intensity warnings as a result of increasing chamber temperature due to inactive water flow).

The Pro Series was selected for a number of reasons:

- NSF Certification
- Manufacturer accessibility and reputation for quality / strong warranty
- "Plug and Play" installation / simplicity of installation will reduce installation costs
- 2-year lamp life will reduce long-term operating costs and dramatically reduce maintenance as compared to competitors' systems with 12 month lamps
- Availability of dose monitoring system (COMMCenter)

A typical requirement of health authorities is that a UV water treatment systems be installed in a manner that prevents water demand during a power outage or in the event of a alarm condition (lamp failure or low UV intensity). In the event of a power failure or electrical outage to the home, the UV lamp in the UV system will lose power. This could leave the application unprotected if a user demands water from the system. Even if water is not demanded from the system during an outage, some bacteria and other waterborne pathogens may swim past the un-powered UV lamp and reach the downstream portion of the system and therefore not receive a dose of UV light once the power is restored. The same situation could occur in the event of a UV lamp failure (rare, but possible). Protection from these scenarios is provided by an optional, but recommended (and included in our proposal), emergency solenoid shut-off kit. The solenoid valve is installed at the output of the Trojan UV system and will physically close in the event of a lamp failure, power outage, or decline in UV dose below the NSF-certified dose level based on the maximum rated flow capacity of the system. The physical barrier created by the closed valve prevents any contaminants from passing through the system untreated. This kit is essential for all homes with a known bacterial, virus, or cyst contamination problem, for all homes with an electrical supply that is prone to frequent outages, or any other application where an extra measure of safety is recommended or desired. A bypass can be plumbed into the system to allow for water access during emergencies (extended power outages) where necessary, however, this is generally discouraged or prohibited by most health authorities.



For applications requiring flow rates exceeding 10 gallons per minute, including restaurants, lodges, hotels, and other commercial applications within the District, we recommend the Trojan UVMax Pro20 and Pro30 models which have all the same features as the Pro10, but are rated at 20 GPM and 30 GPM respectively (NSF- validated flow rates).

A diagram illustrating the recommended installation configuration is attached to this proposal.

COMMCenter

Trojan's optional COMMCenter provides real-time dosage display, lamp history, and system runtime so users can monitor the performance of the UV system. In addition to UV dose, the system displays alarm history and other performance parameters. Moreover, the COMMCenter can be installed just about anywhere - simply connect the COMMCenter to the sterilizer using a standard ethernet cable. The COMMCenter can also be connected directly to a computer where system administrators can use Trojan's free MAXtrack software to obtain real-time dose data, track alarm and dose history, etc. for any given period of time. This data logging capability allows operators to demonstrate proper system operation to regulators and consumers, provides troubleshooting insights, and allows for proactive maintenance. These features make the COMMCenter an excellent choice for commercial / municipal point-of-entry applications where dosage reporting and logging is desirable to prove compliance with health regulations. The COMMCenter is designed to accept standard mini-SD memory cards (same type used by many digital cameras), allowing operators to download data and transfer to a computer so they can view and analyze the data in any standard spread sheet program or the manufacturer's MAXtrack software.

The COMMCenter could be implemented in several ways:

First, given the likelihood that the point-of-entry equipment will be installed indoors where it might not be convenient for a maintenance technician to access the system, it would be possible to for a COMMCenter to be installed on the exterior of the home or business (in a suitable, accessible, weather-proof enclosure) to facilitate data access for a technician. The technician will be able to download data to a laptop or swap the mini-SD card to analyze the data later at a central office to determine if system maintenance is required and to confirm compliance with mandated dose levels, without accessing the interior of the home/business. Access would only be necessary if the system indicated maintenance was required.

The total equipment cost to equip each home and business in the district with this device totals approximately $43,000. This option provides the greatest degree of feedback regarding the overall system performance and has the key advantage of identifying individual system performance characteristics to provide detailed compliance feedback to regulatory agencies and system users on a home-by-home and business-by-business basis.

Alternatively, the COMMCenter could be implemented in only a select group of representative homes and businesses on a sample basis to gain data that could be used to assess overall system efficiency and performance on an extrapolated basis.

