



2019 Awards Competition

SHEDDING LIGHT ON GREATER VERNON'S WATER SYSTEM

Duteau Creek Water Treatment UV Facility

Submission Category: Water Resources



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Three Ultraviolet Disinfection Reactors at Duteau Creek Water Treatment Plant

SUMMARY

The Regional District of North Okanagan (RDNO) needed a \$30million filtration facility at the Duteau Creek Water Treatment Plant to meet the Drinking Water Regulations. With no public support to borrow the funds, WSP as the prime consultant, engineered and delivered an innovative \$7 million ultraviolet disinfection facility within an extremely tight design schedule, that met the Drinking Water Regulations, reduced energy costs by over 10%, and provided 99.9% reliability. Saving the RDNO \$13million.



Left: 3D Computer Model Developed During Design of UV Facility. Right: UV Facility After Construction.

PROJECT HIGHLIGHTS

INNOVATION

The Duteau Creek Water Treatment Plant (DCWTP) treats up to 162 million litres per day, and is one of two sources that supply the businesses and 62,000 residents of Greater Vernon. The DCWTP existing dissolved air flotation clarification (DAF) and chlorine disinfection processes did not provide the required 99.9% (3-log) inactivation of protozoa.

The DCWTP was designed to add filtration to meet the treatment objectives but following an unsuccessful public referendum to borrow the \$30 million needed for filtration, the Regional District of North Okanagan (RDNO) investigated creative alternatives.

The RDNO conducted testing of the DAF process and established a risk profile across the treatment process. The testing demonstrated that ultraviolet disinfection was potentially a viable alternative to filtration for meeting the 3-log treatment of protozoa. The RDNO secured \$7.0 million in grant funding from the Canadian Water & Wastewater Fund for the innovative application of UV disinfection.

WSP leveraged their expertise in UV disinfection and local Okanagan experience to address the following key issues:

- 1) **Unconventional Treatment Approach:** WSP used the findings of the risk assessment and historical water quality data, to establish the optimum siting of the UV reactors downstream of the treated water reservoir. An operational control philosophy was developed to meet the provincial treatment regulations and obtain early approval of the unconventional approach from the local health authority.
- 2) **Reliability:** With the UV system downstream of the reservoir, every drop of water passing through the UV process goes directly to users. By prioritizing the risks namely, the variability in water quality, flow and power reliability conditions, WSP established the design criteria for handling 99.9% of operating conditions. WSP selected a UV reactor that offered a wide turn-down ratio plus a 30% operating safety factor. The system also included a third standby UV Reactor which could operate in duty mode during emergencies. Power reliability was addressed by a 350kW inline uninterrupted power supply (UPS) unit that provides stable clean power to the UV system during voltage sags and the 20-30 minute transition period when loss of utility power initiates the standby diesel generator.
- 3) **Site Footprint and Hydraulics:** Early equipment selection allowed for prompt building layout and footprint. WSP generated a 3D computer model to optimize the building layout, conduct clash investigations and assess constructability issues. The result was a well-coordinated operator-oriented design that offered a cost effective and low footprint solution.



UV Facility Building Located Between West Site Boundary and the 10 Million Litre Treated Water Reservoir

COMPLEXITY

Providing a UV disinfection process to meet the Ministry of Health 4-3-2-1-0 treatment objectives, namely 3-log (99.9%) inactivation and dual (2) barrier protection, that would otherwise traditionally be achieved by filtration. The application of UV disinfection downstream of a clarification process, in the absence of filtration, is not conventional and obtaining consent from health regulators demanded an advanced knowledge of UV treatment technology and effective collaboration with the health regulators. WSP customized a deliverable program that prioritized all major design decisions and input requirements from the Owner and the health regulator. This allowed key decisions to be made in a systematic manner to maintain the critical path for the design and UV equipment pre-purchase schedule.

With the treatment process downstream of the Treated Water Reservoir, every drop of water passing through the process goes directly into the distribution system. Rapid changes in flow or water quality and power surges or interruptions could result in an increased public health risk due to untreated water entering the distribution system. The UV disinfection process needed to be robust, reliable and capable of meeting the treatment targets through diverse and rapidly changing operating parameters.

Criteria of the \$7 million funding from the Canadian Water & Wastewater Fund, required concept design to tender ready contract in just six months, a process that traditionally takes 8 to 12 months. The unconventional UV approach required collaboration with the RDNO and local health regulators to obtain early input and buy-in, allowing for accelerated equipment selection and facility layout.



