Hudson's Hope WTP Control Narrative (REV F)

Water Treatment Plant Upgrade

February 27, 2026

Submitted to: District of Hudson's Hope (DoHH)

Contact:
Christina Saxvik. P.Eng.
Process Engineer
778 247 0668
csaxvik@mcelhanney.com

Reviewed By:
Mark DeGagne. P.Eng.
Water and Wastewater Facilities Division – Business Leader
778 560 2001
mdegagne@mcelhanney.com

Our file: 3111-27018-02

Address
8808 Northern Lights Drive,
Fort St. John BC Canada V1J 6M2

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1. PREFACE

The District of Hudson's Hope (the District) has been moving forward with the detailed design for the retrofit of the existing Water Treatment plant, which began in late 2022. Since then, temporary works have facilitated the conversion of the water source from deep groundwater wells to the riverine environment of the Peace River. These works consist of a Ballasted Flocculation Clarifier (rented from Veolia), followed by two direct filtration processes – Media Filtration and Fine Cartridge Filtration, followed by two disinfection processes – UV and Chlorine Disinfection. The temporary plant produces high quality treated potable water, and it is intended to make these temporary works more permanent within the existing plant. The control of the plant requires several operator manual inputs to ensure high-quality treatment, and the current control strategy is used to form the basis of the control narrative for the future plant upgrades.

This control narrative is intended to serve as a general guide to the overall control philosophy and operational logic of the Water Treatment Plant (WTP). It is not intended to address every possible operational scenario, equipment failure, or unexpected event that could occur during plant operation. The final programming and functional implementation of the control system will require close consultation with the preferred PLC programmer to ensure alignment with site-specific requirements, operator preferences, and equipment capabilities.

1.1. ABBREVIATIONS AND ACRONYMS

Table 1: Abbreviations and Acronyms.

Abbreviation / Acronym	Description:
Clarifier	Veolia ACP2-15 Actiflo® Clarifier
HMI	Human Machine Interface
HOA	Hand-Off-Auto
O&M	Operations and Maintenance
P&ID	Piping and Instrumentation Diagram
PLC	Programmable Logic Controller
PRV	Pressure Regulating Valve
SCADA	Supervisory Control & Data Acquisition
UPS	Uninterruptible Power Supply
VFD	Variable Frequency Drive
VPN	Virtual Private Network
WTP	Water Treatment Plant

1.2. REFERENCE DOCUMENTS

- Hudson's Hope Potable Water Treatment Plant Preliminary Design – Final Report (Project # 3111-27018-00)
- Actiflo® Package Plant (MKIII) Installation, Operation and Maintenance Manual (Veolia, 2024)
- Hydra-Pol MC Compact HP500C / HP1000C Polymer Preparation System Installation, Operation and Maintenance Manual (Veolia, 2025)
- Elgin ABH-240 Standard Package Air Burst System O&M Manual (representative)
- 5000225011_OMM_0001_GEN_VWT Operations and Maintenance (O&M) Manual for Hudsons Hope (Veolia, 2025).
- Shop Drawing Submittal, Hudson's Hope WTP UV System (Ramtech, December 23rd, 2022)
- Block Flow Diagram, Drawing #P-200 (McElhanney, 2025)
- Process and Instrumentation Diagram (P&ID) P-100 drawing set (McElhanney, 2025)
- Polymer Dosing Skid Process Control Description (Veolia, 2025)
- Coagulant Dosing Skid Process Control Description (Veolia, 2025)
- Hydrapol Compact Functional Description (Veolia, 2025)
- Actiflo – ACP Functional Description (Veolia, 2025)
- AERShaft Lamella Cleaning System Functional Description (Veolia, 2025)
- Set Points and Alarm List – Hydrapol Compact (Veolia, 2025)
- Set Points and Alarm List – Actiflo (Veolia, 2025)
- All other vendor documentation for the clarifier, polymer and coagulant systems, supplied by Veolia, including process data sheets, P&IDs, submittal packages, general arrangements, equipment lists and electrical, instrumentation and control documentation.

2. PROCESS OVERVIEW

This document is intended to be read in conjunction with the Block Flow Diagram P-200 and the Process and Instrumentation Diagram (P&ID) P-100 set.

The system is comprised of raw water pumps to draw surface water from the Peace River, a treatment plant, treated water storage reservoirs, and a distribution system servicing the Hudson's Hope community.

2.1. GENERAL

The minimum flow rate of the plant is 7 L/s, and the maximum flow rate of the plant is 24 L/s. Flow rate through the plant is operator adjustable, however a short-term shutdown or time delay is required for the processes to stabilize, at for example the clarifier or media filter.

The WTP will be controlled to the following key control loops:

- Raw water pumps: Reservoir level provides the permissive signal for raw water pumps to start. Flow is measured by the WTP raw water flowmeter (TAG#: FIT-B0105) and pump speed is controlled to balance this measured flow and the WTP flow set point.
- Inline transfer pumps: Flow is measured at the filter inlet flow meter (TAG#: FIT-E0300) and pump speed is controlled to balance this measured flow and the difference between raw water flow meter FIT-B0105 and the clarifier waste flow meter FIT-E0301 (ie, FIT-B0105 minus FIT-E0301).
- Distribution pumps: Flow is measured at the treated water flow meter (TAG#: FIT-K0710) and pump speed is controlled to balance this measured flow and the difference between raw water flow meter FIT-B0105 and the clarifier waste flow meter FIT-E0301 (ie, FIT-B0105 minus FIT-E0301).
- All pumps will have back-up control, upon loss of flow meter signal or for other operational reasons, by tank levels (Inline Transfer Tank, Contact Tank and Treated Reservoir).
- The control point for the raw water pumps is overridden based on the destination of the pumped water. Specifically, the override is selected depending on whether water is being directed to the clarifier or if either the clarifier or the media filters are being bypassed.