As a variation of this option, a series of COMMCenter systems could be alternated / rotated throughout different homes and businesses on a temporary basis (7 to 30 days at a time) to assist in troubleshooting specific performance issues or to prove compliance to concerned or interested consumers and other stakeholders.

The COMMCenter is wireless capable. A pilot project could be undertaken to monitor individual systems remotely either from a central location (devices to boost the wireless signals would be required), or from multiple locations within a neighborhood. A single COMMCenter can monitor up to 9 UV systems. The scope of such an undertaking is beyond the scope of this proposal, however, should the District wish to implement such a project, we would be pleased to participate.

Installation & Maintenance

Our proposal encompasses the supply of the primary treatment equipment only. The District will need to contract out the installation and maintenance of the system, or hire permanent staff for this purpose. In conjunction with the manufacturer, we will provide training to installers and maintenance staff to ensure proper operation of all equipment, including diagnosis/troubleshooting and repair. The nature of the work

required to install and maintain the recommend treatment equipment is not complicated. Extensive training will not be necessary. We have sold thousands of similar systems to individual homeowners who hire general plumbers to perform system installations and generally maintain their own systems effectively as required.

Additional training or certification may be required by the Health Authority to comply with the Drinking Water Protection Act and Regulations.

Location of Installation

The UV system and associated pre-filters are normally installed on the main incoming water line at the point-of-entry to the home, immediately after any branch lines used exclusively for land irrigation purposes. A UV system should be installed indoors or other area that is protected from freezing and direct sun exposure. Interior installation would require, on average, less plumbing alterations, is more likely to have an existing electrical source/access nearby, and provides the greatest assurance of protection from freezing. Alternatively, an exterior installation offers the advantage of accessibility for maintenance personnel, which is a significant factor for this application. In conjunction with the manufacturer, we have reviewed historical winter weather data for the Bella Coola valley and concluded that an exterior installation could only be undertaken within a heated enclosure due to the temperature extremes during the winter months. While conceivable, the costs associated with supplying a suitable exterior enclosure, additional plumbing alterations, and providing a source of electricity to power the UV sterilizer and heater make this option less desirable. Accordingly, our proposal recommends an interior-installed system. We have attempted to mitigate access concerns associated with an interior installation by selecting a UV system with lamps that last twice as long as conventional UV lamps, and selecting oversized pre-filters with high dirt-holding capacity to increase the time interval between filter changes.

However, if desired by the District, the costs and logistics of an exterior installation could be more accurately explored in a pilot project. Such a pilot project would include a review of suitable enclosures, and a comparison of the increased capital costs associated with exterior installation versus the reduced accessibility of an interior installation.

Minimal space is required for the equipment. The pre-filter housings (2 required) are 8 inches in diameter and 24 inches long. The Trojan UVMax Pro10 is only 22 inches long and 4 inches in diameter. To accommodate existing infrastructure at each installation location and to allow for the installation of pressure gauges between each pre-filter housing, we recommend separate mounting brackets be used for each housing as opposed to one “double bracket” for both housings. Each component is designed to be mounted vertically.

Electricity

The UV sterilizer and accompanying solenoid valve are the only pieces of equipment which will require electricity. To comply with the various electrical codes and to provide additional protection from the risk of electric shock, this system should only be connected to a properly grounded power supply receptacle that is protected by a Ground Fault Circuit Interrupter (GFCI).

In the event that an existing electrical outlet exists within about 72 inches of the installation location, it can easily be upgraded to a GFCI outlet to accommodate the installation of the UV sterilizer and solenoid kit. Alternatively, a new outlet will need to be installed either directly from the main electrical panel (new circuit) or in most cases, an additional outlet can be added to an nearby existing circuit. It is recommended that all electrical modifications be conducted by a licensed electrician and that all permits required under local, provincial, and national codes, be obtained. The costs associated with the installation of a suitable electrical outlet will need to be budgeted and are not included in our proposal.

The power consumption of the Pro10 is only 120 watts (designed for continuous operation).

To protect the power supply, a voltage surge protector / suppressor is recommended by the manufacturer but not included in this proposal. A uninterruptible power supply (UPS) similar to those used to provide temporary short-term back-up power to a personal computer can be used to provide surge protection and power during short-term power failures if desired (not included in this proposal).

