MUNICIPALITY OF EAST HANTS

Regional Wastewater Treatment Plant - Optimization Study

Final Report

April 2022 – 21-1665

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Attention: Derek Normanton, P.Eng.
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Regional Wastewater Treatment Plant
Optimization Report

Dillon Consulting Limited (Dillon) is pleased to submit our Final Optimization Report for the Regional Wastewater Treatment Plant located in Lantz. This report provides options analysis and recommendations for equipment upgrades for the optimization of the existing facility in order to serve the rapidly growing population of the communities of Enfield, Elmsdale and Lantz. The report also provides suggestions for next steps prior to implementing proposed upgrades including sludge analysis, sampling and flow monitoring to confirm detailed design parameters.

We look forward to your review of the draft report. Please contact the undersigned if you have any questions.

Sincerely,

DILLON CONSULTING LIMITED

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Our file: 21-1665

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Executive Summary

Dillon has been retained by the Municipality of East Hants (Municipality) to assess potential short term options to restore the rated capacity of the existing Regional Wastewater Treatment Plant (RWWTP) and long term solutions to upgrade the plant for future population growth. After reviewing the projected population growth provided by East Hants and further discussion with the Municipality, it was determined that, due to the significant projected population increase, a short term solution would not be beneficial because the plant already operates near its rated capacity. The study has since focused on the long term solutions for target years 2031 and 2050. We have also evaluated an option to provide additional treatment capacity for the immediate future with a target year of 2026.

The Lantz WWTP was constructed in 1990 and consists of a three cell aerated lagoon system; the facility is considered “medium sized” according to the Canadian Council of Ministers of Environment (CCME). Most of the equipment is nearing or is past the end of its normal service life, and will need to be updated in the immediate future, as noted in the WSP facility assessment report from 2015.

The reported population currently serviced by the plant is 7,375 with a measured average annual daily flow of 4,465 m^3/day. Based on future population projections an ultimate design flow of 10,842m^3/day for a population of 20,879 was determined for the year 2050. Using this design flow, new effluent limits and objectives were determined for the future upgrade in accordance with the Federal CCME guidelines.

To provide treatment that meets the effluent quality, eight upgrade options were evaluated to determine which option would be the most suitable for the Municipality:

- Three lagoon system upgrade alternatives; and
- Five alternatives to construct a new mechanical plant.

Based on this evaluation, implementation of an Intermittently Decanted Extended Aeration Lagoon system, followed by a tertiary filtration using disc filters and disinfection by UV is recommended. This system has the lowest estimated capital ($16.1M) and life cycle costs ($22.1M), has a similar level of operational complexity and a similar footprint to the existing as the current system, the lowest operation and maintenance costs and has the least amount of added equipment compared to other options.

It is recommended that the Municipality implement additional influent sampling and flow monitoring prior to final design of the proposed upgrades to confirm design parameters such as hydraulic and contaminant loading rates and their seasonal variation. Population growth projections should also be reassessed prior to proceeding into the final design as well.

1.0 Introduction

The Lantz Wastewater Treatment Plant (WWTP) also known as the Regional Wastewater Treatment Plant is located at 35 Palley Road, Lantz and serves the communities of Enfield, Elmsdale and Lantz. The facility consists of a three cell aerated lagoon system with chlorination and de-chlorination before discharging into the Shubenacadie River.

Dillon has been retained by the Municipality to assess the short term upgrade options (restoring the exiting plant rated capacity) and long term upgrade options of the WWTP in order to provide the required treatment capacity. This report focuses only on the long term solutions for optimization as it was determined that the short term population projections exceed the capacity that would be provided by a short term solution and therefore the cost incurred for restoring the existing plant rated capacity would not be beneficial. Detailed description of the estimated future flows and evaluation of the capacity of the existing system are provided in the Sections below.

The long term solutions will include upgrading the existing lagoons or constructing a new mechanical WWTP to replace the lagoons.

Figure 1-1 below shows the existing site plan as illustrated in the Lantz WWTP System Assessment Report from 2017.

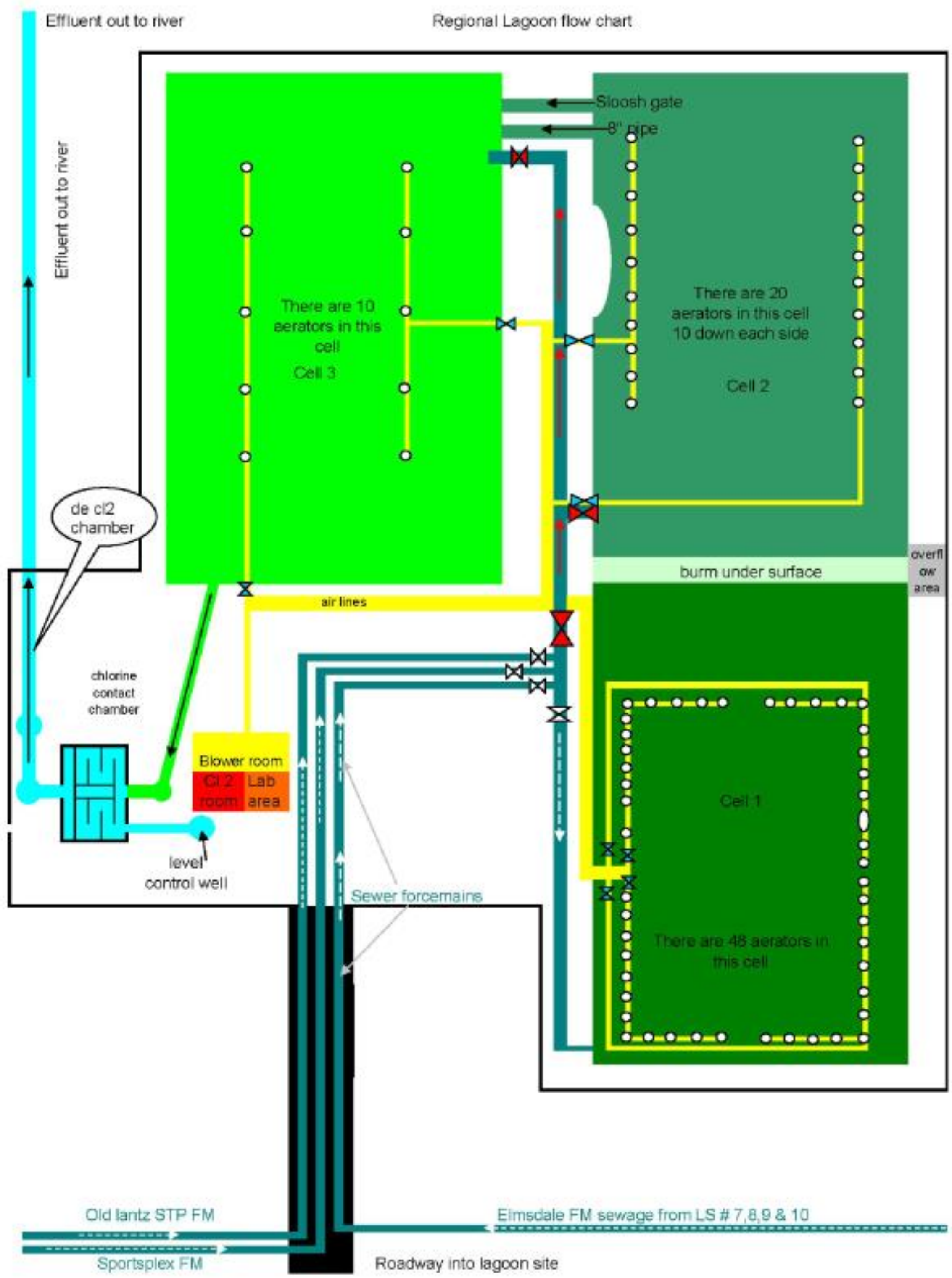


Figure 1-1: Illustration of Current Lagoon

2.0 Background and Design Objectives

2.1 Existing System

The WWTP is a facility that consists of a three cell aerated lagoon system. Diffusers are located at the bottom of the cells suspended by floating laterals, and could be retrieved from a boat when maintenance is required. The number of diffusers in each cell are provided below based on to the Lantz WTP System Assessment Report from 2017:

- Cell 1 - 48 diffusers;
- Cell 2 - 16 diffusers; and
- Cell 3 - 8 diffusers.

Air to the diffusers is provided by three 50 HP blowers that operate on alternating cycles in a 2 duty 1 standby configuration, which are located in blower building adjacent the ponds. The aeration system provides oxygen to the bacteria that converts wastewater contaminants to carbon dioxide, water, inert ash and nitrates. The aeration capacity for each cell as stated in the Sewer Capacity Study from 2015 is listed below:

- Cell 1 – 1,224 m^3/h;
- Cell 2 – 510 m^3/h; and
- Cell 3 – 255 m^3/h.

The approximate lagoon cell volumes and dimensions are listed in **Table 2-1** below as described in the WSP Sewer Capacity Report from 2015. The working depth of each of the lagoons is approximately 7.16m and the side slopes are reported to be 4:1, making the lagoons significantly deeper than the usual average design.

Table 2-1: Lagoon Dimensions and Volumes

	Volume[1] (m^3)	Top Length (m)	Top Width (m)	Bottom Length (m)	Bottom Width (m)
Cell 1	29,902	126	88	59	14
Cell 2	42,771	183	87	182	14
Cell 3	70,023	206	105	133	32

[1]The actual working volumes are reduced due to accumulated sludge. Refer to Section 5 for sludge volume estimates.

Following treatment in the third lagoon cell, effluent is discharged by gravity to the chlorine contact and dechlorination chambers prior to discharge into the receiving water. Chlorine is injected directly into the treated effluent.

The equipment, specifically the aeration system, is past the end of its normal service life and will need to be replaced in the immediate future, consistent with the report from 2015. **Table 2-2** provides a summary of the estimated remaining service life for various components of the plant based on industry standards, with remaining service life adjusted for the year 2021. These values are considered a benchmark and should be reviewed alongside other indicators such as effluent quality, visual inspections and operator feedback.

Table 2-2: Estimated Remaining Service Life for Equipment

Asset	Year Constructed	Normal Service Life	Estimated Remaining Service Life
Aeration Equipment (Diffusers)	1988	20-25 years	Past useful life
Chlorination System	1995	25 years	At end of useful life
Chlorine Contact Chamber (Structural)	1988	50 years	20 years
Building Mechanical Systems (Blowers)	1988	20-25 years	Past useful life

2.2 Existing Flows

There is currently no influent monitoring at the WWTP, and only the plant effluent is monitored and recorded. Dillon reviewed the precipitation and evaporation data available from Environment Canada databases and have concluded that there is a negligible difference between the evaporation and precipitation in the geographic area. Therefore, the average annual lagoon effluent flow data can be used as average influent data for planning and conceptual level design purposes. However the data does not provide sufficient detail about the flow variation during the year which is required for detailed design. Based on flow monitoring for the years 2012-2020, the average annual daily flow is 4,465 m^3/day. **Table 2-3** summarizes the annual average and daily effluent flow as recorded at the WWTP.

Table 2-3: Summary of WWTP Flow

Year	Annual Average Daily Flow (m^3/d)	Maximum Daily Flow (m^3/d)
2012	4537	-
2013	5026	9638
2014	4576	8251
2015	4254	7484
2016	4111	11793
2017	4170	8201
2018	4455	7847
2019	4627	7931
2020	4434	8223
Average	4465	8671

The estimated population currently serviced by the plant is 7,375. Based on this population and the average annual daily flow, the average per capita flow including Inflow and Infiltration (I&I) is estimated to be 605 L/cap/day. It was noted by previous studies that the collection system experiences a significant I&I problem, which explains the relatively high per capita flow. Using the per capita flow of 340 L/cap/day as recommended in the *Atlantic Canada Guidelines (Guidelines)* the I&I is estimated at 265 L/cap/day (44% of total flow). Our understanding is that based on recommendations of the previous studies not to invest in reducing the I&I due to sufficient hydraulic retention time of the lagoons no effort was made to identify the main sources of extensive I&I and no actions were taken to reduce it.

2.3 Design Flow

Prior to determining what options would be suitable for optimization, a design flow was determined in order to size the treatment units and equipment. The per capita flow recommended by the Guidelines were used to estimate the per capita sewage generation from future developments as detailed below.

Flow from future developments was calculated by using the 340 L/day per capita flow rate recommended by the Guidelines. The I&I was assumed at 50% of the current rate, 133 L/cap/day. This is based on an assumption that as new collection system is constructed, it is designed to modern standards and will experience less I&I than the older infrastructure and was considered reasonable by municipal staff.

Average flows from existing developments were assumed to be the same as determined by effluent flow measurements, including the currently observed high I&I. This is a conservative approach assuming no commitment by the Municipality to reduce I&I throughout the existing collection system.

Table 2-4 summarizes the population and average flow rate for present day and the design years which are being evaluated. These population projections were based on new and future developments within the *South Corridor* and *Commercial Growth Management Area* provided by the Municipality. These population projections represent known and possible developments, compared to other estimates that were based on typical growth rates.

Table 2-4: Estimated Population and Flows in Service Area

Year	Population	Average Daily Flow (m^3/d)
2020	7,375	4,461
2026	13,014	7,126
2031	16,417	8,734
2050	20,879	10,842

2.4 Influent Quality and Contaminant Loading

Currently there is no influent sampling performed for the plant, so historical influent quality data is not available. Therefore per capita production rates for domestic sewage recommended by the Guidelines were used to determine the influent quality and contaminant loading rates. **Table 2-5** lists the typical organic loading rates for domestic sewage recommended by the Guidelines.

Table 2-5: Organic Loading Rates

Parameter	Guideline Loading (kg/(cap/d)
BOD_5	0.08
TSS	0.09
TKN	0.016

Regional design guidelines and other technical resources often base their approach on BOD_5, rather than cBOD5. However, Nova Scotia Environment typically issues approvals based on the latter, making it slightly difficult to compare. Using BOD_5 as a preliminary design basis is typically considered conservative, as BOD_5 includes $cBOD_5$ and will accordingly always be greater. This does not impact the findings of our report, but is important to factor into the detailed design of aeration systems and performance forecasts.

Table 2-6 provides the estimated influent concentration and loading rated for current and future years.

Table 2-6: Influent Quality and Contaminant Loading

	Five-day Biochemical Oxygen Demand (BOD_5)		Total Suspended Solids (TSS)		Total Kjeldahl Nitrogen (TKN)	
	Influent Concentration (mg/L)	Contaminant Loading (kg/d)	Influent Concentration (mg/L)	Contaminant Loading (kg/d)	Influent Concentration (mg/L)	Contaminant Loading (kg/d)
Current Population	132	590	149	664	26	176
Future Population (2026)	146	1041	164	1171	29	208
Future Population (2031)	150	1313	169	1477	30	263
Future Population (2050)	154	1670	173	1879	31	334

It is recommended to conduct additional influent sampling and flow monitoring program prior to plant upgrade final design to confirm the loading rates and their seasonal variation. More details are provided in Section 7.2.

2.5 Existing WWTP Capacity

A review of the existing lagoons capacity was completed using the aerated lagoon design parameters according to the Guidelines, and the results are summarized in **Table 2-7**. The existing aeration system does not provide sufficient mixing energy for a completely mixed lagoon and is considered partially mixed. However, the cell depth at 6 m significantly exceeds the minimum recommended depth of 3 m, providing volume for sludge settling and subsequent mineralization. In addition, the hydraulic retention time also exceeds the minimum required time.

The oxygen requirements are the limiting parameter of the capacity of the lagoons, allowing plant loading of approximately 778 kg BOD/d, which corresponds to an average daily flow of 5,200 m^3/d. This gives a remaining theoretical capacity of approximately 735 m^3/d, based on the average flow rate over the past 8 years. However, this number may vary due to factors such as efficiency of diffusers, changing annual flow rates and the actual BOD concentration of the influent. BOD was conservatively estimated to be 150mg/L for the capacity check, but based on the results of the influent sampling done as described in East Hants WWTP Dye Test Memo done by Dillon on December 17th, 2021, it is much lower due to I&I. A lower BOD would allow for a higher theoretical capacity, but a lower efficiency of the diffusers due to age would decrease the theoretical capacity.

Table 2-7: Existing Lagoon Capacity Review

Parameter	Guideline	Existing Lagoon	Maximum Lagoon Capacity Using Guideline Parameter Value
Polishing Cell Hydraulic Retention Time	Min 5 days	Cell 3: 15 days	14,000 m^3/d
Hydraulic Retention Time	5-30 days	Cells 1 and 2 16 days	2,422 - 14,500 m^3/d
Oxygen Transfer Capacity	1 kg O_2/kg BOD	Capacity of the system 778 kg O_2/d 1.32 kg O_2/kg BOD	778 kg BOD/d (5,200 m^3/d)
Organic Loading Rate	0.031-0.048 kg/m3.d	0.013 kg/m3.d	1,325 – 2,053 kg BOD/d
Mixing energy for completely mixed system	6-10 W/m^3	1.7 W/ m^3	Complete mixing not provided

Based on current loading it is estimated that the theoretical remaining capacity of the lagoons is about 400 dwelling units.

2.6 Current Effluent Discharge Objectives

Effluent discharge objectives for the WWTP as stated in Approval No. 2016-095821-A01 Section 7 are shown in **Table 2-8.**

Table 2-8: Current Effluent Discharge Objectives

Parameter	Effluent Limit
$cBOD_5$	20 mg/L
TSS	20 mg/L
E.coli	200 E.coli/100 ml
pH	6-9
Total Chlorine Residual	0.02 mg/L

Effluent quality provided for the past three years satisfies the criteria as stated in the Approval based on quarterly averages for reporting. However, there have been five instances of *E.coli* grab samples, two $cBOD_5$ samples and one TSS sample that exceeded limits. Exceedance of limits by a grab sample is not required to be reported under the Approval, however it may be an indicator of potential plant performance issues or increased loading.

Table 2-9 details the quarterly effluent quality data from 2018-2020. Grab samples with higher values than the effluent objective (average) are highlighted.