2.2. RAW WATER INTAKE AND AIR BURST SYSTEM

The raw water intake includes two (2) intake screens (TAG#: Z-A0001; Z-A0002), within the newly constructed bank stabilization berm. Each screen is designed for a flow of 50 L/s. The system includes an air compressor system (TAG#: Z-A0030) for “burst” cleaning the screens. The air compressor unit for the intake screen air burst system is to be housed in a dedicated building. A description of the default settings for the compressor and air burst cleaning system is described in Elgin Separation Air Burst System O&M Manual. The compressor shall be connected to the Compressor Building PLC Control Panel and will initially be set to run a burst sequence once every 12 hours as recommended by the supplier. This value will be adjusted to suit site conditions following installation.

The intake screens are connected to a 300mm diameter sch 40 stainless steel header complete with isolation valves. The header is connected to three existing vertical well casings, two of which are to be used with one left for redundancy.

The air compressor building will be equipped with a room temperature sensor that triggers a low-temperature alarm to alert the operator of potential condensation risks within the air compressor system.

It is expected that all major alarms relevant to equipment housed in the air compressor building will be communicated to the WTP Master Control Panel for operator attention. Refer to the Elgin Separation Air Burst System vendor documentation for local control panel alarms.

2.3. RAW WATER PUMPING

Two Franklin Electric submersible turbine well pumps (15HP pump model: 350TS8, 20HP motor model: 2366248120) (TAG#: P-A1000; P-A2000) will be installed, one in each of well casing #1 and #3, with well casing #2 left in reserve for possible future service. Each pump will be capable of supplying the treatment

plant with up to 24 L/s of feed water for treatment and will therefore be operated in 1 duty + 1 standby. A shelf spare shall always be available in the public works stores ready for use, in case one pump fails.

Simultaneous operation of both raw water pumps will be an operator override, and the same VFD speed will be applied to both pumps in this scenario.

The pumps will be exercised automatically on an alternating basis based on run hours to ensure similar life cycles of each or selected manually as the duty pump. The pumps will operate on VFDs for soft starting and speed control, with Well Pump VFD #1 and Well Pump VFD #2 housed in the main treatment plant building.

New hydrostatic pressure transmitters (TAG#; LIT-A1001 and LIT-A2001) will be placed in each online well casing to monitor level in each well casing, with a low-level alarm and a low-low level interlock used for pump protection. The transducer will communicate to the WTP Master PLC at the WTP. Pump running status and VFD speed of each pump will also be communicated to the WTP Master Control Panel.

When the reservoir calls for water, the raw water pumps are the first pumps in the process to start-up. Refer to the discussion under Section 3 Start-Up and Normal Operation Mode for further details.

The control point for the raw water pumps is overridden based on the destination of the pumped water. Specifically, the override is selected depending on whether water is being directed to the clarifier or if either the clarifier or the media filters are being bypassed.

In the event of a quick shutdown, the raw water pumps are paused first, and then the transfer tank is emptied to prevent freezing issues.

2.4. WTP INLET, ACTIFLO® CLARIFIER, AND INLINE TRANSFER SYSTEM

Raw water from Well Pump #1 or #2 is pumped to the inlet of the single Veolia ACP2-15 Actiflo® Clarifier (TAG#: TL-20-01 Veolia supplied). The following components are present upstream of the Actiflo® Clarifier:

- Raw water flow (TAG#: FIT-B0105), pressure (TAG#: PT-B0106), and turbidity (TAG#: AIT-B0116) are measured at the entrance to the WTP. Raw water flow metering is imperative to the dosing of coagulant and polymer, and trending extraction volumes from the water source for regulatory reporting. In accordance with the Actiflo Functional Description, a high-high and low-low flow alarm shall cause the Actiflo system to stop running, according to the automatic shutdown sequence. **FIT-B0105 shall serve as the primary reference for flow control within the WTP, and all associated control loops shall operate in coordination with the flow rate measured at FIT-B0105. If no flow is detected at FIT-B0105 after an operator adjustable time delay, the WTP shall shutdown.**
- Existing pH, temperature, and conductivity sensors (TAG#: AT-B0117; TT-B0018 and AT-B0119 respectively) extracted from an existing MTU unit will also be used for raw water monitoring.

- Pressure measurement is generally for information only, but there will be a high-pressure system override in case of blockage or incorrectly set valve positions downstream. A pressure relief valve is also installed at the WTP inlet.
- Raw turbidity is required to provide requirements for clarifier bypass, and/or chemical dosing requirements. Default set points are provided below.
    - 0 – 1.5 NTU Clarifier Bypass – with bypass initiated by the WTP Master PLC.
    - 1.5 – 5 NTU Clarifier Activation in “Low Turbidity Mode” – this range is relevant to the Veolia turbidity matrix and selected chemical dose for coagulant, per the Actiflo ACP Functional Description.
    - 5 – 20 NTU Clarifier Activation in “Moderate Turbidity Mode” – this range relevant to the Veolia turbidity matrix and selected chemical dose for coagulant, per the Actiflo ACP Functional Description.
    - >20 NTU Clarifier Activation in “High Turbidity Mode” – this range is relevant to the Veolia turbidity matrix and selected chemical dose for coagulant, per the Actiflo ACP Functional Description.
- During Clarifier Bypass Mode, the Clarifier Inlet Valve (TAG#: 150-BU-B0120) must close, and must remain closed. The Clarifier Bypass Valve (TAG#: 150-BU-B0123) will open. This valve typically feeds water to the Inline Transfer Tank (TAG#: T-D0204), which is the default operation. However, the operator may choose to operate the Clarifier and Inline Transfer Pump Bypass valve (TAG#: 150-BU-B0122) through the HMI instead, should the Inline Transfer Tank and/or the Inline Transfer Pumps be offline for maintenance.
- Raw water turbidity is measured to determine automatically if the WTP will be operated in “Normal Operation Mode” or “Clarifier Bypass Mode.”
    - Coagulant can be added regardless of Mode to aid the filtration process. Note however, if the clarifier bypass valve (TAG#: 150-BU-B0123 or 150-BU-B0122) AND the media filter bypass valve (TAG#: 75-BU-E0304) are both in the OPEN position and the filter inlet valve (150-BU-E0303) is CLOSED, the PLC must automatically switch off coagulant dosing. This is to ensure coagulated water does not clog up the cartridge filters.
    - Clarifier Bypass Mode is an automated selection based on the raw water turbidity, or by manual selection on the HMI by the operator.
    - If the Clarifier is planned to be bypassed for a long time (exceeding 30 days), refer to the procedure “Actiflo Restart after Long-Term Storage Procedure” under the Actiflo® Package Plant (MKIII) Installation, Operation and Maintenance Manual (Veolia, 2024).
    - Should poor filtered water OR treated water turbidity be observed (TAG#: AIT-E0318; AIT-K0720) consecutively for a pre-determined duration, the WTP will no longer operate in “Clarifier Bypass Mode” and return to “Normal Operation Mode”. The turbidity set point for this operation shall be operator adjustable and is to be optimized following