If the plumbing pipes form part of the electrical grounding system within the building, a suitable jumper wire will need to be installed to span the polypropylene pre-filter housings to maintain the integrity of the grounding system.

Plumbing

The plumbing of the proposed system is very simple. The two pre-filter housings as well as the UV sterilizer and solenoid valves all feature standard 1 inch NPT threaded plumbing connections. If the home or business' plumbing lines are of larger or smaller diameter, simple plumbing fittings can be used to accommodate alternative pipe sizes.

It should be noted that most health authorities recommend that pressure gauges be installed before and after each filter housing to aid in the determination of filter clogging and maintenance needs. Furthermore, a shut-off valve would be installed before and after the system to facilitate convenient maintenance. Since the type of shut-off valve and position and type of pressure gauge may vary from installation to installation, we have not included these components in our proposal. We recommend that an additional $20 to $30 per installation be budgeted for miscellaneous plumbing components to make the required connections. We would be pleased to provide a quotation on these items or they can obtained from the contracted installer or from a plumbing supply store.

We recommend that all plumbing work be conducted by a licensed plumber and that all necessary permits as required by the province or local authorities be obtained.

System Sterilization

In conjunction with the original installation, a complete sterilization of the entire plumbing system is highly recommended. The procedures to do this are described in detail in the Trojan UVMax Pro Series Owner's Manual attached to this proposal.

Accessibility

Accessibility for installation and maintenance personnel is of significant importance. A typical installation will take only a couple of hours and will require some co-ordination with the resident so access can be obtained. Some co-ordination with the home or business owner may be required regarding installation location so it meets the esthetic desires of the homeowner and works within the scope of the existing infrastructure in the home. Careful planning, including a pre-installation meeting on site with each home and business owner and careful documentation of the proposed installation should avoid any problems and ensure resident satisfaction with the project. Access will be required periodically, estimated at once per annum for most sites, to facilitate system maintenance.

Maintenance Recommendations

One of the greatest benefits of UV sterilization is that it requires minimal maintenance. The most critical aspect of maintenance is to ensure that pre-treatment requirements continue to be met. For instance, pre-filters need to replaced regularly to maintain flow performance. We have selected oversized filter cartridges to ensure excellent flow characteristics (negligible pressure loss) and less frequent cartridge replacement, and most importantly, to reduce ongoing maintenance visit requirements. Based on expected turbidity levels, it is anticipated that the pre-filters will only need to be replaced once per annum. In the event of an increase in turbidity during the spring freshet or after periods of heavy rain, the use of settling tanks, etc. or

large commercial-sized sediment filters at the point of collection could greatly reduce the burden on the point-of-entry residential pre-filters, thereby reducing the frequency of filter replacement. At the same time that the filter cartridges are replaced, the housing o-ring should be replaced.

The UV lamps need to be replaced every 24 months, and the UV sleeve should be cleaned regularly as necessary to remove any deposits that may reduce UV transmittance. As noted above, given the low iron and hardness levels and the fact that we will be ensuring adequate pre-filtration (in fact, a higher level of pre-filtration than specified by the manufacturer), it is unlikely that the sleeve will require cleaning more than once per annum in most cases. Sleeve cleaning can be performed at the same time as the replacement of the pre-filter cartridges. In the event that maintenance was insufficient and the UV dose was to drop below a safe level due to fouling of the sleeve, the UV intensity monitor on the system would be triggered and the home or business owner could request service.

The UV sleeve does not need to be replaced unless it is physically damaged. It is fragile, so care should be taken while cleaning the sleeve or performing system maintenance.

The UV intensity monitor sensor requires periodic cleaning similar to the sleeve.

A typical “service call” for maintenance, including replacement of the pre-filters and housing o-rings, inspection of system, replacement of the UV lamp (every second year), and cleaning of the UV sleeve and intensity monitor sensor, would take about 15-20 minutes depending on the accessibility of the sterilizer.

During service calls in which a lamp replacement is undertaken, it is generally recommended to perform another complete plumbing system sterilization. This would require an extra few minutes of time and ideally, the home or business owner should not use their water for several hours afterwards for optimal sterilization.

Budget

Our proposal is for the supply of the majority of the equipment that would be required for this project, together with the aforementioned training only. This section of the report will detail and summarize the specific equipment recommend and the costs and specifications thereof. It will also identify other potential costs associated with point-of-entry treatment that are beyond the scope of this proposal so that they may be appropriately considered by the District.