Table 2-9: Quarterly Effluent Quality Data from 2018-2020

Year	$cBOD_5$		TSS		E.coli	
	Average	Max	Average	Max	Average	Max
2018 – Q1	6.0	7.0	4.8	8.0	3.5	12.0
2018 – Q2	3.7	7.0	3.1	6.0	1.3	5.0
2018 – Q3	2.9	7.0	8.6	16.0	1.0	1.0
2018 – Q4	3.3	6.0	2.5	2.5	3.4	23.0
2019 – Q1	11.7	24.0	6.6	9.0	2.7	6.0
2019 – Q2	6.2	12.0	5.1	8.0	3.2	1120.0
2019 – Q3	7.0	23.0	10.6	18.0	12.8	2420.0
2019 – Q4	2.2	6.0	4.9	10.0	6.8	250.0
2020 – Q1	10.3	14.0	6.9	8.0	8.5	2420.0
2020 – Q2	5.6	11.0	5.1	7.0	1.9	10.0
2020 – Q3	4.2	10.0	15.7	31.0	1.1	2.0
2020 – Q4	4.3	6.0	9.4	12.0		10.0

2.7 Future Effluent Discharge Objectives

As part of the study, Effluent Quality Objectives (EQO’s) and Effluent Discharge Objectives (EDO’s) for the projected future flows and loading were developed by Dillon in accordance with the Federal CCME guidelines. EDO is considered the end of pipe compliance limit for the WWTP and is based on achieving various EQOs in the receiving environment.

In 2017, NATECH Environmental completed mixing models of the receiving water body using CORMIX software. For their study three scenarios were simulated: field case, average case and worst case. The field case was used to calibrate the models based on observed effluent dilution rates. The average case simulated average river flows and average effluent flows, while the worst case simulated a seven day – ten year (7Q10) low flow and the average summer effluent discharge. A 7Q10 was selected as design conditions, which assumes drought conditions with low flow (dry weather conditions).

As the design conditions assume no rainfall, a conservative assumption would be no I&I contributions to the lagoon effluent flow. Dillon selected a lagoon effluent flow without I&I for modeling this condition. The 2017 models were then recreated to calibrate our own CORMIX models in order to determine the EQO's and EDO's for 2026, 2031 and 2050 estimated populations. **Table 2-10** below shows the complete summary of preliminary EQOs and EDOs.

Table 2-10: Preliminary EQOs and EDOs

Parameter	Units	EQO	Ave Background	EDO with 1.4	EDO with 1.2	EDO with 1.1	Notes*
Design Year				2026	2031	2050	
Design Effluent Flow	m^3/d			7,126	8,734	10,842	
Dissolved oxygen	mg/L	6.5	10.6	6.5	6.5	6.5	EQO is EDO
Total Residual Chlorine (TRC)	mg/L	0.0005	0.000	0.0007	0.0006	0.0006	EDO can not exceed Fisheries Act requirement of 0.02. Background below detection limit of 0.05, exceeds EQO
Carbonaceous Biochemical Oxygen Demand (CBOD5)	mg/L	25	4	25	25	25	**Maximum is NPS/WSER of 25. To Be Confirmed that effluent DO >2mg/L.**
Total Suspended Solids (TSS)	mg/L	10	4	12.4	11.2	10.6	Maximum is NPS/WSER of 25
Unionized Ammonia - Nitrogen	mg/L	0.016	0.018	0.0152	0.0156	0.016	Maximum is WSER of 1.25 (at 15oC)
NH3-N Total (June - September)	mg/L	0.89	0.05	1.23	1.06	0.97	**This value needs to be compatible with N+N EDOs**
NH3-N Total (October to May)	mg/L	8.9	0.05	12.44	10.67	9.79	Should not need winter EDO based on Effluent Qual
Total Kjeldahl Nitrogen (TKN) (June - Sep.)	mg/L	0.500	0.16	0.6	0.6	0.5	The EQO for TKN is Preliminary and based on NATECH
Total Phosphorus (TP) (May-Oct.)	mg/L	0.035	0.012	0.044	0.040	0.037	Assumes meso-eutrophic condition (not confirmed)
pH	units	6.5 - 9.0	NA	6.5-9.0	6.5-9.0	6.5-9.0	EQO is EDO
Temperature	oC	25	25	25	25	25	Short term not to excced worst case summer (25oC assumed), Long term not to exceed max. weekly average (TBD)
Chloride	mg/L	120	50	148	134	127	Background assumed
Cyanide (as free CN)	mg/L	0.005	0.002	0.0062	0.0056	0.0053	
Fluoride	mg/L	0.12	0.12	0.12	0.12	0.12	
Nitrate (as N)	mg/L	2.9	0.21	3.98	3.44	3.17	
Nitrite (as N)	mg/L	0.06	0.07	0.0560	0.0580	0.059	Background above GL
E. Coli	CFU or MPN/100ml	200	1	280	240	220	Assumes primary water use at edge of mixing zone.
Aluminum	ug/L	100	158	76.8	88.4	94.2	Background above GL
Arsenic	ug/L	5	4	5.4	5.2	5.1	Background below detection limit of 1
Cadmium	ug/L	0.04	0.028	0.0448	0.0424	0.041	Background below detection limit of 0.01
Chromium	ug/L	1	1	1.0	1.0	1.0	Background below detection limit of 1
Copper	ug/L	2	3	1.6	1.8	1.9	Background below detection limit of 1
Iron	ug/L	300	383	266.8	283.4	291.7	
Lead	ug/L	1	0.8	1.08	1.04	1.020	
Manganese	mg/L	210	80	262.0	236.0	223.0	
Selenium	ug/L	1	1	1.0	1.0	1.0	Background below detection limit of 1
Zinc	ug/L	30	14	36.4	33.2	31.6	
Total PCBs	ug/L	0.001	0.002	0.0006	0.0008	0.001	
Toluene (VOC)	ug/L	2	1	2.40	2.20	2.10	
Chloroform (VOC)	ug/L	1.8	0.5	2.32	2.06	1.93	
Acute Toxity	TU	na	na	**<1 at end of pipe**			
Chronic Toxicity	TU	na	na	**<1 at edge of mixing zone**			
available.							
	New parameters not in NATECH						

Based on our CORMIX analysis, the targeted objectives that were used to size equipment are shown in **Table 2-11** below. For the phosphorus targets modelled, they are not achievable by implementing economically viable commercially available technologies, so 0.5mg/L was used for equipment sizing. This approach was discussed with NSE during the project and was considered appropriate at this stage. Please note that metal limits were not analyzed for preliminary equipment sizing, but will be a factor in the final design.

Table 2-11: Key Preliminary EDO's for Equipment Sizing

Parameter	EDO 2026 (mg/L)	EDO 2031 (mg/L)	EDO 2050 (mg/L)
$cBOD_5$	20	20	20
TSS	12	11	10
Ammonia (Summer)	1	1	0.97
Ammonia (Winter)	12	10	9
Phosphorus (Summer)	0.5	0.5	0.5
E. coli	200 (CFU/100ml)	200(CFU/100ml)	200(CFU/100ml)

2.7.1 Consultation with Nova Scotia Environment

Nova Scotia Environment (NSE) was formally approached during the project to review the results of the mixing zone analysis and proposed effluent limits. Generally, NSE had no issues or concerns with Dillon's approach or the results. The following were the key meeting notes:

- Upgrades to the WWTP will require advanced approval;
- The basis for effluent mixing analysis was based on a standard 7Q10 (drought scenario, equivalent to the lowest 7-day average flow that occurs once every 10 years) and is acceptable to NSE;
- Proposed EDOs and EQOs will be reviewed in the context of commercially available, municipal treatment technologies economically viable for the Municipality; and
- Future changes to effluent limits based on mixing analysis are subject to review and approval of NSE.

NSE should be notified of any proposed changes to the plant. They also noted that if the limit from the mixing analysis was too stringent given the current technology, an argument for a more practical adjustment could be made. In this case, the phosphorus limit (approximately 0.04 mg/L) was considered too stringent for practical equipment to meet modelling targets, so a more reasonable value of 0.5 mg/L achievable by current treatment technologies was used for equipment sizing. Many regions in North America set 1.0 mg/L TP limits, so this is considered a conservative approach.

3.0 Long Term Upgrade Solutions

The following plant upgrades were identified from the assessment to increase the rated capacity of the plant. They have been split into two types: upgrading the existing lagoons and constructing a new mechanical WWTP to replace the lagoons.

3.1 Upgrading Existing Lagoons

For providing TSS, BOD and ammonia removal from the influent, and to meet EDOs, the following treatment technologies were evaluated.

- Attached growth reactors placed in the lagoons;
- Intermittently decanted extended aeration lagoons; and
- Post lagoon moving bed biofilm reactor (MBBR).

All of the evaluated systems provide TSS, BOD and ammonia removal. Complete mix of all lagoon cells was not assessed as there would be much higher energy usage, and partial mix or passive treatment options are more feasible. Reliable and consistent phosphorus removal to the required effluent limits cannot be achieved in most lagoons and requires a tertiary treatment system. The tertiary treatment system will generally be the same for all alternatives and is described in Section 4.

All systems will require a new building(s) to house blowers, tertiary filters, UV system, chemical storage, dosing equipment and electrical panels.

A comparison of the treatment technologies is provided in Section 6.

3.1.1 Attached Growth Reactors

Immersed aerated fixed film systems increase the treatment capacity of existing bioreactors by providing additional treatment of organics and ammonia using modular units containing fixed media by providing large surface area for growth of a biofilm. Each module is equipped with a fine-bubble aeration system placed below the media, which provides oxygen for biomass and treatment. These systems do not require significant capital investments and are used year round in various applications. The system is easily expandable to match the contaminant loads by installing additional modules. Separate modules are provided for BOD and ammonia removal.

Air for aeration is provided by blowers installed in the control building though an air supply header buried in the lagoon berms. The air header is connected to the modules by floating laterals. In addition to the aeration for modules, new aeration diffusers must be provided for cells 1 and 2 for areas outside of the modules to replace the existing aeration. It is recommended to use fine bubble diffusers to lower the overall air requirement. Fine bubble aeration could be also implemented for enhanced digestion of the sludge from the system in cell 3.

Funding opportunities may be available for equipment procurement from the government as the system is considered an emerging green technology. Two funding programs that cover costs include Sustainable Development Technologies Canada (STDC) and the Green Municipal Fund. However, there is a risk to using this technology as there are limited installations in Canada and limited reference data based on the installations.

Table 3-1 shows a description of the equipment of the system for the ultimate flow. Due to the modular design, the installation of modules to the lagoons will be phased in based on the actual flow. Blowers should be selected in a way that allows for enough energy to be provided to both diffusers and modules, and uses pressure control and VFDs for each of the different systems. Number of blowers and power requirements should be confirmed prior to final design.

Table 3-1: Attached Growth Reactor Equipment

Descriptor	Equipment
Number of Blowers	3 combined for diffusers and modules
Number of Diffusers	Cell 1 - 48 diffusers Cell 2 - 16 diffusers Cell 3 - 8 diffusers
Number of Modules	38 (32 BOD removal modules, 6 for Ammonia removal)

Figure A-1 in the Appendix shows the rough layout of the system in the lagoon for the final phase.

3.1.2 Intermittently Decanted Extended Aeration Lagoon System (IDEAL)

The intermittently decanted extended aeration lagoon system consists of fine bubble diffusers installed into existing lagoons, a decanter between Cell 1 and Cell 2 with flow control valves, an overflow pipe, process controls, and a blower package for air supply. In Cell 1, aeration is used alongside decanters to provide treatment of BOD and ammonia using Cell 1 as a Sequencing Batch Reactor to create a complete mix cell. This means that the pond is controlled with aeration, settling and decanting cycles. In Cell 2, fine bubble aeration is used to create a partially mixed polishing cell to capture remaining soluble and particulate BOD and ammonia. Finally in Cell 3, fine bubble aeration could be also implemented for digestion of the waste sludge from the system. The non-aerated part of Cell 3 would be used as a settling basin to remove the suspended solids.

For this system, a concrete berm must be erected between Cells 1 and 2 to separate them and to allow for the installation and operation of the decanter system.

For phasing requirement, there is no reasonable way to save money on phasing this system through the different flow rates. The treatment pond aeration uses only 4% more air at the design capacity then what would be needed to keep the pond completely mixed, so aeration can't be reduced. Similarly, aeration cannot be reduced in the sludge pond. Aeration in the polishing pond would be less intensive but reduction in price would be insignificant. If phase 1 would be approximately 50% of the full design (10,842m^3/day), then splitting the treatment pond into two smaller ponds could be considered which would cut the air requirements in half. In the long run though, price would go up because an additional berm would have to be constructed, and there would be two set of decanters and two sludge wasting points.

Table 3-2 shows a description of the equipment of the system for the ultimate flow. Number of blowers and power requirements should be confirmed prior to final design, depending on the turndown capabilities that are wanted.

Table 3-2: Preliminary Intermittently Decanted Extended Aeration Lagoon Equipment

Descriptor	Equipment
Number of Blowers	3
Number and Type of Diffusers	Cell 1 – 65 diffusers Cell 2 – 20 Diffusers Cell 3 – 36 Diffusers

Figure A-2 in the appendix shows the layout for this system in the current lagoon basins.

3.1.3 Post Lagoon Moving Bed Biofilm Reactor (MBBR)

The MBBR system is a biofilm process that is comprised of small, lightweight, rigid, plastic carrier media in an aerated tank that are kept in suspension by coarse bubble aeration. For this project, it would be installed downstream of the lagoon system (following cell 3) to provide residual BOD and ammonia removal. The existing aeration system of the lagoons would need to be upgraded alongside the addition of the MBBR, as the MBBR cannot be added by itself and the aeration equipment is at its end of life and does not have the required capacity.

MBBR efficiency is increased through specially designed carriers with high surface area to volume ratio. This surface area is optimized to retain a large active biomass inventory within small reactor basins. The result is a compact solution thus reducing costs for tanks and footprint requirements. The MBBR process is a simple, flow-through technology. The aeration system is controlled automatically using DO measurements to reduce energy costs. The biofilm is fairly resilient to shock loading and self-adaptive, removing the need to monitor mixed liquor concentrations or solids retention times.

Table 3-3 shows a preliminary description of the equipment of the system for the ultimate flow. Phasing in of this system provides low economic benefits as most of the infrastructure (concrete tanks) would have to be constructed at the start. For the initial phase, less diffusers would be installed in all ponds (they are all only partial mix) and less media in the MBBR tank. As the flow rates increase, diffusers and media will be added to the system. The sizing of air headers, blower room and MBBR tanks and aeration grid would remain the same, as these elements would be hard to modify in the future. It is estimated that if the flows and loads in phase 1 would decrease by 20% from the design capacity (10.8 MLD down to 8.7 MLD) cost of the scope would be reduced by almost exactly 10%.

Blowers should be selected in a way that allows for enough energy to be provided to both diffusers and MBBRs, and uses pressure control and VFDs for each of the different systems. Number of blowers and power requirements should be confirmed prior to final design.

Table 3-3: Preliminary Post Lagoon MBBR Equipment

Descriptor	Equipment
Number of Blowers	3
Number and Type of Diffusers	Cell 1 – 36 Diffusers Cell 2 – 13 Diffusers Cell 3 – 13 Diffusers
MBBR Footprint	MBBR 1: 12m x 12m x 5m MBBR 2: 20m x 12m x 5m

Figure A-3 in the Appendix shows the layout for the post lagoon MBBR.

3.1.4 Comparison of Lagoon Upgrade Options for 2050 Target Year

Table 3-4 below summarizes the key components of each of the three lagoon upgrade options.

Table 3-4: Comparison of Long Term Lagoon Upgrade Options

Parameter	Attached Growth Reactors	Intermittently Decanted Extended Aeration Lagoon	Post Lagoon Moving Bed Biofilm Reactor (MBBR)
New Equipment Used in Lagoons	38 Modules for BOD and ammonia treatment Upgraded diffuser aeration system for cells 1+2 (cell 3 aeration equipment optional)	4 static decanter assemblies 3 different diffuser assemblies, one in each lagoon Concrete berm to separate Cells 1+2	3 different diffuser assemblies, one in each lagoon Upgraded Diffuser Aeration System for Cells 1, 2 and 3
Additional Equipment Needed	3 Blowers Air supply and distribution system	3 Blowers Air supply and distribution system	Concrete MBBR Tanks 3 Blowers Air supply and distribution system

Parameter	Attached Growth Reactors	Intermittently Decanted Extended Aeration Lagoon	Post Lagoon Moving Bed Biofilm Reactor (MBBR)
Construction Phasing for 2031 and 2050	Install modules to match flows and loads	No reasonable way to save money through phasing, will have to be installed for 2050 flows and loads	Add additional media to MBBR tanks to match loads, install less diffusers initially and add diffusers as flows increase
Sludge Removal	Remove sludge from Cell 1 Confirm sludge accumulation in other cells by survey. Re-evaluate in 10 years after survey	Remove sludge from Cell 1 Confirm sludge accumulation in other cell by survey. Re-evaluate in 10 years after survey	Remove sludge from Cell 1 Confirm sludge accumulation in other cells by survey. Re-evaluate in 10 years after survey

3.2 Replacing Lagoons with a Mechanical Plant

Five technology options were evaluated to achieve the required effluent limits as described earlier. The WWTP treatment options evaluated were:

- Sequencing Batch Reactor (SBR);
- Conventional activated sludge;
- Extended Aeration;
- Moving Bed Bioreactor (MBBR) with Dissolved Air Flotation (DAF); and
- Membrane Bioreactor (MBR).

The new mechanical plant could be constructed within a small portion of the cell 3 footprint. Cell 1 could be used for flow equalization to reduce the peak instantaneous flows associated with high I&I. Cell 2 would receive waste activated sludge from the mechanical treatment and to be used for aerated sludge digestion only and would not receive raw sewage. The aeration system in these cells would have to be replaced. The remaining part of Cell 3 could be converted to a constructed wetland. This wetland would be used in short term to deposit the sludge removed from the lagoon cells (thus saving the transportation and disposal costs), and long terms for disposal of the excess sludge from the aerated digestion cell. These modifications are viable for all proposed mechanical WWTP alternatives. A preliminary treatment consisting of grit removal and screening is also required for all mechanical treatment processes.

All the evaluated systems provide TSS, BOD and ammonia removal. Phosphorus removal to the required effluent limits cannot reliably be achieved biologically in these treatment systems and requires a tertiary treatment system. Tertiary treatment system would be the same as for the lagoon upgrade options and is described in Section 4.

We have used industry standard computer modeling and in-house design aids to assist in evaluating the alternatives.