commissioning, however the default setting shall be >5 NTU for 15 minutes to return to "Normal Operation Mode".

- Coagulant is dosed upstream of the Actiflo® Clarifier, followed by an in-line static mixing (TAG#: MX-B0115). Refer to Section 2.10 for further details on the Coagulant Dosing System.
- Polymer is dosed to the Rapid Mix Tank housed within the Actiflo® Clarifier. Refer to further commentary below on the Rapid Mix Tank and Section 2.10.2 for further details on the Polymer Dosing System.

One Veolia ACP2-15 Actiflo® Ballasted Flocculation Clarifier is installed. This process is a high-speed clarification process that combines ballasted flocculation and lamellar clarification. This process includes several treatment stages all-in-one, including coagulation, flocculation and maturation, with additional integrated technologies such as:

- The injection of Microsand, which supports the ballasted flocs and works as weight to create dense flocs, thus creating a high rate of settling.
- Lamellar settling, which increases the settling surface in a reduced tank volume by using a set of inclined parallel plates.

The Actiflo® Package Plant (MKIII) Installation, Operation and Maintenance Manual (Veolia, 2024) describes how raw water goes through the four (4) successive steps that are part of the Actiflo® treatment process. In summary, these steps (see schematic below) include:

- **Coagulation Tank**: Coagulant-dosed water enters the coagulation tank with a mechanical mixer for further rapid mixing.
- **Flocculation Tank**: Coagulant-dosed water enters the flocculation tank where Microsand and polymer are added simultaneously to foster contact between the solids, polymer and Microsand. This aids in the formation of "ballasted flocs." The tank is equipped with a mechanical mixer.
- **Settling Tank**: Flocs precipitate by the aid of lamella tubes, and the clarified water is collected at the surface using troughs. The settling tank has a circular scraper to direct settled "ballasted floc" to the center of the hopper. Sludge is drawn out of the hopper by a dedicated pump and is directed toward a hydrocyclone. The hydrocyclone is located above the flocculation tank. It separates the Microsand from the sludge floc. The Microsand is recirculated into the system via the underflow of the hydrocyclone while the sludge is evacuated through the overflow to waste. Wastewater handling is described in Section 2.11.

Note that according to the Veolia functional description, approximately 1.0 – 2.4% of water from the clarifier will be wasted.

Refer to the Actiflo – ACP Functional Description (Veolia, 2025) and AERShaft Lamella Cleaning System Functional Description (Veolia, 2025) for further process control information.

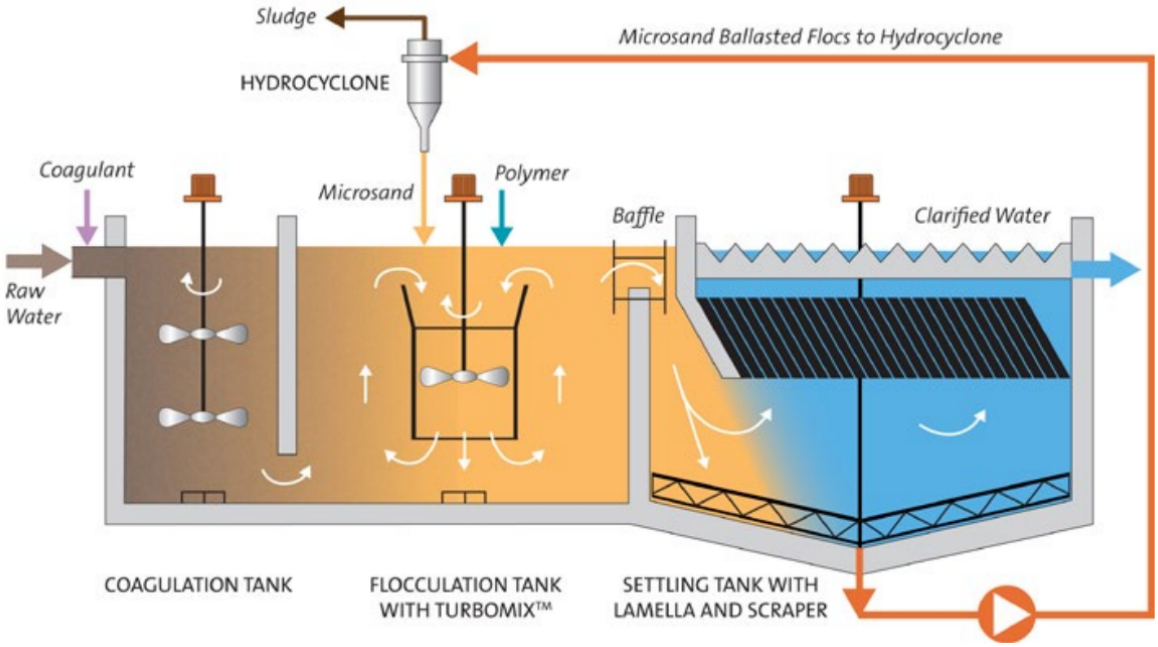


Figure ACTIFLO® Microsand Ballasted Clarification Process (Veolia Water Technologies Communications, 2016).