Water Quality Analyzers for Monitoring Ultraviolet Transmittance and Controlling UV Disinfection to a Minimum of 99.9%

SOCIAL AND ECONOMIC BENEFITS

The addition of UV disinfection provided a minimum of 99.9% inactivation of harmful waterborne disease and dual barrier protection, building resiliency in the water treatment process and therefore reducing the overall public health risks to the community. Less potential for infections and illness creates a healthier and better functioning society in all realms of school, work and play. A new chlorine injection system after the UV process improved chlorine dosing efficiency, reducing chemical consumption and the potential formation of harmful disinfection by-products.

As is the common driver for innovation, necessity drove economic sustainability at the onset with the development of a \$7 million solution for what was considered a \$30 million problem. Energy conservation was at the forefront of the design process with the implementation of capacitor bank technology that improved energy efficiency and reduced costs by over 10% (saving the RDNO over \$750 per month in penalty charges and energy use premiums).

Low power consumption was prioritized during the review of UV technologies leading to the selection of Low Pressure High Output (LPHO) UV lamps – offering the lowest life cycle cost solution to the RDNO. By incorporating constructability throughout design development, construction costs were reduced through an efficient building layout.



UV Disinfection Facility with Solar Tubes on Roof and Grove of Trees Saved Through Alternative Shoring Measures

ENVIRONMENTAL BENEFITS

A Multiple Bottom Line Analysis identified the Low Pressure High Output (LPHO) UV Reactors offered 80% lower energy usage than alternative UV technology. The rows of lamps operate independently and automatically modulate power to optimize UV dosage across the broad range of instantaneous system demands and changes in water quality.

Identification and analysis of the site power usage determined a significant power inefficiency inherent in the existing facility. To address the power inefficiency of the site's electrical service, WSP designed a new 1,000 kVA capacitor bank for the service to the DCWTP. Much like a water reservoir in a distribution system, the capacitor bank stores and releases power during peak periods, reducing the maximum load on an already strained regional power network.

All construction was completed within the compounds of the existing facility, with no offsite works required for utility upgrades and all surplus excavated soil, approximately 4,000 m³, blended into the existing topography onsite. Natural light was harnessed using fifteen roof mounted solar tubes to complement the high efficiency LED luminaires throughout both the process and electrical rooms. The proprietary hood on the solar tube was orientated to harness the limited sunlight of the north facing site.

The established grove of pines and spruce to the west of the site were saved by using alternative slope stability and shoring measures that allowed for steeper temporary grades during construction.



Left: 350kW Uninterruptible Power Supply Equipment. Right: Quick Removal of UV Lamps Through Operator Orientated Design

MEETING CLIENT NEEDS

Facing the fallout of an unsuccessful borrowing referendum to add a \$30 million filtration facility to the existing DCWTP, the RDNO needed a creative solution to reduce the public health risk within their water system and achieved the following goals:

- Provide a UV disinfection process that meets the Ministry of Health treatment objectives without filtration.
- UV disinfection process that is robust, reliable and capable of meeting the treatment targets through a wide range of operating conditions.
- Design and tender the UV Disinfection facility within a 6-month timeframe.
- Deliver an operator orientated design for equipment layout, maintenance, and function.
- Optimize chlorine dosage to improve water quality and reduce potential formation of harmful disinfection by-products through improved chlorine dose control.

As the prime consultant, WSP rose to the challenge and met the client's goals through working outside of conventional water treatment practices, developing customized project delivery processes, and leveraging expertise in regulatory approval requirements.

WSP's extensive knowledge of UV disinfection and relevant Okanagan project experience provided the framework for accelerating critical decision milestones necessary to gain health authority support and meet the aggressive project delivery schedule. Through technical and project delivery excellence, WSP provided a \$7 million solution to their client's \$30 million problem – getting the UV Disinfection Facility out to market under budget and ahead of schedule.

WSP | Shedding UV Light of Greater Vernon's Water System





Figure 3 - View of UV reactor trains from inside the UV disinfection facility



Figure 4: Operations platform with UV reactor orientated to facilitate UV lamp removal and maintenance.



Figure 5: Inside the K143 UV reactor showing internal bracing and quartz sleeves for UV Lamps.



Figure 6: Completing the tie-in for the 900mm diameter bypass around the UV building.



Figure 7: Stainless steel flow vane engineered by WSP to reduce headloss through the UV Facility wet well outlet.



Figure 8: UV Reactor's human machine interface (HMI) cabinet

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