3.2.1 Sequencing Batch Reactor

A sequencing batch reactor (SBR) is a well-established wastewater treatment process that uses a fill and draw method to treat influent. To optimize the performance of the system, two or more batch reactors are typically used in a predetermined sequence of operations. SBR systems have been successfully used to treat both municipal and industrial wastewater throughout the world. In a typical true batch set up, sewage will enter one of the tanks while the two other tanks will be at consecutive treatment stages, such as react and decant/discharge. Each tank is equipped with aeration and mixers to provide aeration and mixing capability. Continuous-feed SBRs are also available which receive influent during all phases of the treatment cycle and decant intermittently. No RAS is required as the mixed liquor remains in the reactor at all times, with WAS being withdrawn as necessary. The entire process is controlled using a programmable logic controller (PLC).

Advantages of SBR treatment include:

- Common and proven technology used by neighboring operating authorities;
- Primary clarification (in most cases), biological treatment, and secondary clarification can be achieved in a single reactor vessel if needed;
- Smaller footprint;
- Potential capital cost savings by eliminating clarifiers and other equipment;
- Process control is fully automated. Periodic supervision and adjustment will be done by operators;
- Aeration and mixing power demands are separated which could reduce actual power demand;
- Plant expansion could be accomplished in stages, thus reducing capital cost for each upgrade; and
- The Municipality currently operates other SBRs and is comfortable with the technology.

Disadvantages of SBR treatment include:

- A higher level of sophistication of operation and maintenance is required compared to lagoons due to the automation and controls;
- Consideration to flow equalization is required;
- Maintenance cost is high as a result of the large numbers of equipment;
- Operating cost is on the higher side compared to other treatment processes;
- Downstream systems, such as UV disinfection or filtration, are generally required to be upsized. This is due to the decant nature of the SBRs, which release the average daily flow intermittently, assuming there are no equalization tanks; and
- Waste sludge management required.

An SBR treatment system would require the construction of headworks (grit removal and screening), SBR tanks, tertiary filters, and UV disinfection. Sludge produced by the SBR is usually diverted to be thickened or dewatered, before being collected and disposed if the constructed wetland is not implemented.

Figure 3-1 below shows a simple flow diagram of the system. This does not including UV treatment prior to effluent discharge, but UV system would be required following the disc filter.

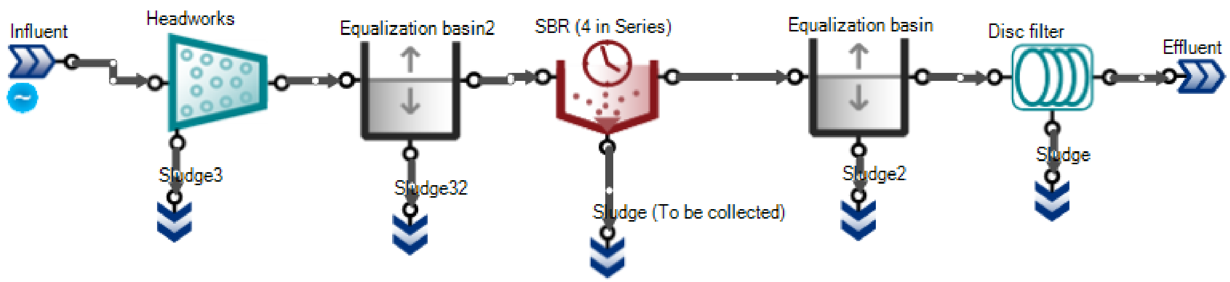


Figure 3-1: SBR Treatment System Schematic

3.2.2 Conventional Activated Sludge

Conventional activated sludge treatment is a common wastewater treatment process that consists of the following steps: preliminary treatment (grit removal and screening), primary clarification, aeration and secondary clarification. The process is then typically followed by tertiary treatment such as filtration and UV disinfection.

Advantages of conventional activated sludge process include:

- Well established process with hundreds of installations worldwide and in Canada;
- Flexible process, operating parameters could be adjusted to provide sufficient treatment under different operating conditions;
- Plant upgrade could be implemented in increments thus reducing the upfront capital cost requirement; and
- Lower installation cost compared to other options.

Disadvantages of conventional activated sludge process include:

- Complex system with a large number of equipment, requires skilled operators to adjust operating parameters compared to lagoons;
- Process troubleshooting by operators, contractor and equipment suppliers will assist with individual equipment only, rather than the entire system; and
- Requires primary clarifiers, which have a higher cost and footprint compared to other mechanical options like extended aeration.

Figure 3-2 below shows a typical flow diagram of the system. This does not including UV treatment prior to effluent discharge, but UV system would be required following the disc filter.

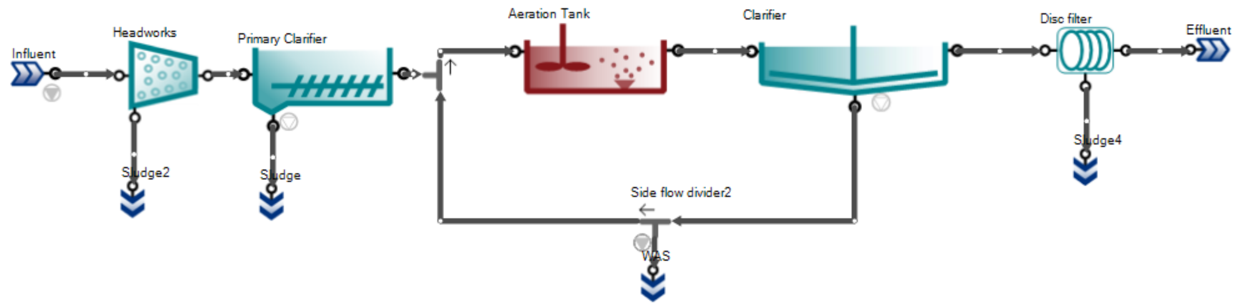


Figure 3-2: Conventional Activated Sludge System Schematic

3.2.3 Extended Aeration

Extended aeration secondary treatment uses a modified activated sludge process. BOD removal efficiency of extended aeration is higher (due to the higher oxygen input and mixing energy) than the conventional activated sludge, and the process also allows for enhanced nitrification. An extended aeration treatment plant would require the construction of headworks (grit removal and screening), aeration tanks, secondary clarifiers, tertiary filters, and UV disinfection.

Advantages of extended aeration treatment include:

- Well established process with hundreds of installations, simple operation;
- Flexible process, operating parameters could be adjusted to provide sufficient treatment under different operating conditions;
- Lower installation cost compared to other options; and
- Less waste activated sludge compared to other technologies.

Disadvantages of extended aeration treatment include:

- Larger aeration tank footprint;
- Higher operation cost compared to conventional activated sludge; and
- Requires a higher operator skill level compared to lagoons.

Figure 3-3 below shows a simple flow diagram of the system.

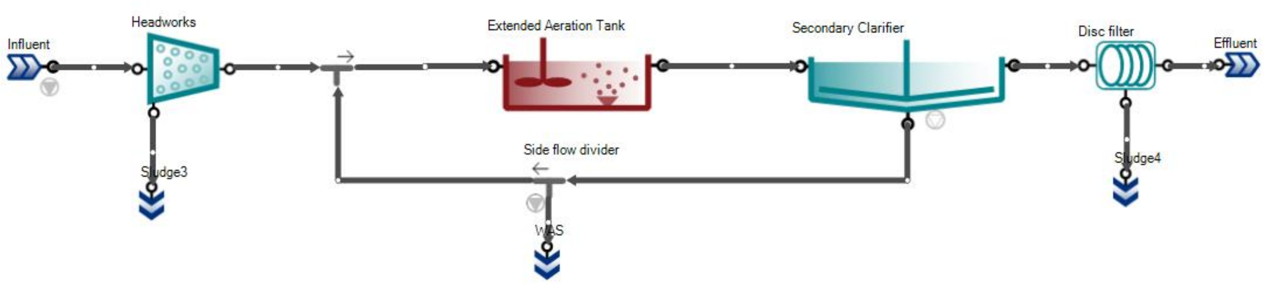


Figure 3-3: Extended Aeration System Schematic

3.2.4 Moving Bed Bioreactor (MBBR) followed by Dissolved Air Floatation (DAF)

The MBBR system is a biofilm process that is comprised of small, lightweight, rigid, plastic carrier media in the aeration tank that are kept in suspension by coarse bubble aeration and/or mixing. Biofilm reactors can be constructed without suspended growth, thus eliminating the need for sludge return streams. Secondary clarification is required following the MBBR system. Dissolved air flotation (DAF) is a tertiary treatment technology that releases dissolved air into the wastewater stream, creating microbubbles that attach to and float suspended solids and insoluble BOD particles to the liquid surface, where they are skimmed and removed. The wastewater is mixed with a coagulant in a flocculation tank sized for approximately 5 minutes of contact time before it enters the DAF for the clarification process, which allows smaller particulates to agglomerate into larger particles. The effluent is then polished using a disc filter to meet the requirements.

DAF is required for secondary clarification due to the poor settle ability of the sludge released from the MBBR process that cannot be treated solely by sedimentation. Further tertiary treatment following use of DAF is required to achieve the effluent phosphorus requirements.

Advantages of MBBR and DAF treatment technology include:

- Smaller footprint than other systems that use clarifiers and aeration tanks;
- Lower sludge production;
- Lower capital costs; and
- Can handle variable flow and occasional shock load conditions.

Disadvantages of MBBR and DAF treatment technology include:

- Abandonment of lagoons and replacement with MBBR and DAF is less economically feasible than installing an MBBR for post lagoon treatment; and
- Higher operating costs as DAF (or a similar clarification technology) must be used for tertiary treatment to achieve the ideal effluent quality, which adds complexity and cost. Additional complexity includes chemical dosing and additional operator controls.

3.2.5 Membrane Bioreactor (MBR)

Membrane Bioreactor (MBR) systems consist of a biological reactor and microfiltration membranes. This combines the unit processes of aeration, secondary clarification, and tertiary filtration in a single process stage. MBRs can operate at higher mixed liquor suspended solids concentration in comparison to other suspended growth processes such as conventional activated sludge, leading to higher organic removal efficiency. Due to the risk of fouling the fine-pore membrane used by the MBR process, a more sophisticated preliminary treatment process with fine-mesh screening is required to protect downstream equipment. Fine pore screening increases the amount of solid screenings collected for disposal.

Advantages of MBR treatment technology include:

- Higher volumetric loading rates and shorter reactor hydraulic retention times;
- Longer solid retention times (SRT) resulting in less sludge production and more robust treatment performance for variable loads and temperature conditions;
- Achieves very high quality effluent, low in particulate matter and TP and in ammonia, often suitable for additional treatment and re-use;
- Less space required compared to conventional processes; and
- Can be phased in as capacity is proportional to the number of membrane modules installed.

Disadvantages of MBR treatment technology include:

- Higher life-cycle cost due to power consumptions and the potential high cost of periodic membrane replacement;
- More sophisticated process requires a greater level of operator certification and skill; and
- If membranes foul or fail, the train must be bypassed.

Design of MBR processes depends on the specific membrane unit selected and the desired installation configuration. In some cases, selection of appropriate design parameters may require pilot testing or data from similar full-scale installations. Due to the high cost and sophisticated operation of the MBR system compared to the current lagoon system, Dillon does not recommend MBR for East Hants for future upgrades.

3.2.6 Option Evaluation

Screening criteria were developed to identify and eliminate treatment alternatives and process options that would not be considered applicable, economically feasible or practical for East Hants. Screening is best used to eliminate options, to create a shortlist rather than identify the preferred path, unless the rating discrepancy is significant. To be considered feasible or practical, alternatives must meet all screening criteria.

The following screening criteria were used to identify the short list of alternative design concepts:

- **Operational and Performance Objectives** – Can the treatment process reliably meet the needs of the municipality and the specific requirements for discharge?
- **Experience and Implementation** – Is the process well-established as an accepted treatment alternative for the municipality and locally?
- **Feasibility and Expandability** – Is the process feasible for the specific local conditions and capable of expansion to accommodate growth or the gradual connection of users?

In **Table 3-5**, 'fail' indicates that the alternative does not meet one or more criteria and is screened out.

Table 3-5: Screening of Alternative Treatment Technologies

Alternative	Operational and Performance Objectives	Experience and Operating Requirements	Feasibility and Expandability	Overall
SBR	Pass	Pass	Pass	Pass
Conventional Activated Sludge	Pass	Pass	Pass	Pass
Extended Aeration	Pass	Pass	Pass	Pass
MBR	Pass	Fail	Pass	Fail
MBBR with DAF	Pass	Fail	Fail	Fail

Alternative	Evaluation
SBR	Meets all criteria; is economically feasible and can be phased into expansion
Conventional Activated Sludge	Meets all criteria; is economically feasible and can be phased into expansion
Extended Aeration	Meets all criteria; is economically feasible and can be phased into expansion
MBR	Configuration and operation of process is complicated, therefore it's not an ideal alternative for the municipality
MBBR with DAF	Configuration of process required to meet effluent requirements is uncommon for municipal plants and not economical feasible compared to post lagoon MBBR.

Alternative design concepts which passed all three screening criteria above were short-listed for further review. Short-listed alternatives are compared in greater detail below with respect to their cost, size and performance. **Table 3-6** shows the preliminary tankage footprint estimate for the short-listed mechanical alternatives. Results of the cost evaluation are presented in Section 6.

Table 3-6: Tank Sizing for Mechanical Plant Options

System	Primary Clarifier Size (m^3)	Secondary Clarifier Size (m^3)	Aeration Tank Size (m^3)
Conventional Activated Sludge	480m^3 each (3 units) 20m x 5m x 4.8m	3475m^3 each (2 clarifiers) Diameter: 33m Depth: 4m	5300m^3 (2 tanks at 2650m3 and 5m depth)
Extended Aeration	N/A	2680m^3 each (2 clarifiers) Diameter: 29m Depth: 4m	8400m^3 (2 tanks at 4200m^3 and 5m depth)
SBR	N/A	N/A	8400m^3 (4 reactors at 2100m^3 and 5m depth)

4.0 Tertiary Treatment

4.1 Filtration

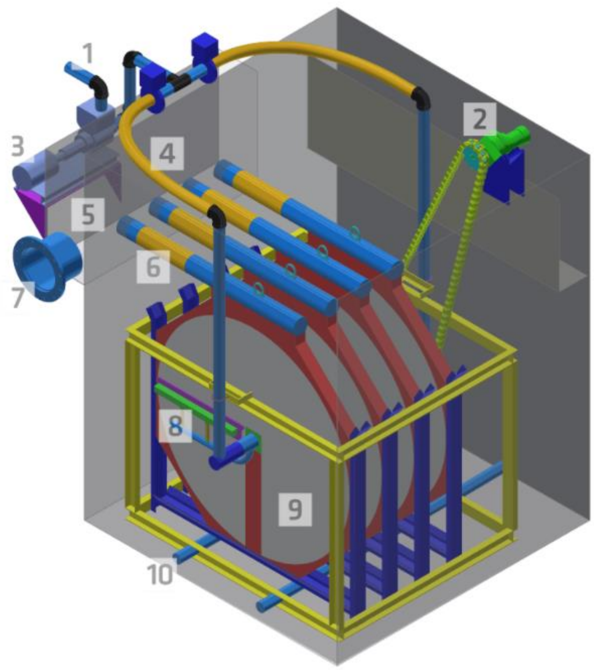
A tertiary treatment system will be required for all above treatment options to achieve the effluent phosphorus concentrations determined by the receiving water study. Dillon recommends that this treatment system consist of chemical coagulation to convert soluble phosphorus to particulate and increase floc particle size, followed by an engineered filtration system, such as a disc filter to remove suspended solids. This would be required for all evaluated treatment options as none are capable of consistent phosphorus removal to the required level. Filtration also adds a level of protection to the effluent in terms of TSS and insoluble BOD.

There are various tertiary treatment technology options available such as disc filters, DAF, sand filters and engineered wetlands. Based on a comparison of the various technologies, a disc filter system would be most suited to the WWTP. A disc filter is a tertiary treatment technology that removes suspended solids and associated insoluble BOD. It consists of multiple mesh screens that are mounted to a shaft within a drum where they rotate. The wastewater flows into the drum and through the mesh panels that are partially submerged; as the panels rotate out of the wastewater, solids are contained on the screens and are backwashed to a sludge collection waste stream. Disc filters are the cheapest option, highly reliable and are not greatly affected due to seasonal variations. It would also require the least amount of space compared to the three other options mentioned. There are numerous installations in Canada from different manufacturers. Reference list from Veolia installations is included in Appendix B.

Most of the disc filter's mechanical components are not submerged within the wastewater stream and are accessible by operators, to allow for maintenance and repair. Chemical cleaning of the filter screens can be completed without taking the entire system offline, as each screen can also be removed while the system is online. This would likely be required during periods of the year where solids loading increases, such as due to algae. Generally, the chemical cleaning system is automated and included as part of the system.

To remove phosphorus soluble phosphorus need to be converted to non-soluble forms. Flocculation and coagulation is common practice to accomplish this requirement. Alum or ferric salts can be used for flocculation. An alum dosing system which produces less sludge, with flocculation tanks (with a duty/standby pump system) and disc filtration were assumed for the plant. These systems should be able to achieve the proposed effluent discharge parameters of 10 mg/L TSS and 0.5 mg/L phosphorus (which is considered a conservative design target for disc filtration systems).

Number of units and number discs needed can be optimized based on confirmation of phasing in requirements. **Figure 4-1** below shows a typical disc filter set up.



LEGEND: 1. Reject waste; **2.** Drive motor; **3.** Vacuum pump; **4.** Vacuum line; **5.** Discharge trough; **6.** Discharge port; **7.** Effluent; **8.** Vacuum head; **9.** Filter disk; **10.** Sludge withdrawal

Figure 4-1: Typical Disc Filter Set Up

The system would be installed in a new building which would also house the blowers, UV system and electrical equipment. **Figure A-4** in the appendix shows an example layout for the building that would house the blowers and tertiary treatment.

4.2 Ultraviolet Disinfection

The facility currently utilizes chlorination for effluent disinfection. Our understanding is that, similar to many other communities, the Municipality has been phasing out chlorine based effluent disinfection systems and converting to UV based systems. Considering that the chlorination system was identified as being at the end of its service life, we recommend decommissioning the existing chlorination and dechlorination system and replacing it with a UV system. For UV based disinfection there are two main types: contact and non-contact, both offering advantages and disadvantages. A non-contact UV disinfection system which has been used by the Municipality at other treatment plants is recommended for the system. Contact UV systems can accumulate inorganic and organic substances which can cause fouling, which decreases the effectiveness of the light. This makes non-contact systems more effective and reliable.