Downstream of the Actiflo® Clarifier:

- Clarified water turbidity is measured by a turbidity meter (TAG#: AIT-20-01 Veolia supplied). A high-turbidity alarm will alert the operator of poor clarifier performance, and a high-high clarified water turbidity will divert the clarified water to waste (via TAG#: 150-BU-D0201 in OPEN and 150-BU-D0202 in CLOSED position) or shut-down the Actiflo® Clarifier after a time delay. The turbidity alarm setpoints shall be operator adjustable.
- Clarified water will be received at the Inline Transfer Tank (TAG#: T-D0204). The tank will be equipped with a level transmitter (TAG#: LT-D0205) complete with high- and low-level alarming. This tank will supply water to the Inline Transfer Pumps.
- Clarified water flow rate will be calculated by the PLC as the difference between the raw water flowmeter and the clarifier's hydrocyclone waste flow meter (TAG#: FIT-B0105 and FIT-E0301).
- Two parallel Inline Transfer Pumps with one duty and one standby (TAG#: P-D1000 and P-D2000), complete with isolation valves, deliver water from the Transfer tank to the Media Filters. The pumps will be exercised automatically on an alternating basis based on run hours to ensure similar life cycles of each and be equipped with VFDs for soft starting and speed control. The default pressure setting for the inlet to the Media Filters is 40 psi to ensure the process water will make it to the end of the plant after the media filtration step.
- High level in the Transfer Tank will start the Inline Transfer Pumps, low level in the tank will stop the Inline Transfer Pumps for pump protection, and high-high level in the tank indicates an overflow condition and will stop the WTP. As noted in Section 2.9, a high-high alarm at the Contact Tank will stop the WTP, signalling an overflow condition, and will also remove the run permissive for the Inline Transfer Pumps.

- The Inline Transfer Pumps are designed with a minimum operational flow rate of 7 L/s, as specified by the pump supplier.
- In the event of a quick shutdown, the raw water pumps are paused first, and then the transfer tank is emptied to prevent freezing issues. The transfer tank is emptied (ie, to the inline transfer pump stop level) regardless of the destination of the pumped water from the raw water pumps.
- If the clarifier is in “Clarifier Bypass Mode”, and the operator chooses to bypass the Inline Transfer Pumps (by operating valve TAG#: 150-BU-B0122 instead of 150-BU-B0123), the Inline Transfer Pumps must shut down and the downstream isolation valve (TAG#: 150-BU-D0206) must also close.

The clarifier also comes equipped with a blower package. Refer to Veolia documentation for further details on blower operation.

2.5. MEDIA FILTRATION

The existing filtration system consists of four media filter vessels (TAG#: F-E1000; F-E2000; F-E3000; F-E4000). Based on a maximum filtration rate of 14 gpm/ft^2 with Nextsand media, three vessels in service satisfy the plant's design capacity of 2000 m^3/day with one filter removed from service, or in a backwash cycle, providing redundancy. Based on a maximum filtration rate of 7 gpm/ft^2 with a multi-media sand and anthracite filter, four vessels in service satisfy the plant’s design capacity of 2000 m^3/day. Should the Nextsand media be replaced with sand and anthracite in future, the PLC programming shall allow for reduction in WTP flow rate during a backwash sequence, to ensure the maximum design filtration rate for the duty filters is not exceeded.

The media filtration system offers a supplementary barrier for removing suspended solids before subsequent disinfection processes. It is imperative that during a clarifier bypass scenario where good raw water quality is observed, or during an emergency if the clarifier is inoperable, the dual filtration system (media and cartridges) must be prepared to handle the raw water filtration process. The clarifier bypass has therefore been placed post-coagulant dosing, to allow coagulant-dosed water to enter the media filters for a direct filtration process with the aid of a coagulant, if necessary and at the option of the operator.

Pre-media filtration turbidity (TAG#: AIT-E0302) is measured and used to detect turbidity spikes arising from the Inline Transfer Tank, indicating potential sedimentation in the tank.

Each media filter is equipped with an inlet and outlet valve (TAG#: 75-BU-E1001; 75-BU-1002 etc. respectively, typical to all media filters), a backwash supply valve (TAG#: 100-BU-E1003, typical to all filters), a backwash waste valve (TAG#: 75-BU-E1004, typical to all filters), and a filter-to-waste valve (TAG#: 75-BU-E1005, typical to all filters).

The filters are equipped with an existing pressure differential system (TAG#: PT-E0308, PT-E0322 and PT-E0314) on the inlet and outlet headers for the filters. In addition, existing local pressure gauges are available on each individual filter inlet, outlet, and clean backwash inlet connections. The existing process of initiating a backwash for all filters should the differential pressure between PT-E0308/22 and PIT-

E0314 exceed a certain setpoint, and the process of initiating a manual backwash based on local pressure gauge readings, will be retained and the programming will not be modified. Default differential pressure to activate a backwash is 7 psi. The current backwash rate is approximately 15.5 – 16 L/s. Water from the distribution system is used for filter backwashing and no filters are in forward production mode during backwashing.

A backwash function based on filter run time is also programmed into the existing system, and a backwash cycle will be initiated after 72 hours of run-time (the default time) regardless of pressure differential measurement and deferred to 1PM as preferred by operations.

When a backwash sequence is initiated, filters are first backwashed individually, then a filter-to-waste/rinse sequence is completed with all filters rinsed simultaneously.

Filters are not currently backwashed on high turbidity, and as preferred by operations, this will remain in place.

After the water passes through the Media Filtration System, turbidity (TAG#: AIT-E0318 common to all filters) is measured for trend analysis and diagnosis of system efficacy.