Pricing Terms:
- Canadian dollars
- sales taxes are <u>not</u> included in stated prices
- valid for 120 days (may be extended upon request)
- FOB Kamloops, B.C.

System Hardware:

Pentek Big Blue™ 20” Heavy-Duty Polypropylene Water Filter Housings
Quantity Required Per Installation: 2
Includes housing cap/head with 1” NPT threaded fittings, pressure relief button, filter sump, original o-ring, and spanner wrench.
Certification: NSF / ANSI Standard 42 for Material Requirements

Pentek Heavy-Duty Stainless Steel Mounting Bracket
Quantity Required Per Installation: 2
Includes associated screws for mounting to housing cap. Does not include wall anchors or screws required to mount to wall.

Trojan UVMax Pro10 Ultraviolet (UV) Sterilizer
Quantity Required Per Installation: 1
Certification: NSF / ANSI Standard 55, Class A, UL Canada
Includes original 2-year lamp and sleeve

Trojan UVMax 1" Emergency Solenoid Shut-Off Kit
Quantity Required Per Installation: 1
Includes wire harness, actuator, and 1" valve.

Trojan COMMCenter - Optional
Quantity Required Per Installation: 1
Does not include Mini-SD card, or network cable – can be obtained from any electronics supply store.

Consumables:

Liquatec SDF-45-2001 Multi-Gradient 1 Micron Filter
Quantity Required Per Installation: Approximately 1 per year
Material: 100% pure polypropylene fibers (spun)
Size: 4 ½ x 20"
<0.5 PSI pressure loss at 10 GPM
Certification: NSF / ANSI Standard 42 for Material Requirements

Harmsco Poly-Pleat PP-BB-20-1 1 Micron Absolute Filter
Quantity Required Per Installation: Approximately 1 per year
Material: 100% pure polypropylene (pleated – 16.5 square feet surface area), with polyethylene netting
Size: 4 ½ x 20"
Estimated 1 PSI pressure loss at 8.25 GPM
Pleated polypropylene filter
Certification: NSF / ANSI Standard 61

Replacement Lamp Trojan UVMax Pro 10
Quantity Required Per Installation: 1 per 24 months

Buna-N Big Blue Housing O-Ring
Quantity Required Per Installation: Approximately 1 per year

Pricing:

The following table illustrates the initial cost of the proposed point-of-entry treatment equipment based on the Trojan UVMax Pro10 system (includes original set of filters and UV lamp):

Item	Quantity per Installation	Price (Each)	Cost per System
Pentek Big Blue™ 20" Heavy-Duty Polypro Water Filter Housings	2	$ 57	$ 114
Pentek Heavy-Duty Stainless Steel Mounting Bracket	2	$ 24	$ 48
Trojan UVMax Pro10 Ultraviolet (UV) Sterilizer	1	$ 1,296	$ 1,296
Trojan UVMax 1" Emergency Solenoid Shut-Off Kit	1	$ 108	$ 108
Liquatec SDF-45-2001 Multi-Gradient 1 Micron Filter	1	$15	$15
Harmsco Poly-Pleat PP-BB-20-1 1 Micron Absolute Filter	1	$84	$84
TOTAL INITITAL COST PER SYSTEM (TREATMENT EQUIPMENT)			$ 1,665
TOTAL INITITAL COST BASED ON 180 INSTALLATIONS			$ 299,700

Optional accessories and upgrades:

Item	Quantity per Installation	Price (Each)	Cost per System
Trojan COMMCenter (Recommended)	1	$ 239	$ 239
Upgrade to Trojan UVMax Pro20 (20 gallons per minute)*	1	$ 445	$ 445
Upgrade to Trojan UVMax Pro30 (30 gallons per minute)**	1	$ 1,193	$ 1,193

* Requires a second stage 2 Harmsco Poly-Pleat PP-BB-20-1 filter and associated housing and housing bracket in order to handle the additional flow rate.

** Requires an additional stage 1 Liquatec SDF-45-2001 sediment filter and 2 additional stage 2 Harmsco Poly-Pleat PP-BB-20-1 filter, and associated housings and housing brackets in order to handle the additional flow rate.