The capacity of the UV disinfection system is based on a peak flow rate. The peaking factor was determined from the past five years (2016-2020) average flow rate data, and using the 90th percentile of flow. **Table 4-1** below summarizes the predicted average and peak flows for the UV systems for the years 2026, 2031, and 2050.

Table 4-1: East Hants Flows for UV Design

Year	Population	Average flow (m^3)	Projected 90th Percentile Flow
2021	7,375	4,356	6,316
2026	13,014	7,126	10,333
2031	16,417	8,734	12,664
2050	20,879	10,842	15,721

Based on these flow projections, a UV system configuration was developed by assuming two phases to size the UV equipment, with the units installed in parallel. There are two banks within one UV reactor unit, with a total of 140 lamps per reactor. The proposed configuration and capacity of the UV system is:

- Initial Phase (2026 Flow) – Two units (for a flow capacity of 8,734 m^3/day); and
- Final Phase (2050 Flow) – One additional unit (for a flow capacity of 10,842 m^3/day).

Upgrades or replacement to previously installed UV equipment may need to be considered in the future depending on the age and condition of the equipment at the time of the upgrade. It is assumed that the UV disinfection will be housed alongside the blowers, tertiary treatment equipment and electrical and control system in a multipurpose building.

4.2.1 Equipment Building

Regardless of the selected lagoon treatment option, an equipment building is required to house the blowers, UV disinfection and disc filtration treatment, as well as electrical and control panels. **Figure A-4** shows a potential layout for this building to give a sense of the footprint needed.

In order to make room for the equipment building, a small part of lagoon cell 3 may need to be backfilled in to create room for the building, and allow the current blower building and chlorine dosing system to still be operational during construction. The exact location of the building should be confirmed prior to final design

5.0 Sludge Management

Sludge management is a large component of both capital and long-term operational costs and labour requirements for wastewater treatment plants. WSP investigated the record drawings for the existing treatment lagoons and it seems that in the original design, which includes very deep lagoon cells, the WWTP was not intended to be de-sludged (WSP 2015). In general, redistribution of aeration equipment and/or replacement of the aerators at the Regional STP have resulted in deferring the need to complete a physical removal and disposal of the biomass in many of the systems.

Nova Scotia Environment (NSE) states that the province has the most stringent standards related to biosolids in all of North America. Untreated wastewater sludge that is removed from the lagoons may not be directly land applied in Nova Scotia without additional treatment to become classified as biosolids. The Province's policies and guidelines related to biosolids can be found in the *Guidelines for Land Application and Storage of Municipal Biosolids in Nova Scotia (2010)*. Biosolids are divided into two different categories.

- **Class A** municipal biosolids are treated and stabilized products that meet a very high standard for contaminant reduction. As a result of the extensive treatment process required, the Department does not consider Class A municipal biosolids to be generated waste that would require an Approval in accordance with section 23 of the Activities Designation Regulations; and
- **Class B** municipal biosolids are not treated and stabilized to the same extent as Class A products. These municipal biosolids meet a lower quality standard for contaminant reduction. The Department considers Class B municipal biosolids to be a generated waste that requires an Approval in accordance with section 23 of the Activities Designation Regulations. Class B biosolids may commonly be managed through land application, subject to regulatory limits.

In 2015, Stantec Consulting Ltd. was retained by the Municipality to analyze the sludge. **Table 5-1** lists the sludge composition from each cell as well as the category (same as Class) A and B parameter exceedances, which would have to be addressed prior to land application.

Table 5-1: Sludge Analysis Summary for Lantz Lagoon

	% of Cell Volume	Sludge Depths (m)	% TS	Class A Exceedances	Class B Exceedances
Cell 1	19	0.21-3.05	7.2	mercury, molybdenum, selenium and zinc	molybdenum
Cell 2	14	0.6-2.29	7.3	arsenic, copper, mercury, molybdenum, selenium and zinc	molybdenum
Cell 3	13	0.2-2.29	15.7	molybdenum	N/A

Based on these results, only Cell 3's sludge meets the standard for Class B. The rest of the sludge is not acceptable for land application in its current state. The solids would have to be treated further before being used for other applications. There are limited biosolids facilities in Nova Scotia, which makes this option even more restrictive. If further sampling indicates that these exceedances are still present, it would be best to haul and dispose the sludge at a landfill rather than apply further treatment.

It is recommended to repeat the sludge analyses that were completed in 2015 by Stantec to confirm the changes in sludge volume and composition. This should be done prior to development of a sludge management plan. A sludge management plan must be submitted to the Department of the Environment prior to any sludge removal and disposal.

5.1 Sludge Removal

In order to implement the lagoon based upgrade options it is recommended to remove the sludge from Cell 1 to allow for installation of new air diffusers and free up cell volume for treatment. It is recommended to develop a plan for future sludge removal and disposal for Cells 2 and 3. An assessment of the available storage volume should be conducted, and a formal plan be put in place for cleaning and maintenance of these cells. For mechanical options, if the lagoons were to not be used anymore, a complete removal of sludge would be required.

Prior to sludge removal, a sampling and bench test should be performed to determine the current composition of the sludge and its chemical dosing requirements. It is also recommended to assess the amount of sludge in the lagoon prior to sludge removal. Mobile mechanical dewatering equipment (e.g., trucked centrifuge) or geotextile tubes (e.g. Geotubes) made of permeable material could be used for sludge dewatering. Sludge would be pumped for dewatering using a dredging equipment without draining the cell. There is limited land available for the setup of *Geotubes* around the cells, which would limit the options of available technologies to mobile dewatering units. Alternatively, a temporary dewatering pad may need to be created for placing of the *Geotubes*.

For the upgrades utilizing existing lagoon cells, the dewatered sludge would have to be transported and disposed at a site depending on the sludge quality. Section 5.2 outlines disposal in more detail.

For upgrades using a mechanical plant the lagoon cell would have to be desludged and sludge would have to be dewatered. Alternatively, the dewatered sludge could be deposited in Cell 3, which would be converted to a constructed wetland. The sludge would remain stored and mineralized in the wetland and would not have to be removed.

Table 5-2 shows the estimated costs to remove and dewater sludge from each cell, based on the information provided in the sludge study from 2015. These costs include equipment, mobilization and demobilization and operations. Cost may differ once a new sludge analysis is taken prior to development of a sludge management plan.

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Table 5-2: Estimated Sludge Removal Costs

Year 1 (Cell 1)	Year 2 (Cell 2)	Year 3 (Cell 3)	Total
$265,000	$260,000	$350,000	$870,000

For sludge removal from all three cells, the laydown areas for the Geotubes would be approximately 70x100m, and at a 1.5 metres depth. As mentioned previously, there is limited land available for setup, so additional land would need to be used temporarily in order to construct the dewatering cell. Sludge removal will take anywhere between 25 to 40 days depending on the size of the cell.

5.2 Sludge Disposal

Following removal of the sludge from the lagoon and dewatering, the sludge must be disposed of at an approved facility. If the quality of the sludge is confirmed to be non-compliant for land application it is recommended to dispose of it at a landfill. **Table 5-3** below summarizes the estimated sludge hauling and disposal costs to West Hants landfill. It was assumed that it would be for sludge that is dewatered to 15% solids, which is a standard requirement for landfilling. Costs are based off information from the 2015 sludge study, and may differ once a new sludge analysis is undertaken.

Table 5-3: Sludge Disposal and Hauling Costs

West Hants	15% TS		Fee	Cost
	Volume (m^3)	Weight (Tonnes)		
Cell 1	2,717	2,735	$115	$315,000
Cell 2	2,903	2,923	$115	$337,000
Cell 3	4,232	4,260	$115	$490,000
			Totals:	**$1,142,000**

There is a possibility to dispose the sludge from Cell 1 to Cell 3 where it would undergo further mineralization. If the chosen treatment upgrade option allows for Cell 3 to become a sludge retention cell, this would remove the need for disposal to a facility. To confirm sludge volumes in the cells and to assess the volume available for sludge disposal in Cell 3, it is recommended to conduct a sludge inventory survey through all cells.

6.0 Cost Estimate

6.1 Analysis of Options and Cost Estimate

The estimated cost of implementation for each alternative was developed considering the equipment cost, construction costs associated with the components described above and operating and maintenance costs. Costs were established through input from equipment vendors, standard unit pricing and Dillon's professional experience. **Tables 6-1** and **Table 6-2** summarize the estimated capital costs, operational costs and life cycle costs for all evaluated options in 2021 dollars.

6.1.1 Capital Cost

Capital costing has been developed for each alternative and consider the following:

- Capital equipment purchase and installation including auxiliary equipment and piping;
- Site preparation;
- Construction of process buildings and site aces roads;
- Building services and supporting equipment; and
- Transfer of sludge from existing lagoons and potential offsite disposal.

Costs include installation markups of between 20% and 40% per equipment cost depending on the complexity. Standard subcontractor and general contractor markups of 15% and 10% respectively have been considered. In addition to the total "direct" cost of construction, standard "indirect" markups have been included to reflect the assumed actual cost of implementation such as mobilization, demobilization, cost of insurance and bonds, and usual overhead at 10% of the equipment and installation costs. A contingency allowance (20% of equipment and installation costs), and engineering cost was also included as part of the final capital cost.

6.1.2 Operating Costs

Estimated operating costs have been established for each alternative. Where possible, costs have been estimated using technology specific utility consumptions and operating requirements based on discussions with vendors. Preliminary operating cost estimates are established primarily to demonstrate the relative cost to operate different process equipment alternatives. Additional operating costs associated with staff facilities are anticipated to be minor. The operating costs include the following:

- Electrical utility costs;
- Chemical consumption (where appropriate);
- Allowance for routine maintenance, asset management and spare parts. Based on vendors costs and/or a 0.5% of equipment cost where vendor details were not provided; and
- Capital replacement allowance. This annual cost represents the annual capital allocation for anticipated equipment replacement and varies from year to year. Replacement frequencies are

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based on vendor information on the equipment, but can vary depending on site specific operation and maintenance. Capital replacement costs do not include building structures or concrete tanks, both of which are expected to have a longer lifespan.

6.1.3 Life Cycle Cost

Life cycle costing was completed in 2021 dollars to allow comparison of overall costs associated with each alternative. Life cycle costs are based on a 30-year system lifespan, assuming a 2021 implementation date. Actual replacement life of the treatment process may differ from what was costed, but replacement costs were determined through communication with the vendor. Life cycle costing was completed with the following assumptions, which may change over the time:

- 4% Net Present Value Discount Rate;
- 2% Annual inflation for costs associated with labour, capital expenditures and consumables; and
- 2021 construction date for the alternative, with capital dated to this year.

6.1.4 Evaluation Tables

Tables 6-1 and Table 6-2 provide a summary of major plant improvements up to an average day rated capacity of 10,842 m^3/d in 2050. These tables include an opinion of probable costs for the plant upgrades, based on order-of-magnitude cost estimates. These are split into the two options; the lagoon upgrade options and mechanical upgrade options. Cells that are highlighted blue show the preferred technology. The estimated capital and life cycle costs were developed for cost comparison purposes and do not include costs for engineering, approvals and contingencies. These costs should not be used for short term budgeting purposes.

Table 6-1: Lagoon Upgrades Option Evaluation

Criteria/Indicator	Attached Growth Reactor	IDEAL	Post lagoon MBBR
Treatment Performance			
Familiarity of technology	Less common technology, has not been installed in Nova Scotia, limited long term results	Familiar technology (Similar aeration equipment, SBR functionality)	Familiar technology (Similar aeration equipment, filtration treatment)
Feasibility of Phased Construction			
System Footprint	Lagoon footprint remains the same, additional footprint for tertiary treatment and UV. May require to backfill small part of lagoon cell #3 to install MBBR's due to lack of room	Lagoon footprint remains the same, additional footprint for tertiary treatment and UV. May require to backfill small part of lagoon cell #3 to install MBBR's due to lack of room	Larger footprint to install MBBR's compared to other methods. Would require to backfill small part of lagoon cell #3 to install MBBR's due to lack of room
Estimated Cost (2021 $)			
Estimated Capital cost for Initial Phase (including	$16.6 Million	$16.1 Million	$21.9 Million

Criteria/Indicator	Attached Growth Reactor	IDEAL	Post lagoon MBBR
engineering, contingencies + overheads)			
Total Capital Cost for ultimate phase including initial phases (10,482 m3/d)	$19.3 Million	$16.1 Million	$22.5 Million
Average Operations and Maintenance Costs by ultimate phase (10,482 m^3/d) including cost for capital replacement	$570,000	$370,000	$485,000
Life Cycle Cost (30-years assuming 2021 construction) including operation and maintenance costs	$25.6 Million	$22.1 Million	$29.7 Million
Overall Evaluation	**High Replacement Cost**	**Lowest LCC**	**Highest LCC**

Table 6-2: Mechanical Plant Upgrade Evaluation

Criteria/Indicator	Extended Aeration	Conventional Activated Sludge	SBR
Treatment Performance			
Ease of Operation	Simplest to operate.	More complex than extended aeration, and less complex than SBR	Automated process but the most complex to operate
Ability to Include Lagoons in to Design	Lagoon can be used for flow equalization and sludge digestion	Lagoon can be used for flow equalization and sludge digestion	Lagoon can be used for flow equalization and sludge digestion
Ease of Expandability	Room for expansion	Room for expansion	Room for expansion
Feasibility of Phased Construction			
System Footprint	Footprint accommodated within existing property area, but has largest tanks for aerations	Largest footprint due to the need for primary clarifiers	Smallest footprint for mechanical plant options
Estimated Costs			
Capital Costs	$22.5 Million	$23.3 Million	$23.9 Million
O&M Costs	$795,000	$770,000	$810,000
Life Cycle Cost (30-years assuming 2021 construction) including operation and maintenance costs	$27.7 Million	$28.5 Million	$29.3 Million
Overall Evaluation	**High LCC**	**Not Recommended Highest LCC**	**Highest LCC**

Note: Cost for construction of the plants in phases was not evaluated due to much higher cost of these alternatives compared to lagoon based alternatives.

Table 6-3 summarizes all the costs from the previous tables.

Table 6-3: Cost Summary of All Six WWTP Options

Costs	Attached Growth Reactor	IDEAL	Post lagoon MBBR	Extended Aeration	Conventional Activated Sludge	SBR
Capital	$19.3 Million	$16.1 Million	$22.5 Million	$22.5 Million	$23.3 Million	$23.9 Million
Operational[1]	$570,000	$370,000	$485,000	$795,000	$770,000	$810,000
LCC	$25.6 Million	$22.1 Million	$29.7 Million	$27.7 Million	$28.5 Million	$29.3 Million

[1]Average cost over 30 year cycle. Operational costs vary from year to year, costs will be lower in early phases

Table 6-4 categorizes all costs from the lagoon upgrade options including engineering and contingency estimates.

Table 6-4: Cost Breakdown of Lagoon Upgrade Options

Costs	IDEAL	Attached Growth Reactor	Post lagoon MBBR
Equipment Costs	$4,095,300	$5,057,300	$5,380,300
Sludge Management	$576,300	$576,300	$576,300
Installation, Process Buildings and Site Work (including contractor markups)	$6,204,500	$5,576,600	$7,121,800
Process Tanks	$240,000	$240,000	$2,040,000
Sub-total	$11,116,000	$11,450,100	$15,118,200
Contingency (20% of Sub-total)	$2,223,200	$2,290,100	$3,023,700
Engineering Costs (15% of Sub-total)	$1,667,400	$1,717,600	$2,267,800
Mobilization/Demobilization, Insurance, Bonds and Other Overhead Items (10% of Sub-Total)	$1,111,600	$1,145,100	$1,511,900
Total Cost	$16,118,100	$16,602,600	$21,921,400
Total Cost Ultimate Phase	$16,118,100	$19,347,500	$22,522,700

7.0 Recommendations

7.1 Recommended Upgrade Option

Based on the evaluation of upgrade options, implementation of an Intermittently Decanted Extended Aeration Lagoon system (IDEAL), followed by a tertiary filtration system using disc filters and disinfection by UV system is recommended. This system has the estimated lowest capital, operation and life cycle costs, has similar operational complexity to the existing system, has a small additional footprint requirement for added equipment outside of the lagoons and has the least amount of added equipment compared to other options.

An influent flow monitoring and sampling program is recommended prior to proceeding to the final design in order to confirm the design parameters and the sizing of the equipment and facilities.

Population growth projections should also be reassessed prior to proceeding into the final design as well.

7.2 Flow Monitoring and Sampling Programs

Flow monitoring and raw sewage quality sampling are important steps to gather the most accurate information for short and long term planning when it comes to lagoon design.

It is recommended to conduct a flow monitoring study in order to accurately determine the average and peak flows to the plant, as well as their seasonal variation. The flow monitoring program shall be designed to capture the periods of dry weather flow and wet weather flow. A comprehensive long term sampling program of the influent sewage should also be conducted for parameters such as BOD, TKN, TSS, phosphorus and ammonia. The sampling program shall include dry and wet weather seasons. The gathered data will be used to confirm and refine the design parameters used for sizing of the equipment and facilities prior to the final design.

Prior to desludging, sludge volume and quality shall be confirmed prior to developing a dewatering and disposal plan.

It is also recommended to conduct a sludge inventory survey in all cells to confirm the sludge volumes and available volume in Cell 3 to dispose sludge from Cell 1.

8.0 References

Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal. 2020.

Analysis of Sludge Accumulation – Technical Services, Stantec. December 1, 2015.

Lantz WTP System Assessment Report, Municipality of East Hants. December 13, 2017.