- If the high turbidity set point is reached (for example, above 0.75 NTU, but is operator adjustable), a high turbidity alert will be issued to the operator.
- If the high-high turbidity set point is reached (for example, above 0.9 NTU, but is operator adjustable), a high-high turbidity alert will be issued to the operator. If poor performance continues for a pre-set amount of time, the influent and effluent valves will close, the WTP will shutdown and a second alert will be sent to the operator noting poor process performance.

Filter backwash water supply will be provided under distribution pressure. A manual backwash flow control valve with a pre-set position achieves the desired backwash flow. Backwash water will be discharged to the river as the default mode of operation, with an optional overflow to sanitary sewer that can be manually activated by the operator through the HMI and actuated valving. Refer to Section 2.11 on wastewater handling.

The Media Filtration system can be manually by-passed in an adverse operational scenario, supplying water straight to the cartridge filters. This is done by opening the Media Filter Bypass Valve (TAG#: 100-BU-E0304) and closing Filter Inlet Valve (150-BU-E0303). If the clarifier bypass valve (TAG#: 150-BU-B0122) AND the media filter bypass valve (TAG#: 100-BU-E0304) are in the OPEN position, coagulant dosing must be switched off.

2.6. CARTRIDGE FILTRATION

This process has no active control, and the below description is for monitoring purposes only.

The existing cartridge filters are Fil-Trek (S4GL-20-40) type, rated for 50 L/s each. This system aids in the removal of solids from the post-media filter water stream and protects the UV reactors from fouling by materials that may flow past the media filters during normal operations, especially directly after

backwashing cycles. Cartridge filtration is typically not being used as an additional barrier for log removal credits, per the Guidelines for Pathogen Log Reduction Credit Assignment (Ministry of Health, 2022) but could be considered if 1-micron absolute cartridges are installed.

The cartridge filters are operated in series, with 40 - 3 micron cartridge in the first assembly (TAG#: F-E0400), and 40 – 1 micron cartridges in the second assembly (TAG#: F-E0401). The cartridge filters are equipped with manual isolation valves, a pressure transmitter on the first cartridge filter's inlet (TAG#: PT-E0403), the outlet of the first cartridge filter (TAG#: PT-E0405), and the second cartridge filter outlet (TAG #: PT-E0406). The filter cartridges are replaced when the pressure differential across the assembly reaches 18 psi.

There will also be a manual bypass around the cartridge filters available to enable cartridge change outs without shutting down the WTP. The operations staff note that the cartridge in F-E0400 is currently changed out weekly, and the cartridge in F-E0401 is changed out monthly.

If both the clarifier and media filters are being bypassed, the second cartridge filter housing must be equipped with 1-micron absolute cartridges (replacing the 5-micron nominal cartridges) to comply with the BC Guidelines for Pathogen Log Reduction Credit Assignment (Ministry of Health, 2022).

2.7. UV DISINFECTION

This system includes two parallel UV disinfection reactors (Trojan SwiftSC D03) (TAG#: UV-H1000 and UV-H2000) complete with automated valves. The UVs can be operated in duty/standby configuration, and the duty UV is cycled automatically following a WTP shutdown, per current operations. Cartridge filters are currently being swapped out by operations about once a week, therefore this is likely longest duration a single UV reactor will be in the "duty" position.

The existing UV system will function as per current operations, refer to supplier manual. The functional description should be designed such that the UV reactors enter Standby Mode if 0 L/s flow is detected through the WTP for 89 minutes (according to the supplier) and allow the UV reactors to shutdown after a time delay in alignment with supplier recommendations.

2.8. CHLORINE DISINFECTION AND CONTACT TANK

Chlorine disinfection is accomplished via two existing dosing pumps (TAG#: P-C9309; P-C9310), operated in one duty + one standby configuration. This chemical dosing system uses 12% sodium hypochlorite from a common supplier. Dosage is flow paced based on the "Filtered Water Meter" (TAG#: FT-H0608) located downstream of the filters. Dosage rates are set on the HMI and are dependent on the actual raw sodium hypochlorite concentration and desired chlorine residual. The default minimum chlorine residual is 1.0 mg/L when operating below or equal to 14.5 L/s, or minimum 1.5 mg/L when operating at the maximum plant capacity of 24 L/s. Thus, chlorine dose (in mg/L) must be scaled accordingly to suit. The minimum chlorine residual required at other flow rates is based on the table below.

WTP Flow Rate (in L/s)	Minimum Chlorine Residual (in mg/L) to Achieve CT of 12 mg-min/L	Calculated CT Value (in mg-min/L) Based on Low Contact Tank Level, At Low Level Switch Alarm
14.5 and less	1.0	13.4
14.6 – 17	1.1	12.6 – 14.6
18 - 19	1.2	12.3 – 12.9
20	1.3	12.6
21 - 22	1.4	12.3 – 12.9
23 – 24 (Max Flow)	1.5	12.1 – 12.7

No automation of chlorine dose selection (ie, residual-trim) is present currently, but it is intended to upgrade the controls with residual-trim dosing, such that the chlorine addition is automated based on WTP flow and residual chlorine measurements downstream of the contact tank within this WTP upgrade. Chlorine residual measuring upstream of the Contact Tank (TAG#: AIT-H0508) verifies the dose and can be used to calculate chlorine demand at the contact tank.

Chlorinated water will have contact time and be stored in the plant's Chlorine Contact Tank (TAG#: T-J0600) before it is pumped to the distribution system. Free chlorine residual to the distribution system is currently measured downstream of the distribution pumps (TAG#: AIT-K0719), and manual measurements are also taken to ensure proper residuals throughout the distribution system.

The Contact Tank will be equipped with two level transmitters, a hydrostatic pressure transmitter (the main one), and a radar level transmitter (back-up). Information regarding distribution pump control and tank levels is provided in the next section.