Cost of Replacement UV Lamps, Sleeves, O-Rings, and Filters:

Item	Expected Replacement Frequency	Cost Each	Case Quantity	Case Price
Liquatec SDF-45-2001 Multi-Gradient 1 Micron Filter	Every 12 months	$ 15	6	$ 90
Harmsco Poly-Pleat PP-BB-20-1 1 Micron Absolute Filter	Every 12 months	$ 84	8	$ 672
Replacement Lamp Trojan UVMax Pro 10	Every 24 months	$ 148	10	$ 1,480
Replacement Lamp Trojan UVMax Pro 20	Every 24 months	$ 168	5	$ 840
Replacement Lamp Trojan UVMax Pro 30	Every 24 months	$ 199	5	$ 995
Replacement Sleeve Trojan UVMax Pro 10	Only if broken	$ 48	1	$48
Replacement Sleeve Trojan UVMax Pro 20	Only if broken	$ 57	1	$57
Replacement Sleeve Trojan UVMax Pro 30	Only if broken	$ 62	1	$ 62
Buna-N Big Blue Housing O-Ring	Every 12 months	$ 4.60	25	$ 115

Estimate Annual Operating Cost Per Installation (Consumables)
Liquatec SDF-45-2001 Multi-Gradient 1 Micron Filter: $15
Harmsco Poly-Pleat PP-BB-20-1 1 Micron Absolute Filter: $84.00
Replacement Lamp Trojan UVMax Pro 10 (pro-rated): $74
Buna-N Big Blue Housing O-Ring: $4.60
TOTAL: $177.60 or $14.80 per month

It is recommended that a replacement parts inventory be maintained by the District to handle unexpected equipment failures, accidental parts damage (UV sleeves), and filter replacements. This inventory should consist of several complete systems, solenoid kits, COMMCenter packages, UV lamps, UV sleeves, replacement filters, housings, and o-rings. In conjunction with the Health Authority, the District will need to determine the appropriate inventory levels necessary to assure the desired standard of service to as to ensure no downtime for residents. Some health authorities require a minimum of one set of replacement lamps and filters be in stock at each installation site, however, given the small size of the community, the storage of replacement parts and filters at a central facility in the area is likely sufficiently practical to meet the objectives. It should be noted that, in most cases, replacement parts can also be obtained on an overnight basis from our warehouse facility in Kamloops, B.C. if required on an expedited basis.

Please Note: additional plumbing supplies including expander/reducer fittings, pressure gauges (3 per installation recommended), shut-off valves (2 per installation recommended) as well as GFCI receptacles, electrical breakers and wiring may be required for some or all installations. These components are not included in our quotation. While the costs of these accessories will vary from installation to installation, we anticipate an average materials cost of under $100 per installation for these incidentals.

Additional Recommendations

Turbidity Testing

As previously noted, this proposal and the recommendations contained herein are based on the results of a water sample analyzed by ALS Laboratory Group of Vancouver, BC. The date of the water sample was October 31, 2008, and the date of the report was November 13, 2008. We recommend that historical water tests for the District be examined on a detailed basis to assess possible seasonal or weather-related changes in turbidity levels. We are very confident that the selected equipment and system will meet all objectives under the 4-3-2-1-0 protocol even in the event of a very significant increase in turbidity levels, however, the increase in turbidity levels could have a significant impact on the life expectancy of the two pre-filters, particularly the Liquatec SDF-45-2010. Accordingly, a more frequent filter replacement regime would increase system maintenance costs. If historical turbidity data is not available, we recommend that testing be conducted during the 2009 spring freshet to provide this data. We would pleased to provide assistance in interpreting this data and the implications to our proposal.

If increased turbidity is found to exist during freshet and after rain events, a central high-capacity sediment filter or settling pond/tank could also be installed at or near the source to significantly reduce sediment load to prevent pre-mature fouling of the point-of-entry systems so that the filter maintenance can be maintained at less frequent intervals. It has been indicated that water storage will likely need to be enhanced at or near the creek intake in order to provide flow rates necessary for fire protection. This storage facility could, in part, act as a settling tank/pond thereby helping to reduce turbidity during freshet conditions in the event that turbidity levels were elevated during this period or after periods of heavy rain.