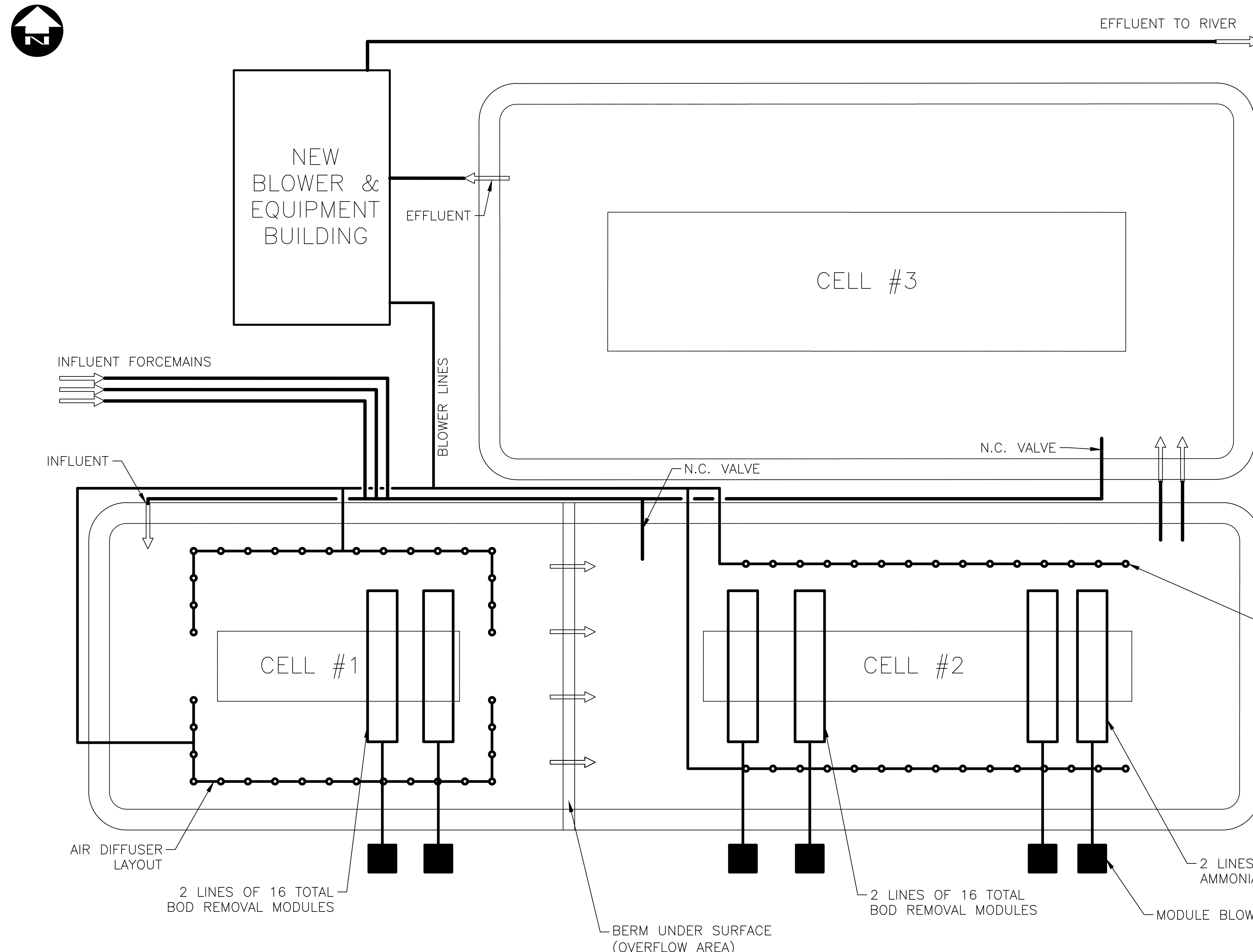
Lantz Annual Reports, Municipality of East Hants. 2019-2020.

Sewer Capacity Study, WSP. November 30, 2015.

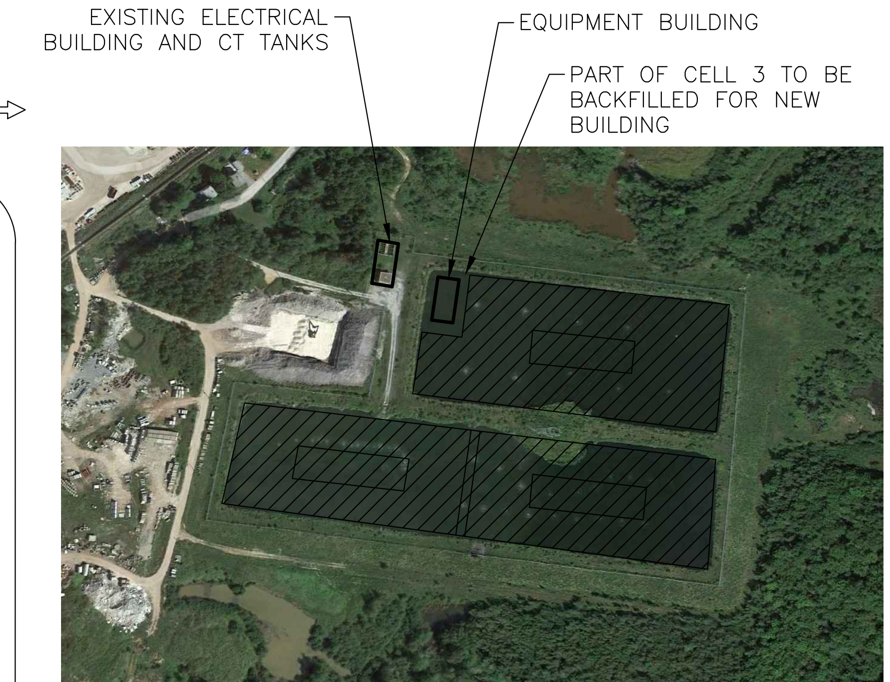
DILLON CONSULTING

Appendix A

Preliminary Layouts



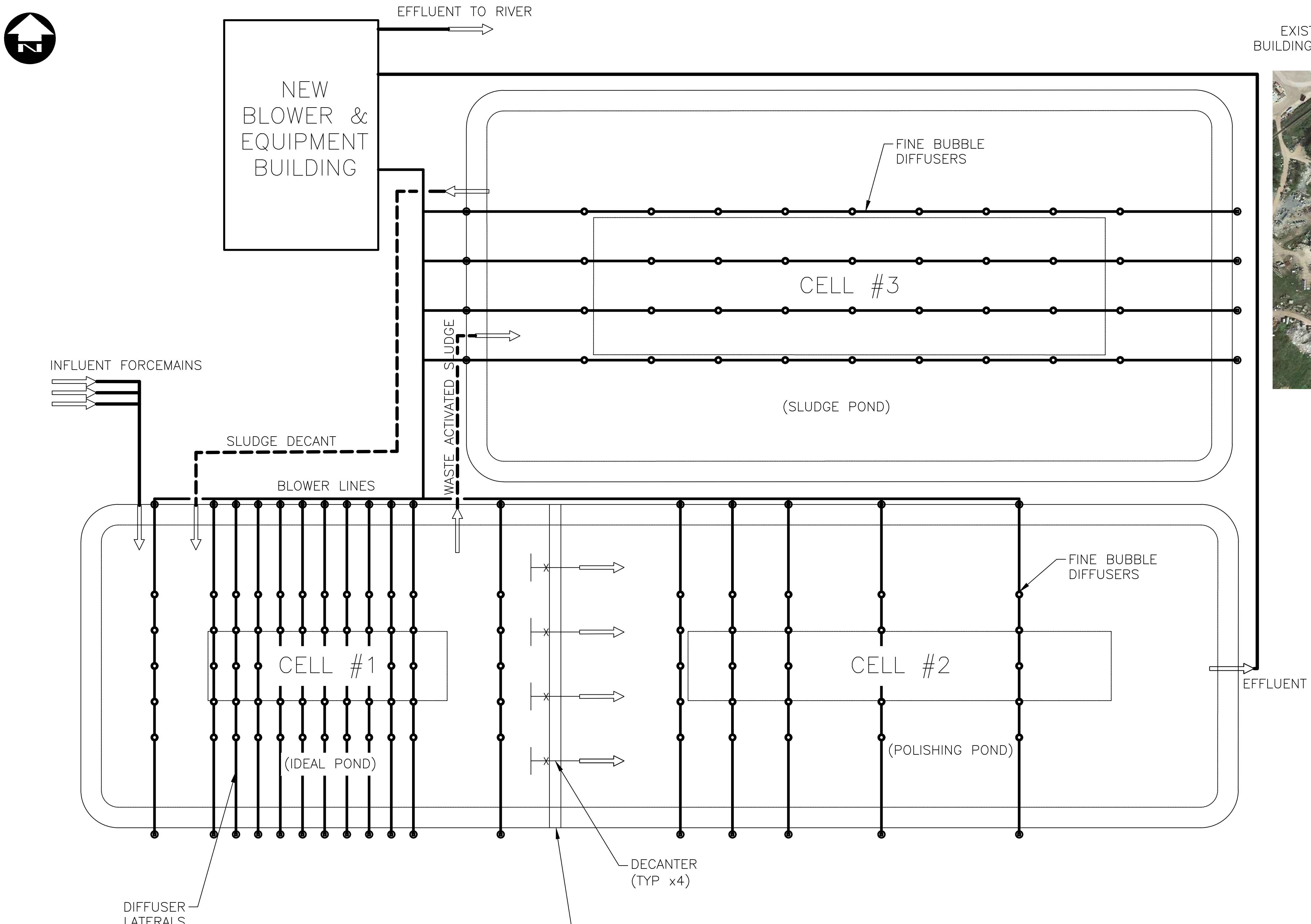
PLAN
NTS



AERIAL PHOTO
NTS

DILLON CONSULTING	PROJECT MUNICIPALITY OF EAST HANTS REGIONAL WASTEWATER TREATMENT PLANT	PROJECT NO. 21-1665
DATE March 2022	TITLE OPTIMIZATION STUDY-PRELIMINARY LAYOUT FLOATING ATTACHED GROWTH REACTOR	FIGURE NO. A-1

FileName:c:\pw working directory\projects 2021\dillon_43abs\dms19839\211665-10-www-fig.dwg



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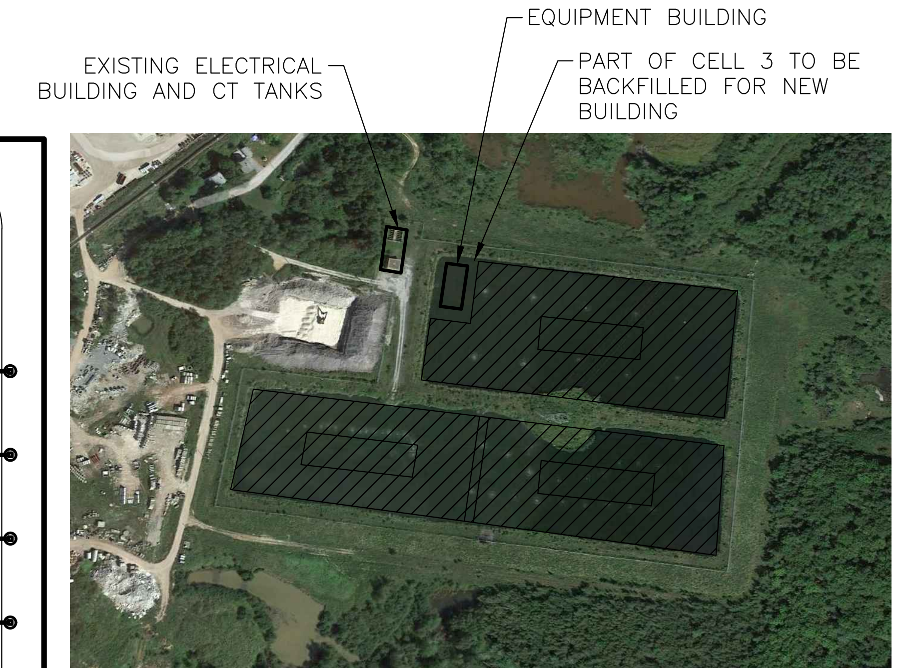

AERIAL PHOTO
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DILLON CONSULTING	PROJECT MUNICIPALITY OF EAST HANTS REGIONAL WASTEWATER TREATMENT PLANT	PROJECT NO. 21-1665
DATE March 2022	TITLE OPTIMIZATION STUDY-PRELIMINARY LAYOUT INTERMITTENTLY DECANTED EXTENDED AERATION LAGOON SYSTEM	FIGURE NO. A-2

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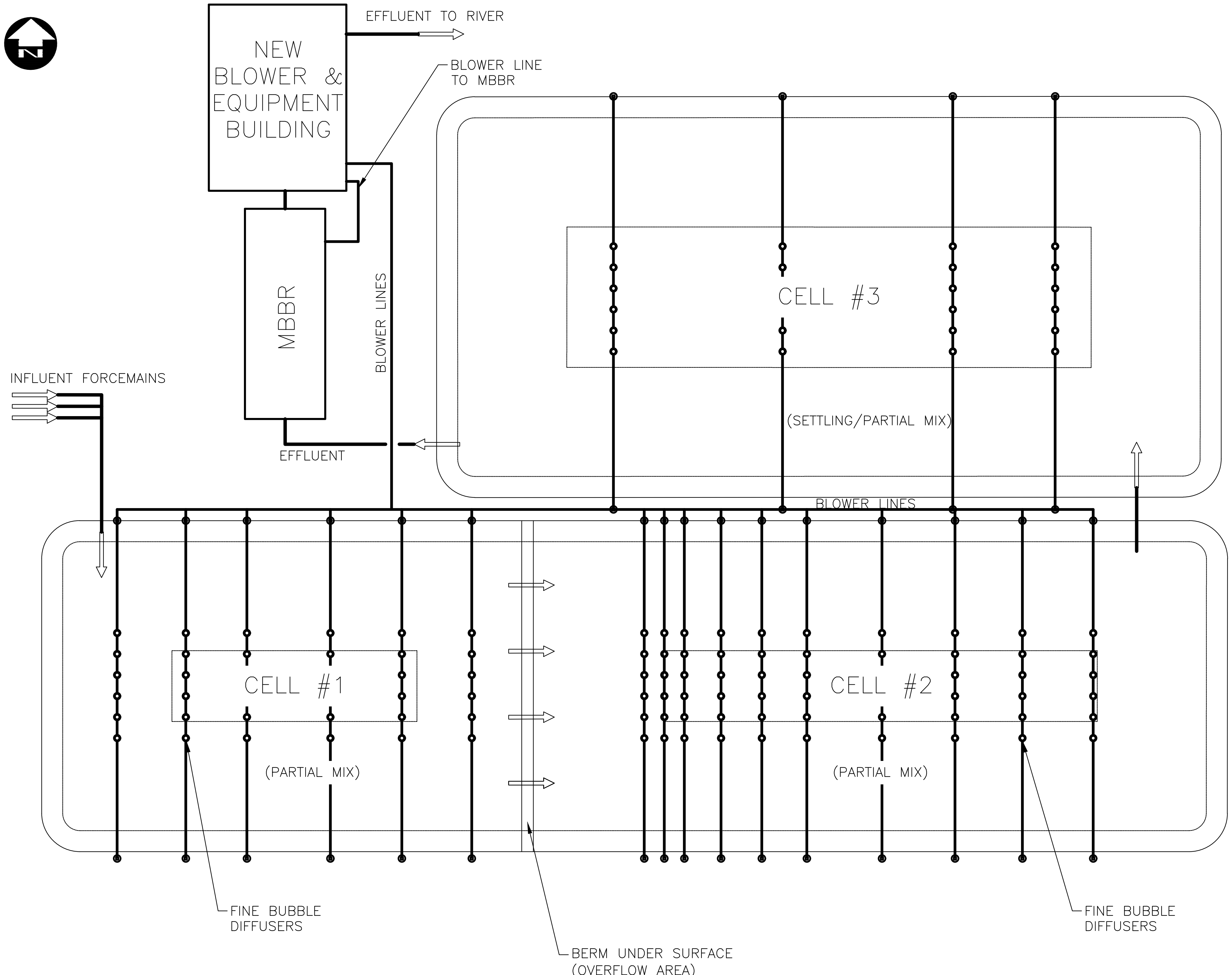

PLAN
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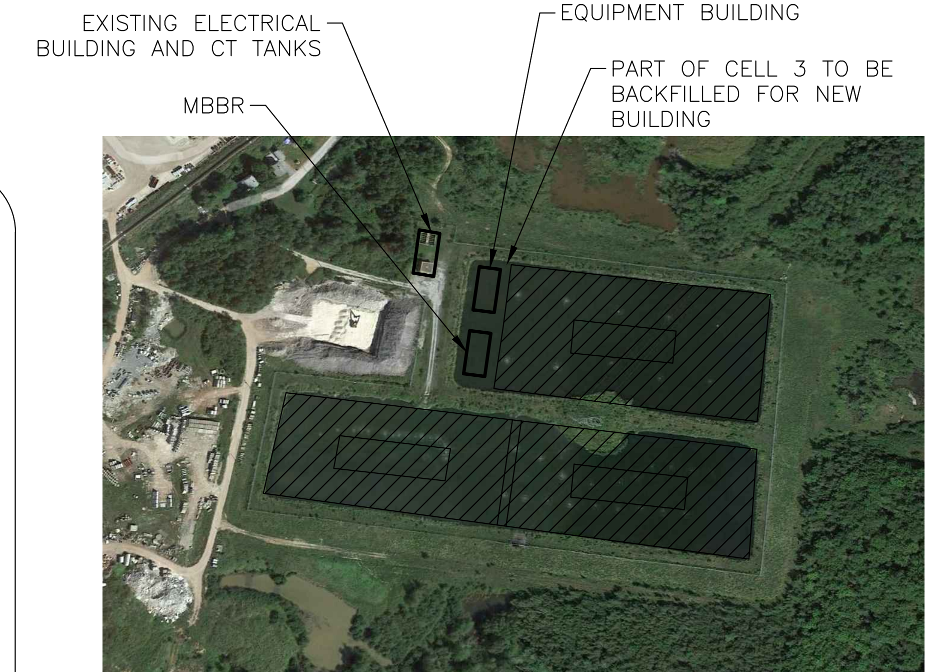

AERIAL PHOTO
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DATE March 2022	TITLE OPTIMIZATION STUDY-PRELIMINARY LAYOUT POST LAGOON MBBR	FIGURE NO. A-3