2.9. DISTRIBUTION PUMPING AND RESERVOIR

The two distribution supply pumps (one duty + one standby) (TAG#: P-K1000; P-K2000) are installed, each capable of pumping up to 24 L/s. High level in the Contact Tank (TAG#: T-J0600) will signal the duty Distribution Pump to start. Low level in the Contact Tank will signal the duty Distribution Pump to stop for pump protection and to maintain minimum chlorine contact time. A high-high alarm at the Contact Tank will shutdown the WTP, signalling an overflow condition.

The pumps will be exercised automatically on an alternating basis based on run hours to ensure similar life cycles of each or selected manually by the operator as the duty pump. The pumps will operate on VFDs for soft starting and speed control. **Balancing of flow rate through the WTP will drive the pump speed control,** however if there is an issue within the plant, such as loss of signal from the flowmeter, the distribution pumps will look to maintain Contact Tank level as a backup.

The Distribution Pumps are designed with a minimum operational flow rate of 7 L/s, as specified by the pump supplier.

Simultaneous operation of both distribution pumps shall be an operator override, and the same VFD speed shall be applied to both pumps in this scenario.

Flow, turbidity, pressure and free chlorine residual will be measured downstream of the distribution pumps (TAG#: FT-K0710, AIT-K0720, PT-K0715 and AIT-K0719 respectively). Should the treated water turbidity exceed 1 NTU for more than 5 minutes, the emergency water-to-waste valve (TAG#: 150-BU-K0725) shall open to prevent off-spec water reaching the distribution system. After a default period of a further of 5 mins (operator adjustable value), if the treated water turbidity has not improved, the treatment system will be shut down and an alarm raised for the operator to investigate poor process performance.

If no flow is detected at FT-K0710 after an operator adjustable time delay, the WTP shall shutdown.

2.10. CHEMICAL DOSING SYSTEMS

2.10.1. Coagulant Dosing System

Coagulant will be stored in a small polyethylene tank (with chemical transferred from drum) and dosed into the raw water via dosing pumps (TAG#: PV51-01, PV51-02 Veolia supplied), operated in a 1 duty + 1 standby arrangement. Coagulant dose rate (mL/min) will be flow paced to the raw water flow meter (TAG#: FIT-B0105), with the dose set point (mg/L) adjusted either automatically or manually by the operator based on the raw water turbidity reading (TAG#: AIT-B0116). Operator override on dosing will occur at the Veolia HMI. Refer to the Coagulant Dosing Skid Process Control Description (Veolia, 2025) for further information on coagulant dosing process control.

2.10.2. Polymer Dosing System

Operation and control of the polymer dosing system is described in the Hydra-Pol MC Compact HP500C / HP1000C Polymer Preparation System Installation, Operation and Maintenance Manual (Veolia, 2025). Polymer dosing will be flow paced to the raw water flow meter (TAG#: FIT-B0105), with the dose set point (mg/L) operator adjustable. Operator override on dosing will occur at the Veolia HMI.

Refer to the HydraPOL™ Compact Functional Description (Veolia, 2025) and the Polymer Dosing Skid Process Control Description (Veolia, 2025) for further information on polymer preparation and dosing process control.

2.10.3. Sodium Hypochlorite Dosing System

Detailed under Section 2.8.

2.10.4. Dechlorination Chemical Dosing System

Sodium ascorbate or other preferred chemical will be used to dechlorinate the media filter backwash waste and the off-spec treated water diversion, should it be directed to the river. The dechlorinating chemical arrives to site as a solid product and will be batched by hand in a small day tank by operations staff as required. The site's existing RO antiscalant dosing panel and dosing tank will be repurposed for use for dechlorination chemical dosing. The chemical will be dosed via the existing available dosing

pumps (TAG#: P-C9504; P-C9505), operated in a 1 duty + 1 standby arrangement. Chemical dose rate (mL/min) will be flow paced to the waste stream (either backwash flow rate set point, or WTP flow set point if off-spec treated diversion enabled). The dose set point (mg/L) will be set during commissioning and can be adjusted on the HMI if required. The dose set point should consider worst case chlorine residual.

2.11. WASTEWATER HANDLING

The following wastewaters are generated from the water treatment plant. Some waste streams can be sent to the District's sanitary sewer system for processing, and some waste streams can be diverted to the raw water reservoir downstream of the intakes. All unchlorinated water should default to the river where possible. Filter backwash waste shall default to the river, per current operations. Clarifier waste (except Microsand) shall default to the river, with a 2-hour maximum wasting duration before plant shutdown (with time override by operator). Microsand waste shall default to the sewer system. Chlorinated off-spec water shall default to sewer, up to 5 minutes maximum before plant shutdown. Refer to the P&IDs for further information regarding for wastewater handling connections:

- Hydrocyclone waste from the Actiflo® Clarifier - sent to river or sewer via Air Gap Tank 1 (TAG#: T-G0906) and associated automatic valves (TAG#: 150-BU-G0905; 150-BU-G0904). The WTP programmer must synchronize the timing of the hydrocyclone waste valves to ensure proper coordination with the Veolia Actiflo Clarifier control system.
- Manual drain valves on the Actiflo® Clarifier - sent to river only.
- Dirty backwash water and filter-to waste from the Media Filters - sent to river by default (via valve TAG#: 200-BU-G0900) or to sewer via Air Gap Tank 2 (TAG#: T-G0907). The operator will manually select which valve will be open on the HMI.
- Off-spec clarified water - sent to river or sewer via Air Gap Tank 1 (TAG#: T-G0906) and associated automatic valves (TAG#: 150-BU-G0905; 150-BU-G0904).
- Emergency treated water-to-waste, to discharge off-spec water prior to distribution. Sent to Air Gap Tank 2 (TAG#: T-G0907), and then to sewer.
- Contact tank overflow – sent to Air Gap Tank 2 (TAG#: T-G0907), and then to sewer.
- Raw water pressure relief valve drain – sent to river only.
- Well start-up waste – sent to river only.