Pilot Project

We recognize that a project of this scope involves a major investment on the part of the District and the community members. We would be pleased to undertake a pilot project in conjunction with the District and the Health Authority to prove the efficacy of the proposed system. Such a pilot project would provide the most accurate information regarding expected installation times and labour costs and contribute to our overall understanding of expected filter lives for the purposes of more accurately estimating annual filter replacement costs and maintenance intervals.

Exterior Installation

To improve the accessibility of the point-of-entry treatment equipment for maintenance by District contractors or staff, exterior installation would offer some significant advantages. A complete assessment of the added costs associated with an exterior installation is beyond the scope of this proposal, however, if desired by the District or Health Authority, we would be pleased to undertake a separate review of this option.

Historical winter weather data for the Bella Coola valley confirms that an exterior installation could only be undertaken within a heated enclosure due to the temperature extremes during the winter months. In addition to an insulated enclosure, a heat source and thermostatic control would be required to maintain a suitable ambient air temperature within the enclosure to prevent freezing and overheating (overheating will increase energy costs and reduce UV performance). The UV lamp itself will provide some heat output but we have deemed it to be insufficient on its own to protect the UV unit and the pre-filter housings. We believe that suitable equipment does exist and that the costs would not be extreme, but certainly material to the scope of the project.

Alternatively, it may be possible to install the point-of-entry system underground on the water supply line to the home, protected by a waterproof enclosure. This would eliminate the need for a heating system if installed below the frost line, however, excavation costs could negate the advantage. Access would need to be maintained for filter and lamp replacement, etc. which may create the need for a rather large enclosure

especially given the preferred vertical orientation of the housings and UV system.

Our greatest concern with an exterior installation is related to the effects on plumbing and electrical costs. It is likely that additional plumbing and electrical costs would be incurred due to the location of the incoming main water line to the home relative to a suitable exterior installation location, and the unlikelihood of an available electrical source in the same vicinity.

A pilot project could assess the relative difference in labour cost between interior and exterior installation, and explore the viability of various equipment options to accomplish this.

About Trojan Technologies

Founded in 1976, Trojan Technologies is a world leader in UV sterilization. Based in London, Ontario, Trojan has annual sales well in excess of $100 million, and has emerged as a leading player in its five focus markets - municipal drinking water, municipal wastewater, environmental contaminant treatment, industrial / commercial applications, and consumer water purification systems. Every day, Trojan systems treat over 17 billion gallons of water in more than 25 countries worldwide.

Warranty
10 Year Limited Warranty for Trojan UVMax Reaction Chamber
5 Year Limited Warranty for Structural, Hardware and Electrical Components
1 Year Limited Warranty for Lamps, Sleeves and UV Sensors

About Home Water Purifiers And Filters

Home Water Purifiers and Filters (HWP&F) is a division of MediaWave Communications Corp. and is a major distributor of residential and light industrial water treatment products with an emphasis on general whole house water treatment, ultraviolet (UV) sterilization, iron treatment, point-of-use reverse osmosis and drinking water systems, and replacement filter cartridges. HWP&F represents a number of the residential water treatment industry's most notable brands including Pentek (US Filter, Ametek, American Plumber, etc.), Liquatec, Fleck, Trojan / Sterilight (VIQUA), Harmsco, and more. HWP&F is the one of the largest distributors of Trojan UV sterilizers in Western Canada.

MediaWave Communications Corp. is part of a consortium of three companies involved in the distribution of products designed to improve the quality of life of homeowners including products that deal with the home environment such as water treatment, on demand water heating, air purification, humidification, and water leak detection. Founded in 1999, the MediaWave Group of Companies is based in Kamloops, B.C., and operates a branch distribution warehouse in Racine, Wisconsin. In 2003, MediaWave was ranked by PROFIT magazine as the 6th fastest growing emerging company in Canada, and in 2007, it joined the prestigious publication's list of the top 50 fastest growing companies in the country.

ATTACHMENTS

UV Dose Required to Achieve Incremental Log Inactivation of Bacteria, Protozoa and Viruses
Trojan UVMax Pro Series Brochure
Trojan UVMax Pro Series Owner's Manual (Installation Guide)
Trojan UVMax COMMCenter Manual

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