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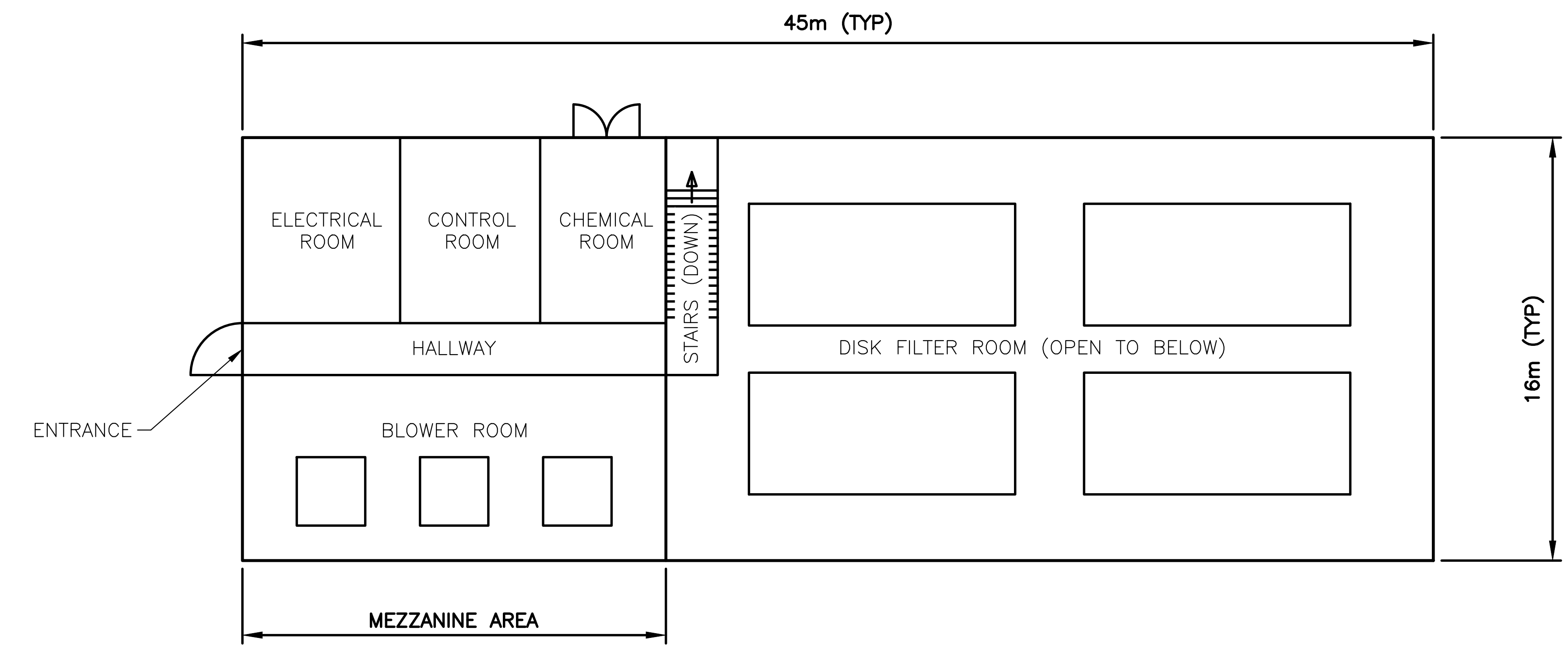
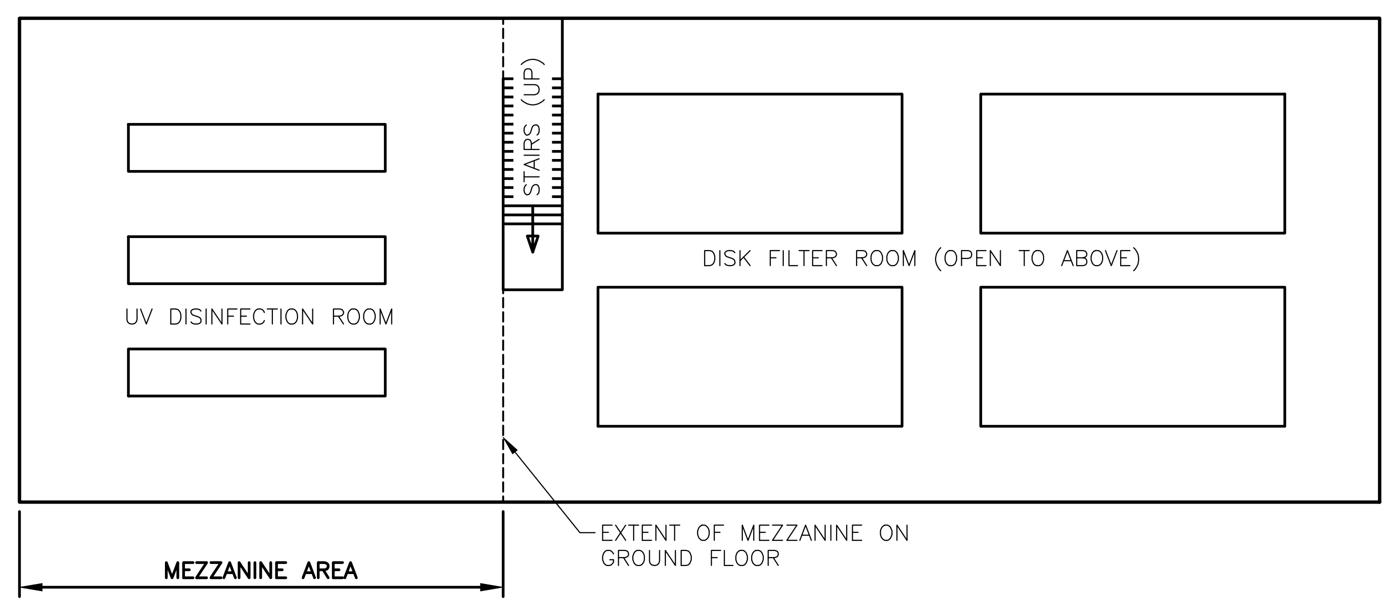


UPPER LEVEL (GROUND FLOOR)

NTS



LOWER LEVEL

NTS

DILLON CONSULTING	PROJECT MUNICIPALITY OF EAST HANTS REGIONAL WASTEWATER TREATMENT PLANT	PROJECT NO. 21-1665
DATE March 2022	TITLE OPTIMIZATION STUDY-PRELIMINARY LAYOUT EQUIPMENT BUILDING	FIGURE NO. A-4

Appendix B

Equipment Information

Nexom®

infini-D™ ZERO-DOWNTIME CLOTH DISK FILTER

Criteria		infini-D™
Effluent Quality		
Turbidity	<2 NTU	●
Total Suspended Solids (TSS)	<5 mg/L	●
Advantages		
Remove phosphorus as well as solids		●
Title 22-approved filter cloth		●
Maintain individual disks while filter is online		●
Inspect performance of individual disks		●
Applications		
Phosphorus removal		●
Approved **water reuse**		●
TSS reduction		●
Tertiary filtration		●
Post-lagoon filtration		●
CSO treatment		●

Problem

Your plant needs to meet reuse requirements and/or phosphorus limits. You want a proven solution that will meet your requirements without a substantial increase in footprint or O&M, and the idea of overpurchasing equipment to accommodate maintenance downtime doesn't sit well with you either.

The Nexom Answer

The infini-D™ Zero-Downtime Cloth Disk Filter removes TSS, is approved for Title-22 reuse, and can be configured to remove phosphorus, all in the simplest O&M filter available. Here's why:

- **Removes TSS** to <5 mg/L
- **Removes phosphorus**, meeting limits as low as 0.3 mg/L
- **Easy and cost-effective to operate:** Individual disks' effluent can be isolated, evaluated and, if necessary, disks can be maintained while filter remains online.
- **Uses pile cloth** that filters without the risk of long-term fouling.

How infini-D™ works

In the infini-D cloth disk filter, water enters the tank and passes through the cloth filter media, on the outside of which solids collect. The disks don't rotate: to eliminate rotating seals and effluent contamination in the case of a seal failure, only the vacuum head rotates around the disk during the automatic backwash cycle.

Designed to be better

The infini-D cloth filter uses individual effluent ports for each disk to enable operators to monitor individual disks' operation and isolate performance metrics. If a disk cloth needs to be replaced, these effluent ports enable each disk cartridge to be removed without stopping filtration.

technologies for cleaner water

5 Burks Way · Winnipeg MB · R2J 3R8
888·426·8180 • **www.nexom.com**

infini-D helps Camp Verde keep ball diamonds green through water reuse

Located 90 miles north of Phoenix in arid Arizona, Camp Verde was exploring plans in 2017 for a new outdoor sports complex including six baseball fields. The town's engineers decided on irrigation using reuse wastewater, which would mean the 24-hour average turbidity criterion of <2 NTUs and must not exceed 5 NTUs at any time. After exploring various options, they chose Nexom's infini-D™ Cloth Disk Filter for tertiary treatment for achieving a Class A+ target.

Construction started in October 2018. Engineers and staff at the WWTP in Camp Verde did most of the installation work, with guidance and input from the operations team at Nexom. The Infini-D system was commissioned in July 2019. Since then, they have successfully treated their wastewater to a Class A+ level, enabling them to begin irrigating the nearby baseball fields as planned.

Nexom knows filtration

The Nexom team has been pushing the bounds of filtration for over decade, covering hundreds of projects across the U.S and Canada. Our engineers are the leading experts in a range of technologies and pioneered Blue PRO reactive filtration.

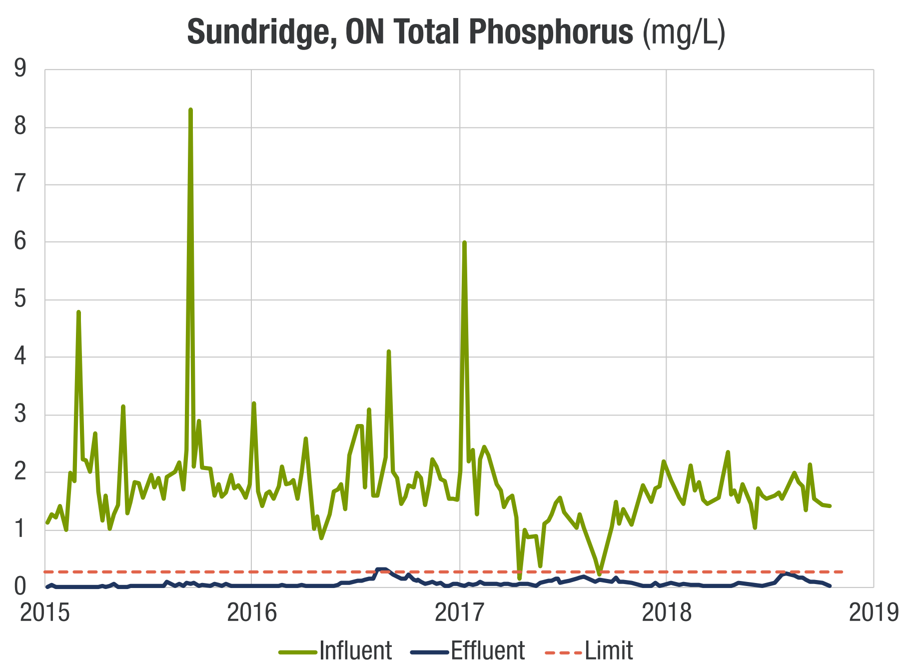
Nexom brings this experience and the patented processes it has developed to the world of disk filters with infini-D. With dozens of sites across North America already using the technology, infini-D is the go-to technology for TSS and phosphorus removal as well as meeting reuse requirements!

Sundridge meet Phosphorus limit with post-lagoon infini-D filter

The infini-D cloth disk filter is also the signature component in the system which Nexom designed to meet Sundridge, Ontario's low Phosphorus limits.

Targeting an effluent phosphorus level of 0.27 mg/L, the engineers chose to place the disk filters after the lagoons and the SAGR, so the majority of the phosphate flocs could settle out well in advance, improving the phosphorus-removal performance and further saving operating costs on the disk filters.

With over three years of data under its belt, the Sundridge plant has seen influent phosphorus as high as 8.3 mg/L, but has demonstrated consistent compliance with it's effluent results, with an average effluent phosphorus of 0.07 mg/L (anything below 0.03 mg/L registered as undetectable on the test).



UPGRADING WITH INFINI-D IS EASY AND EFFECTIVE

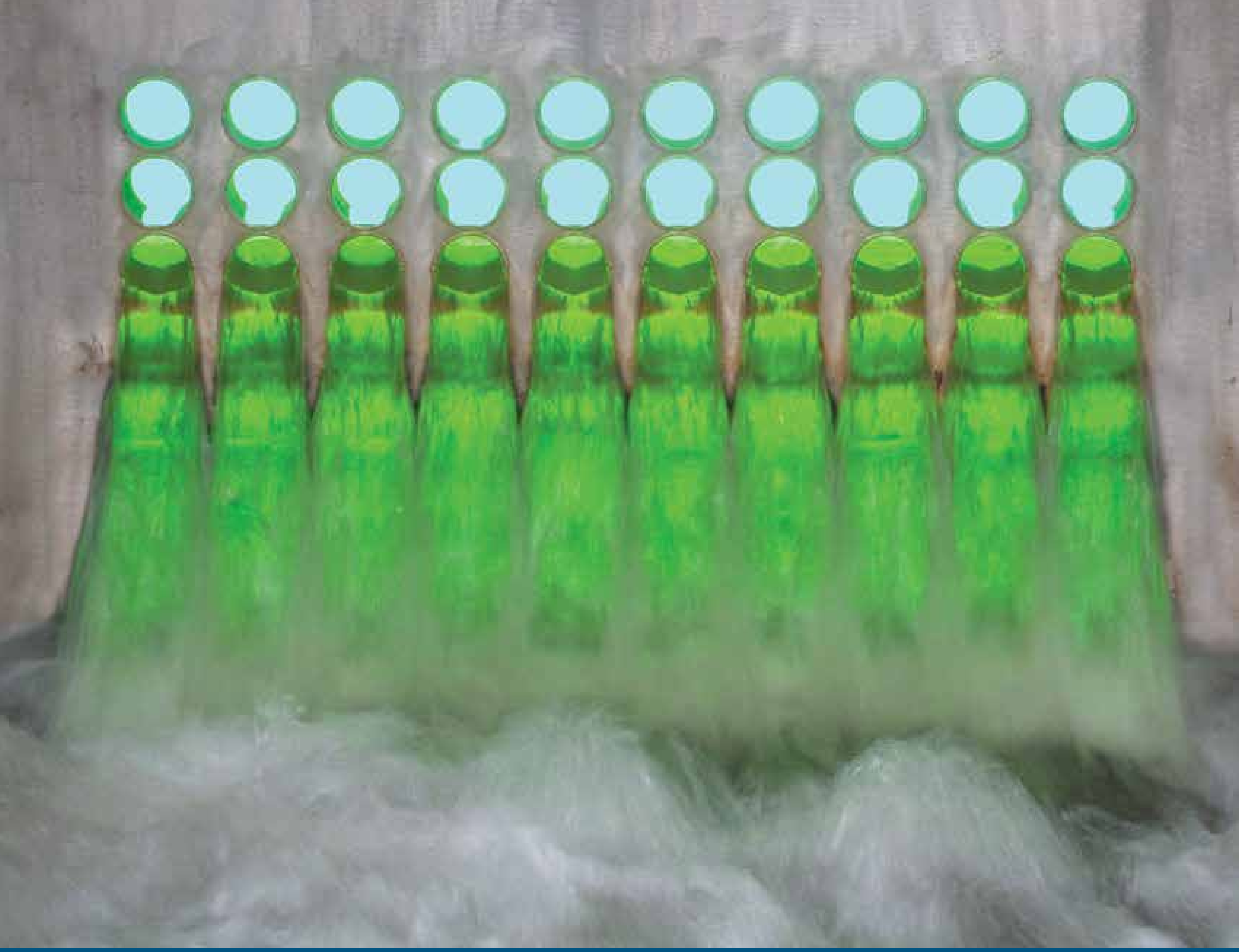
1 **We walk you through exactly what project details we need. Call 888-426-8180 or email info@nexom.com.**

2 **We supply design-ready drawings, proprietary technologies, and responsive support.**

3 **You never worry about your TSS, Turbidity, or Phosphorus levels again.**

Non-contact UV disinfection systems

Dry · Simple · Intelligent · Energy Efficient



ENAQUA™
A GRUNDFOS COMPANY

Designed and manufactured in USA

The right choice

UV is the most cost effective and environmental friendly disinfection solution for wastewater.

About UV Disinfection

Ultraviolet light irradiation is a proven disinfection process using short wave length 254nm Ultraviolet (UV) energy to inactivate harmful microorganisms. UV radiation disrupts the DNA of pathogenic organisms such as bacteria, viruses and molds, leaving them unable to reproduce. UV has been used to disinfect various types of effluent from low-quality combined sewer overflow (CSO) to high-quality tertiary effluent since early 1900's.

UV – The preferred disinfection method in municipal wastewater

To comply federal Clean Water Act, and other regulations for indicator organisms, municipal wastewater must be disinfected before discharging or reusing. There are multiple options for chemical disinfection, but only one non-chemical disinfection technology. UV is the preferred disinfection method for municipal wastewater discharge or water reuse applications various chemical disinfection technologies. Currently more than 20% of wastewater treatment plants in the United States use UV as their preferred disinfection technology and this percentage has been increasing year over year.

Enaqua – a history of innovation

1985	1990	1992	1993	1997	1999	2003	2007	2009	2012	2013	2015	2017
Enaqua founded									**Acquisition by Grundfos**			
First Non-Contact UV System Water Technology Consulting	Patented Non-Contact Opaque Fluid UV System	Chemical Recovery RO Systems Brackish Water RO Systems	Municipal UV Waste-water System	Distribution of Membrane Products	Large Municipal UV Waste-water Systems	Seawater De-salination RO Systems	UV Web-based Control System	UV / UF / RO Municipal Waste-water Systems	Ensure Dosing System(EDS)* SMART Lamps*	$11 Million UV/ UF/ RO Chemical Recovery System	Validation test NWRI Title 22 and T1	Approval for CA Title 22 recycled water

*Patent pending

Advantages & benefits

Compared to conventional chlorination

	Ultraviolet light	Sodium hypochlorite	Chlorine gas
Disinfection effectiveness	High	High*	High*
Disinfection by products	No	Yes	Yes
Safety risks	Low	High	High
De-chlorination required	No	Yes	Yes
Contact channel	Small	Large	Large
pH dependency, Corrosion	No	Yes	Yes
O&M Cost	Low	High	Medium
Capital Investment	Medium	Low	High

**Cryptosporidium and Giardia are resistant against chlorination*

Third party validated technology, approved for CA Title 22 Recycled Water.

Enaqua is the first non-contact UV system supplier to have applied and received Third Party Validation, as a result of continuous efforts improving the Non-Contact UV disinfection technology. The validation testing and reports were conducted in 2015 by Carollo Engineers in accordance with the following protocols:

1. UV - Disinfection Guidelines for Drinking Water and Water Reuse (National Water Research Institute [NWRI]), August 2012
   • 53% to 80.0 % UVT range validated*
2. Uniform Protocol for Wastewater UV Validation Applications (International Ultraviolet Association [IUVA], 2011) – 36.0% to 81.0% UVT validated range*
   • MS2 Bacteriophage
   • T1 Coliphage

**Please contact Enaqua for validation range, parameters, and other technical details.*

UV made simple – features at a glance

All of Enaqua's Non-Contact UV disinfection systems are built out of standard modules with high customization flexibility. The UV reactors are offered for both In-pipe or In-Channel configurations with variable plug & play inlets and outlets (page 10).