Typically, waste to river valve (TAG#: 150-BU-G0904) on Air Gap Tank 1 will be used and remain open unless the process calls for hydrocyclone wasting. At this time, waste to sewer valve (TAG#: 150-BU-G0905) on Air Gap Tank 1 will open and waste to river valve (TAG#: 150-BU-G0904) will close automatically. Once the sequence has finished, the waste valve positions will return to their previous settings.

3. START-UP AND NORMAL OPERATION MODE

The intention of Normal Operation Mode is for the plant to run continuously. When the potable water storage reservoir is nearly at capacity, the plant slows production. When it drops to a set level, the plant increases production in order to reduce plant shutdown frequency. Rapid changes in flow rates must be avoided to avoid process upset.

The operator must ensure all processes are full of water prior to starting in normal operation mode.

A 900MHz radio communication is available with the District's existing reservoir. The radio signal provides information to the WTP on reservoir level using a submersible pressure level transmitter calling for water. When the "Call for Water" level is reached, a signal is relayed to the WTP Master PLC to start up the WTP, so long as no major equipment fault alarms are reported to the PLC.

The following sequence of Plant Start-Up is then initiated:

1. The duty UV Reactor (TAG#: UV-H1000 OR UV-H2000) will be placed into a 3-minute Warm-up mode until the UV intensity has stabilized. The start-up of the UV system can be initiated in advance of other processes, as the UV reactor does not require water to flow through it during the warm-up sequencing, but must be full of water. Per vendor information, the reactor can remain online for 89 minutes with no flow before overheating. During the first 18 seconds of the warm-up mode, most alarms are suspended except for UV Reactor high temperature. Water does not need to be sent to waste during UV reactor warm-up. The duty UV reactor shall provide a signal that it is ready to operate.
2. The raw water pumps (TAG#: P-A1000; P-A2000) are started and begin to pump water to the treatment building in one of the below modes. **Feedback from the reading on the WTP inlet flowmeter (TAG#: FIT-B0105), in comparison to the WTP flow set point, will control the raw water pump VFD speed.** The PLC will ensure the pressure coming into the plant (TAG#: PIT-B0106) is within the acceptable range. If high pressure is detected, potentially due to the clarifier inlet valve faulting, it will shut off the raw water pumps.
    a. "Low Reservoir Volume" Mode is activated at the first reservoir set-point (default setting is 93% at the reservoir). Default WTP Low Volume Mode flow rate in the winter is 8 L/s, and 14.5L/s in the summer of **net water production**, assuming 1.0 – 2.4% of water from the clarifier will be wasted (to be confirmed by hydrocyclone waste flow meter reading).
    b. "High Reservoir Volume" mode is activated when the reservoir reaches 99%, the flow rate slows to 7L/s in the winter and 11L/s in the summer of **net water production**, assuming 1.0 – 2.4% of water from the clarifier will be wasted (to be confirmed by hydrocyclone waste flow meter reading). Intention is to keep the WTP in service and operating at steady state for as long as possible, without frequent start/stops.
3. The pre-treatment chemical dosing systems will start up (coagulant and polymer) upon detection of flow at the WTP inlet flowmeter (TAG#: FIT-B0105). The start-up of the Veolia Actiflo Clarifier (TAG#: TL20-01 Veolia supplied) is initiated to treat water at one of the two volume modes. Water from the clarifier will be wasted for 5 mins (default, operator adjustable value) through the clarified water waste valve (TAG#: 150-BU-D0201) to allow the process time to stabilize before the step below.

4. Clarified water is then directed to the Transfer Tank (TAG#: T-D0204). Clarified water is sent to waste if turbidity out of the clarifier exceeds 5 NTU (as the default setting, to be adjusted following commissioning) as measured by the clarified turbidity meter (TAG#: AIT-20-01 Veolia supplied). Once the Transfer Tank (TAG#: T-D0204) reaches a high enough level, one of the Inline Transfer Pumps (TAG#: P-D1000; P-D2000), is activated to supply water to the filtration system. **Feedback from the media filter inlet flowmeter (TAG#: FIT-E0300), and the difference between raw water flow meter FIT-B0105 and the clarifier waste flow meter FIT-E0301 (ie, FIT-B0105 minus FIT-E0301), will control the Inline Transfer Pump VFD speed to balance the flow through the WTP.** If no flow is detected at FIT-E0300 after an operator adjustable time delay, the WTP shall shutdown.
5. Once the Inline Transfer Pump is in service, the online Media Filters (TAG#: F-E1000, typical) will enter a brief filter-to-waste mode first to prevent turbidity breakthrough to distribution upon startup. This will proceed for 5 minutes (default, operator adjustable setting). Once this is complete, the filters will go into normal operation mode and operate per the description provided in Section 2.5.
6. Once water in the Chlorine Contact Tank (TAG#: T-J0600) reaches 95%, the duty Distribution Pump (TAG#: P-K1000 or P-K2000) is activated to start filling the reservoir. The pumps draw water from the chlorine contact tank. **Feedback from the distribution water flowmeter (TAG#: FIT-E0300), and the difference between raw water flow meter FIT-B0105 and the clarifier waste flow meter FIT-E0301 (ie, FIT-B0105 minus FIT-E0301), will control the Distribution Pump VFD speed to balance the flow through the WTP**. A 60-second (default, operator adjustable setpoint, can be 0) off-spec diversion of treated water to waste will initiate before pumping to treated water reservoir.

A local Operator must review the status of the Actiflo® Clarifier, Media Filters, and other system components to confirm that the process equipment is in a safe state to operate. Prior to startup, it is assumed that the WTP components have sufficient liquid level capacity available. Several permissives must be met before the Actiflo® Clarifier can start up. Refer to the Actiflo® Package Plant (MKIII) Installation, Operation and Maintenance Manual (Veolia, 2024) for more details. Before executing a start up sequence, ensure all HOAs and controllers are in auto mode.

At the treatment plant, via the SCADApack HMI or via SCADA the operator can define the low-level setpoint for the reservoir level which will “Call for Water” (on & off setpoints). The operator can also define the flow set points at the Low and High-Volume Modes.