The systems are very easy to install as they are prefabricated and self-contained.

1 SMART Lamps
Cost efficient non-amalgam SMART lamp (page 9)

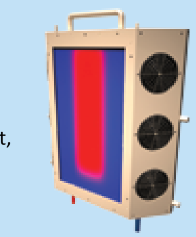
AFP™ Tubes
Fouling resistant virtually self-maintaining (page 6)

2 Ensure Dosing System (EDS)
Intelligent monitoring, control and FAIL SAFE ensures compliance at all times (page 8)

3 Electrical panel
Simple, compact and operator friendly HMI

4 Flow & Level pacing
Optimize energy consumption & life of consumables

5 Heat Exchange System
Controls reactor temperature for optimal UVC output using Effluent, plant W3 water, Potable, or Closed Loop system



6 UV Intensity Monitor
UV Sensor placed outside of AFP™ tubes – Dry without fouling

7 Individually fused and switched lamp racks
No cranes required, simple maintenance (page 7)

Single lamp ballast
Non-prorated Warranty up to 24 on/off cycles per day

8 Controlled Water Level Downstream
No level control mechanism required – simple hydraulic design

Always dry – AFP™ Non-Contact UV Technology

Enaqua – The Pioneer in cost effective Non-Contact UV design

Enaqua's innovative non-contact UV technology means no more repairing and replacing submerged components. Effluent flows through Enaqua's AFP tubes leaving the UV lamps, electronics and other components- accessible, and easy to maintain in the dry body of the UV reactor.

AFP™ tubes – The secret behind the performance

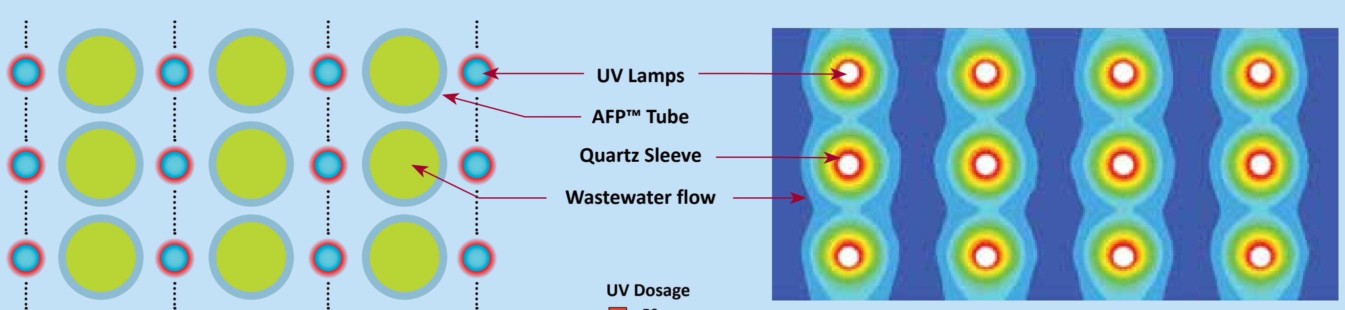
AFP stands for "Activated Fluoropolymer" which Enaqua specifically developed for Non-Contact UV applications:

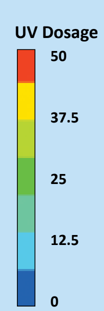
- High transmissivity of UVC
- AFP Tubes have no micro-structure-hence very resistant to scaling and fouling
- Durable, flexible, and fracture resistant material
- Long term UVC stability and Chemical resistance
- Multiple plants with over 20+ years of continuous operation

Technologies in comparison

ENAQUA AFP™
Non-Contact Technology

Quartz Sleeve UV
traditional Contact Technology





ENAQUA AFP™

- Low cost high output lamps
- No quartz sleeves
- Fouling and Scaling Resistant AFP tube
- Turbulent flow provides self-cleaning of AFP™ tube
- No AFP tube replacement needed under normal operating conditions
- Simple pipe hydraulics makes UV disinfection easy to predict
- Level Control Devices typically not required

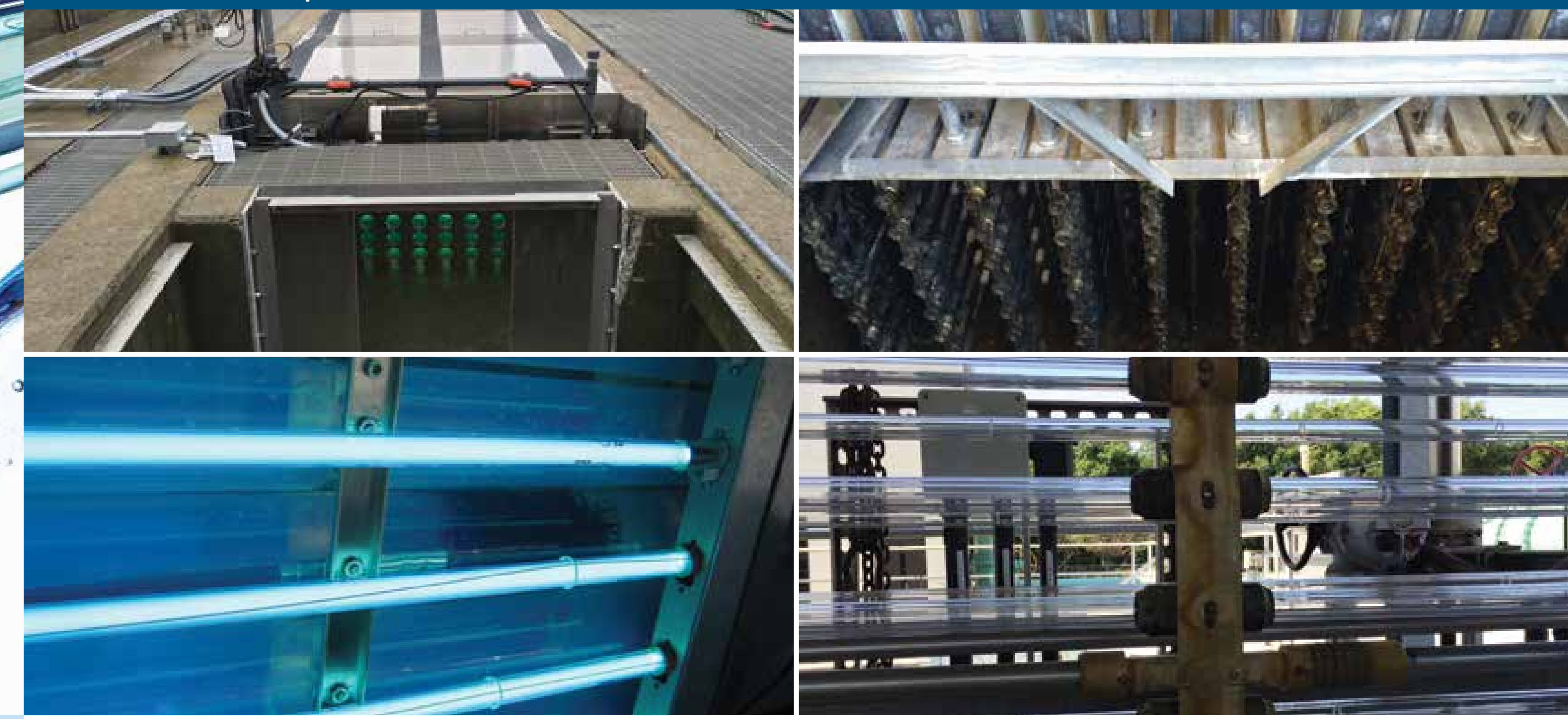
Quartz Sleeve UV

- High cost amalgam lamps
- Fragile quartz sleeves with risk of mercury and glass contamination
- Fouling-prone quartz sleeves
- Cleaning system required
- Quartz sleeves need to be replaced over time
- Channel hydraulics makes UV disinfection less predictable
- Level control devices increase footprint

Simple – maintenance made clean, fast and easy

Enaqua's Non-Contact UV technology system maintenance is simple:

Enaqua's Non-Contact UV	Traditional Contact UV

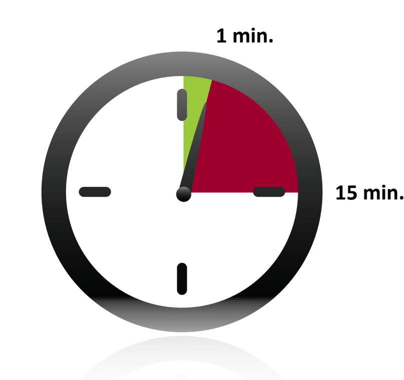


No more:

- High cost amalgam lamps
- Dirty and fouled quartz sleeves
- Problems with quartz cleaning devices
- Need to interrupt or remove any hydraulic seals
- Heavy duty cranes required for system maintenance
- Minimize Civil and Structural construction costs
- Time consuming lamp replacements
- Algae growth on the lamp racks
- Quartz sleeves to break and replace*
- SCADA programming

**No AFP™ tube replacement under normal conditions (20+ year history)*

Typical lamp replacement time



1 minute – Enaqua's Non-Contact UV

15 minutes – Traditional Contact UV

Intelligence – you don't want to miss...

Where Energy Efficiency matters

The Ensure Dosing System (EDS) is the most comprehensive monitoring and control system in the industry.

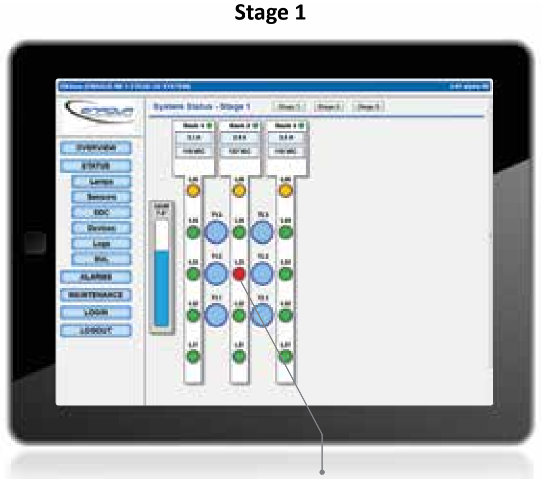
SCADA built in – Full system control and performance monitoring wherever and whenever you want:

- No special hardware and software requirements
- Simple connection via web browser
- Multiple Levels of Access
- Remote monitoring and control via Internet
- Stand-alone WiFi control e.g. with iPad®
- SCADA integration with ModBUS TCP/IP
- Remote troubleshooting
- Email and text notification

Fail Safe – Intuitive protection

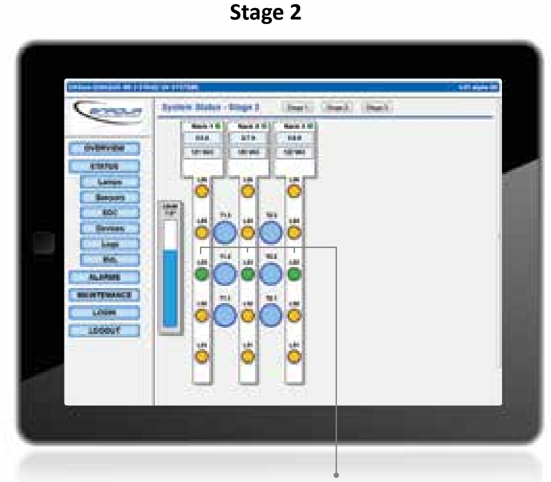
Enaqua's FAIL SAFE intelligence ensures compliance at all times. In case a lamp in one stage fails, the system will command selected lamps in a redundant stage to power-on to compensate for any UV dosage reduction (see application example).

Stage 1



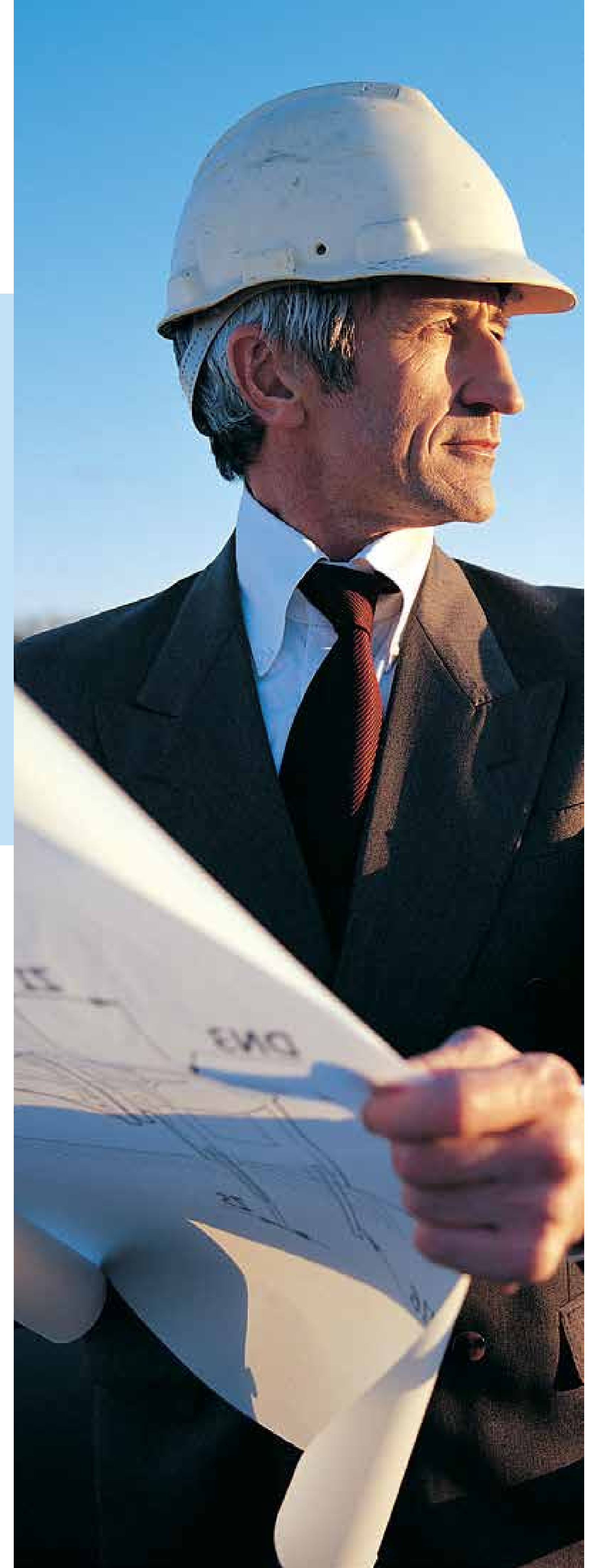
Lamp fault in stage 1: Alarm Alerts

Stage 2



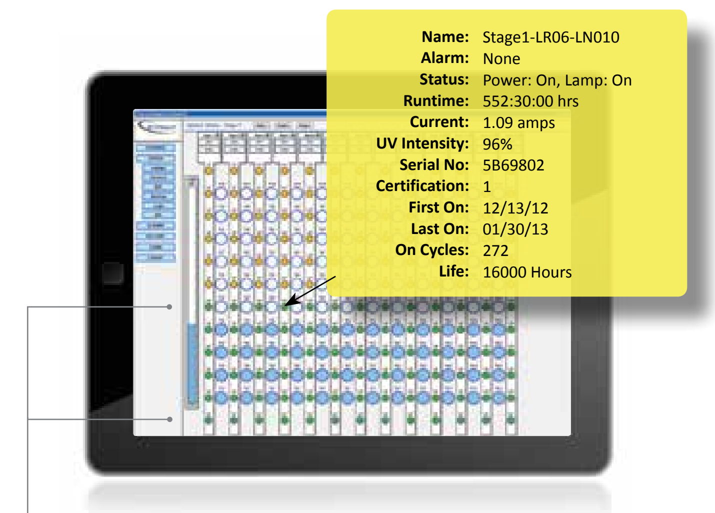
Automatically energizes ONLY selective lamps in Stage 2 to ensure disinfection while optimizing use of energy and consumables

Ipad® is a registered trademark of Apple



SMART Lamps – Advanced lamp control

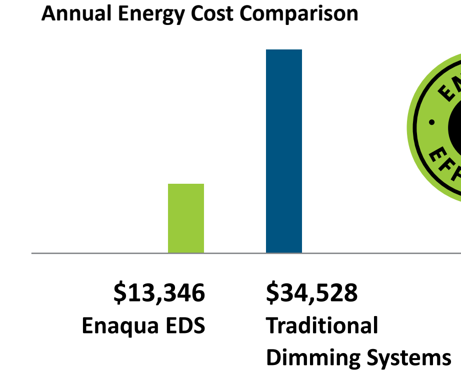
Enaqua's Low Pressure High Output (LPHO) lamps are equipped with a unique Smart Lamp Technology, a microchip integrated with the lamp connector identifies each UV lamp with a unique ID, monitors and logs lamp status, run time, lamp cycles, etc.



Flow & Level Pacing – Best energy efficiency

Enaqua's Flow & Level Pacing system automatically turns on only lamps which are required. This improves lamp and ballast life and reduces power consumption compared to systems that use "dimming".

Annual Energy Cost Comparison



ENERGY EFFICIENT

Actual comparison of bid guaranteed UV energy costs for Wastewater Plant, Peak 28MGD, Average 6MGD, $0.10/kWh.

Features and functions

For specific selection and sizing please contact Enaqua

		M3	M4	M5	C-Series	D-Series	E-Series
Maximum F low and Pressure							
Flow Range*1	MGD	0.03 - 0.12	0.04 - 0.17	0.2 - 0.5	0.5 - 10	0.5 - 21	0.5 - 27
	gpm	20 - 80	30 - 120	140 - 350	350 - 6944	350 - 14600	380 - 18500
	m3/h	5 - 18	6.8 - 27	32 - 80	80 - 1600	80 - 3300	80 - 4200
Max. Operating Pressure	psi	40*[2]	40*[2]	40*[2]	20	15	10
	bar	2.8	2.8	2.8	1.4	1.0	0.7
Mechanical data							
Max. Number of AFP™ Tubes	pcs	2	2	6	180	160	140
Max. UV Lamps per Stage	pcs	8			228	204	180
Inlet and Outlet Configuration	inch	Flange 2	Flange 4, 6	Flange 8, 10	In-Channel or Flange Options		
Wetted Materials		AFP™, 304SS Option: 316SS, PVC, CPVC		AFP™, 304SS Option: 316SS			
Multistage Design		–	–	Option	Option	Option	
Electrical data							
Operating Voltage at 50/60 Hz	V, 1PH	120, 220			220		
	V, 3PH	–		220, 380, 415, 480*[3]			
Ballast Type		Auto Ranging 110-277 VAC 50/60 Hz with 5 Year Warranty					
Controls							
LCD Status Display		✓	✓	✓	Option	Option	Option
Hand-Off-Automatic Switch		✓*[4]	✓*[4]	✓	✓	✓	✓
Control Light: Alarm/Running		–	–	✓	Option	Option	Option
Individual Lamp Rack Fuse and Switch		✓	✓	✓	✓	✓	✓
UV Status LEDs in Lamp Racks		–	✓	✓	✓	✓	✓
Ensure Dosing System (EDS)		Option	Option	Option	✓	✓	✓
SMART Lamps		✓	✓	✓	✓	✓	✓
Flow & Level Pacing		–	–	–	Option	Option	Option
Fail Safe		Option	Option	Option	Option	Option	Option
UV Sensor		Option	Option	Option	✓	✓	✓
Heat Exchange System (Lamp Temperature Control)		Ambient Air Exchange			Air to Air. Air to Liquid using Effluent, plant W3 water, Potable, or Closed Loop system		

*1 Design consideration 65% UVT, ~30 mJ/cm^2, Contact Enaqua for more details
*2 Max pressure for High Pressure Option: 80 psi (5.5 bar)
*3 Three-phase voltage requires neutral wire
*4 On/Off switch only

M Series UV reactors

– compact uv reactors ideal for small treatment plants for surface discharge, reuse, and industrial applications.

M3 Series
Flow rates up to 80 gpm (18.2 m^3/ h)

M4 Series
Flow rates up to 120 gpm (27.25 m^3/ h)

M5 Series
Flow rates up to 360 gpm (81.8 m^3/ h)

C1, C2, C3 & D1, D2, D3 UV series reactors

– medium size uv reactors for surface discharge, reuse, and industrial applications.

C1 & D1 Series
In pipe UV reactors , single or double banks- for Flow rates up to 2.0 MGD (315.4 m^3/ h).

C2 & D2 Series
In pipe UV reactors, single or double banks- for Flow rates up to 4.2 MGD (662.5 m^3/ h).

C3 & D3 Series
In pipe UV reactors, single or double banks- for Flow rates up to 6.0 MGD (946.4 m^3/ h).

4 – 11 Series UV reactors

– large uv reactors offered "in-pipe" or " in-channel" configurations.

C Series "In pipe" or "In Channel"
Multi Bank UV reactors for Flow rates up to 24.0 + MGD . Applications– UV disinfection for surface discharge, Reuse, industrial appli-cation, Etc.

C Series "In Pipe " Reactor

C Series "In Channel" Reactor

D Series "In pipe" or "In Channel"
Multi Bank UV reactors for Flow rates up to 36 + MGD . Applications– UV disinfec-tion for surface discharge, CSO, Industrial Applications, Etc.

D Series "In Pipe " Reactor

D Series "In Channel" Reactor

E Series "In Channel"
Multi Bank UV reactors for Flow rates up to 100 + MGD . Applications– UV disinfection for surface discharge, CSO, Etc.

Designed and manufactured in USA

Enaqua – UV made simple
Non-contact UV disinfection

- The **Engineer's Choice** for State-of-the-Art Technology
- The **City Manager's Choice** for Low Capital Cost
- The **Superintendent's Choice** for Low O&M Cost
- The **Operator's Choice** for Simple Operation
- The **Contractor's Choice** for Simple Installation
- The **Finance Director's Choice** for Lowest 20 Years Capital and Operations Cost Potential

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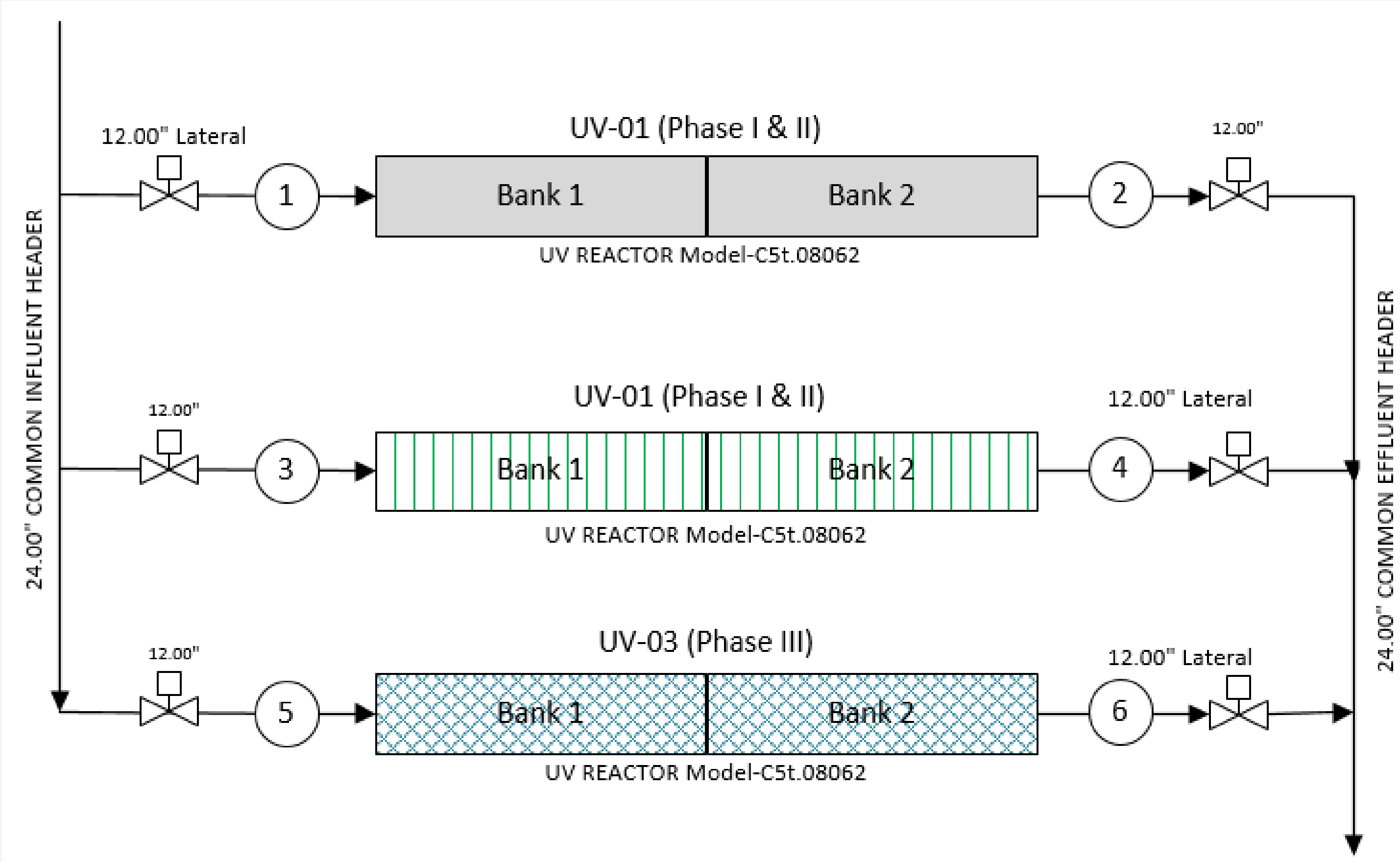
A GRUNDFOS COMPANY

Figure 1: Preliminary Process Flow Diagram



VEOLIA

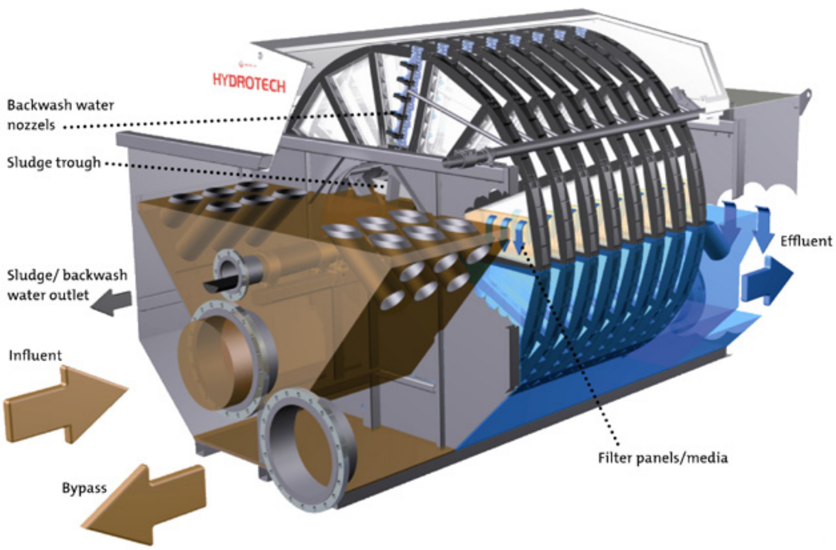
Hydrotech Discfilter
Pure Performance

WATER TECHNOLOGIES

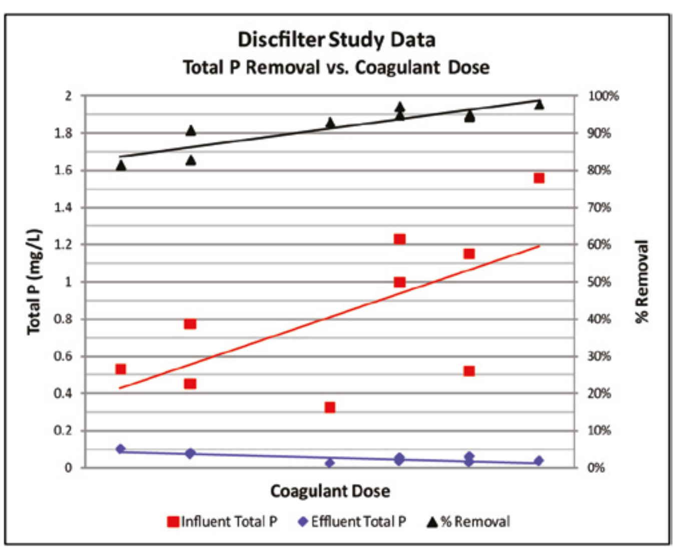
The Discfilter Process

The Hydrotech Discfilter provides proven experience for today's demanding wastewater treatment applications through an efficient, yet easy-to-operate design. Influent flows by gravity into the center drum and then passes through the filter media mounted on both sides of the discs. The solids are retained on the media within the discs. Only purified water flows to the collection tank. The inside-out flow path prevents solids accumulation in the tank.

As solids collect on the inside of the media the influent water level rises. Maximum head loss through the media is <12 inches. The inlet water level is measured and the control system automatically initiates backwashing. The filtered effluent is pumped to the backwash spray nozzles, washing solids into the sludge trough as the discs rotate. The backwash water is typically 1% to 2% of the total flow to the filter, while the sludge return is typically <1%. Filtration is continuously maintained, even during backwash.



Advanced Treatment



Hydrotech Advantages

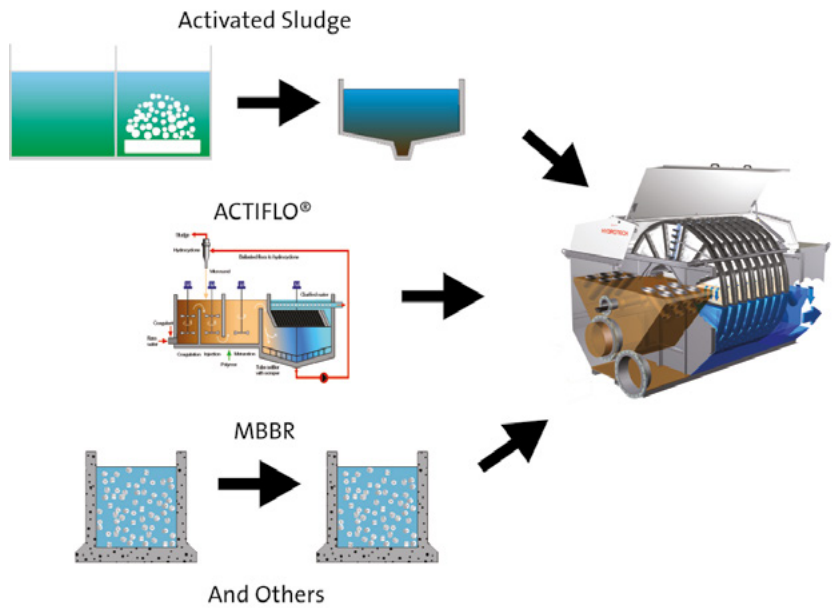
- Unmatched experience and performance
- Innovation: patented designs offer real savings
- Robust construction with 304 or 316 SSTL
- Proven media: durable and chemically resistant
- Meets or exceeds Title 22 requirements at hydraulic loading rates up to and above 6 gpm/ft²
- Consistently produces high quality effluent despite high-solids loadings and upset conditions
- Ideal for "retro-fit" projects in existing basins
- Compact design requires far less space
- Simplified control system and lower installation costs than other filtration technologies
- Improved backwash efficiency reduces operating costs and carbon footprint
- Veolia has pioneered use of the discfilter in combination with coagulation/ flocculation as a cost effective means to reduce effluent phosphorus to < 0.1 mg/L

Proven Performance

The compact Hydrotech Discfilter is used in a wide range of applications:

- Effluent polishing of wastewater
- Phosphorus removal
- Water reuse (Title 22 approved)
- Retrofit/replacement of existing systems
- CSO, SSO, and primary treatment
- Process water filtration
- Membrane pre-treatment

The Hydrotech Discfilter is ideal for treating effluent from a variety of processes (e.g., activated sludge, fixed film, etc.). Veolia offers full-scale pilots to demonstrate performance.



Designed To Save

Hydrotech systems enable customers to achieve performance with lower cost and straight-forward maintenance. Hydrotech Discfilters provide a large filter area in a small footprint; up to 75% smaller than sand filters and up to 20% smaller than other cloth filters.

The discfilter is delivered as an assembled unit. Other cloth filters require substantial labor for site assembly and a larger footprint for backwash pumps and valves. The discfilter eliminates these concerns and costs. Installation is as simple as off-loading from a trailer, anchoring the unit, and completing mechanical and electrical connections.

O&M is simple and reduces operating costs. Fabrication is in 304 or 316 SSTL for trouble-free operation in the toughest conditions. Durable filter media provides long life without frequent and costly replacement. The efficient backwash process reduces energy costs.

Progressive Innovation

The Hydrotech Discfilter is available in a variety of models:

1700 series

- Up to 8 discs
- Up to 1 MGD per unit in effluent polishing
- Ideal for small scale projects

2200 series

- Up to 24 discs
- Up to 9 MGD per unit in effluent polishing
- Excellent for a wide range of project sizes

2600 series

- Up to 30 discs for 15 MGD per unit in effluent polishing
- Provides highest filtration area and most compact footprint
- High flow rates maximize treatment in a given footprint
- Energy reduced 15% and footprint by 25%
- User-friendly design for minimal maintenance

HYDROTECH DISCFILTER REFERENCE LIST - CANADA

VEOLIA WATER TECHNOLOGIES CANADA

MARKET	CLIENT	PROV	DATE	FLOW (m3/d)	Application/ Parameters
Municipal	Okotoks	AB	2009	24 400	TSS ≤5 mg/L
Municipal	Sunshine Village	AB	2009	300	TSS ≤5 mg/L
Municipal	Fort MacLeod	AB	2011	17 800	Activated sludge; TSS ≤5 mg/L, PT <0,5 mg/L
Municipal	Okanagan Falls	BC	2012	2 000	Activated sludge; TSS ≤5 mg/L
Mining	KGHM Victoria Copper Nickel Mine, Sudbury	ON	2014	3 000	Actiflo polishing; Metals, TSS
Mining	DeBeers Diamond Mine, Snap Lake	NT	2014	10 000	ACTIFLO polishing; TSS
Municipal	Calgary Bonnybrook WWTP	AB	2016	248 000	Activated sludge; TSS <3 mg/L, PT 0,18 mg/L
Mining	Brucejack Pretivm Permanent Plant	BC	2016	10 500	Metals
Municipal	Conestoga Tertiary Discfilter	ON	2016	148	Activated sludge; TSS <5 mg/L, PT <0,2 mg/L
Municipal	WildRose WWTP	AB	2017	410	Activated sludge; TSS, BOD
Municipal	Banff WWTP	AB	2017	12 350	Activated sludge; TSS <5 mg/L
Pulp & Paper	Canfor Pulp Ltd.	BC	2018	215 000	ACTIFLO polishing; TSS <5 mg/L, Color <10 TCU
Municipal	Casselman WWTP - **Post-Lagoon**	ON	2019	5 000	LagoonGuard polishing; TSS <15 mg/L, PT < 0,8 mg/L
Municipal	Cultus Lake - North Cultus WWTP	BC	2019	900	Activated sludge; TSS <10 mg/L
Municipal	Galt WWTP DF	ON	2019	160 000	Activated sludge; TSS <5 mg/L, PT <0,2 mg/L
Food & Bev	Parmalat Winchester	ON	2019	2 400	TSS <20 mg/L, PT <0,6 mg/L
Municipal	St-Paul WWTP	AB	2019	13 000	Activated sludge; TSS <10 mg/L
MINING	Battle North Gold - Bateman Gold_Rubicon	ON	2020	3 100	< 15 mg/L TSS
MW	Kingsville Cottam LagoonGuard	ON	2020	1 203	LagoonGuard polishing; TSS<10 mg/L, P
MINING	PureGold Mining-Madsen Mine	ON	2020	5 520	ACTIFLO polishing; TSS, As, Cu, Ni, Zn, P
MINING	Stillwater Sibanye - Nye, MT - Discfilter SB	MT	2020	16 350	ACTIFLO polishing; TSS
MINING	TMAC-Doris/Hope Mine	NU	2020	12 000	ACTIFLO polishing; TSS
MW	Neepawa Tertiary	MB	2021	3 500	LagoonGuard polishing; TSS<20; TP<1
MW	Wasaga Beach	ON	2021	21 110	Activated sludge; TSS<5; TP<0,15