A general fault alarm will signal if the SCADApack system encounters problems (i.e. loss of communication with the radio, fault from the submersible pressure transmitter, etc.) Note that the WTP will not be shut down if there is a loss of communication with the reservoir level transmitter radio signal and will continue to operate at the latest operating settings. The District has confirmed that the existing reservoir has an overflow.

Once the process has stabilized with a delay time of XX minutes (where XX is operator adjustable and to be set during commissioning), the PLC will use the signal from the raw water turbidity meter (TAG#: AIT-B0116) to calculate the coagulant dose, and the PLC will adjust coagulant dose rate accordingly. This can be activated by the operator via a dosage matrix, with the operator entering the matrix values on the HMI.

After one hour of operation, the raw water turbidity meter (TAG#: AIT-B0116) will confirm if the WTP will continue to operate in “Normal Operation Mode” or change to “Clarifier Bypass Mode”.

When the reservoir level reaches the high-high level setpoint, the “Call for Water” command will be removed. This will result in each of the systems noted above shutting down, with the raw water pumps shut off first. Note that the high-high reservoir set point must be set such that it can handle additional water volume produced until the distribution pumps switch off. The plant will remain in operation until the Chlorine Contact Tank (TK-7000) reaches the low-level set point.

Solenoid valves associated with water quality analyzers throughout the WTP shall be programmed to link directly to flow detection signals through the plant. For example, the solenoids shall close upon detection of no flow through the plant—either due to plant shutdown or process interruption. This action isolates the analyzers from the process stream, prevents erroneous water quality readings and unnecessary drainage of the water piping. Conversely, when process flow is detected within the WTP, as measured by the nearest flow meter, the solenoid valves will open. This allows water to be directed to the analyzers, ensuring that measurements are taken from actively flowing water and accurately reflects current plant conditions.

4. EMERGENCY PLANT SHUTDOWN

An emergency plant shutdown is initiated automatically or manually in response to critical alarms or unsafe operating conditions that may pose a risk to equipment, personnel, or public health. Triggers for an emergency shutdown may include low suction level at the intake, low chlorine residuals, loss of power, or control system failure. Equipment is stopped in a sequenced but expedited manner to prevent pressure surges or water hammer, while ensuring no untreated water passes downstream.

Emergency stop procedures shall follow current plant shutdown procedures. Initiation of the E-stop / panic button will stop all processes, with the raw water pumps and transfer pumps stopping at the same time. This would be followed by the distribution pumps and UV system shutting down next. All key process units are isolated by closing motorized valves. Manual intervention may be required to verify field conditions and reset the system after the issue has been resolved. The plant remains in a safe, isolated state until an operator confirms that all conditions have returned to normal and restarts the process using the designated start-up procedure. Emergency shutdown logic is programmed to override all other modes of operation, including manual control, to ensure safety is prioritized.

5. MANUAL OPERATION

Manual operation mode allows operators to directly control individual process components—such as pumps, valves, and chemical dosing equipment—outside of the automated control sequences programmed in the PLC. Manual control can be accessed through the local control panels, depending on the component designs. When in manual mode, the system bypasses automatic setpoints, timers, and interlocks, granting the operator full responsibility for safe operation. To prevent unintended consequences, manual mode activation is restricted to authorized personnel. Key interlocks, such as pump shutdown on low water level, remain enforced even in manual mode for safety. The operators will have to maintain constant flow across the plant to ensure intermediate tanks are full of water.

6. FUNCTIONAL PROGRAMMING

The description provided in this document is intended to assist the programmer and the functional design intent of the facility. As with any facility, the programmer should work closely with the designer to run through the functional design at programming kickoff, during programming along with formal testing in the form of either:

- Office based client acceptance test using a bench PLC, HMI, VFD and such, prior to field commissioning to cut down on field work; or,
- Field based testing with the Owner accepting additional hours to days of testing at the time of commissioning.

At a minimum, the programmer and Owner should expect:

- Testing of all devices prior to scheduling commissioning
- Loop testing of all devices prior to dry testing
- Dry testing of programming, interlocks, and alarms with a narrative along with punch list provided by the programmer.
- Wet testing upon successful completion of dry testing

At any point during commissioning, the programmer must be available on site to adjust programming if changes are required by the designer, or the Owner. Upon completion of commissioning, the programmer shall be available to train operators.

Pop-up windows on the HMI shall be included in the programming, requiring the operator to confirm their selection prior to making any changes to programming variables that are not explicitly contained within this document.

All Emergency Stop buttons, and other devices should have latch functionality, and must be in their “ready” state to enable the function of the equipment.

The control system for the building HVAC will operate independently to the narrative described here. Alarms raised from the HVAC system shall be communicated to the WTP Master PLC and display on the HMI.

The control system shall be configured with multiple security levels to manage access to data and control over PLC programming, in accordance with the operational needs of the WTP. These levels are defined in alignment with Veolia documentation and are as follows:

- Default: Users can view all system pages but cannot perform any actions.
- Operator: Users can start and stop equipment and modify operating instructions.
- Maintenance: Users can edit instrument calibrations.
- Admin: Users have access to password management and full administrative controls.

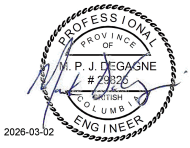
Each security level provides access to all functions of the levels below it.

7. CLOSING

Prepared by:

Christina Saxvik., P.Eng
Water Process Engineer
CSaxvik@mcelhanney.com
778 247 0668

Reviewed by:



Mark DeGagne, P.Eng
Process Engineer of Record
mdegagne@mcelhanney.com
778 560 2001

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McElhanney Ltd.

PERMIT NUMBER: 1003299
Engineers and Geoscientists of BC

APPENDICES

APPENDIX A

Statement of Limitations

Statement of Limitations

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APPENDIX B

Block Flow Diagram

Contact

Mark DeGagne, P.Eng.

+17785602001

mdegagne@mcelhanney.com

McElhanney

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