WASTEWATER TREATMENT FACILITY MASTER PLAN

FOR THE

TOWN OF LYONS

SEPTEMBER 2024

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JVA, Inc.
1319 Spruce Street
Boulder, CO 80302
phone: 303-444-1951
fax: 303-444-1957

JVA Project No. 240558.ENV

SEPTEMBER 2024

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EXECUTIVE SUMMARY

BACKGROUND AND PURPOSE

The Town of Lyons (Town) is located in Boulder County and is approximately 15 miles north of the City of Boulder, Colorado, along US Highway 36. The Town owns and operates an existing wastewater treatment facility (WWTF) located on 2nd Avenue along the St. Vrain Creek jogging path and Kayak Park. The WWTF was originally constructed in 1976 and has been upgraded several times. The original WWTF was replaced in 2014 with the existing WWTF, approved under a Regulation 22 Amendment of Site Location Approval No: ES.12.45343.

The WWTF was approved for a capacity rerating under Site Location Approval Number 4289 in January 2020 to better reflect the conditions seen at the facility. The existing WWTF is permitted for influent hydraulic and organic loads of 0.3065 million gallons per day (MGD) and 1,535 pounds per day (ppd) of biochemical oxygen demand (BOD_5) discharging under CDPS General Permit COG591156. A previous 2019 *JVA Rerating Report and Site Application* (2019 Rerating Report) was developed and submitted to Colorado Department of Public Health and Environment (CDPHE) to allow for rerating of the Town's WWTF capacity. The report is included in Appendix A.

The purpose of this Wastewater Treatment Facility Master Plan (Plan) is to develop a comprehensive planning document to provide guidance for the Town's wastewater treatment system. This Plan should be viewed as a dynamic working document, reviewed regularly and updated as conditions in the Town's service area change. The Plan includes historical and projected population data, wastewater flow and loading, and an evaluation of the existing WWTF. Additionally, this Plan includes a detailed alternative analysis and recommended alternatives for WWTF improvements.

SCOPE

This Plan is focused primarily on the WWTF itself; it does not provide analysis or recommendations regarding the collection system. The following information will be included in this report:

1. Analysis of Existing Conditions – Discussion of the service area, characterization of historical influent wastewater, description of the WWTF, and a condition and performance assessment of the WWTF process areas.
2. Projected Future Planning Conditions – Projection of future service area growth and associated flow and loading into the WWTF.
3. Alternatives Analysis – Various treatment alternatives to meet the future conditions described in this Plan are presented in this section.
4. Recommended Alternative – Costs and non-quantitative factors are evaluated for each alternative and a recommended alternative is presented.

Planning Period

The planning period for this report is 20 years, which is consistent with the planning horizon used in Town's adopted 2023 Comprehensive Plan (Comp Plan), as well as CDPHE requirements for consideration of new or expanded WWTF.

Summary of Treatment Alternatives

The future conditions used to plan for treatment alternatives can be separated into two main options. Both options suggest reducing the hydraulic capacity of the WWTF in order to accept a higher organic loading capacity. They are summarized in Table 1.

Table 1 – Loading Scenario Summary

Scenario	Hydraulic Capacity MGD	Organic Capacity ppd	Organic Concentration mg/L
Increased Organic Capacity	0.253	1,900	900
Current Rated Organic Capacity	0.253	1,535	727

Reducing the organic loading to the WWTF should be a top priority as it is one of the primary drivers for significant facility improvements. The loading scenarios presented in Table 1 are considered the worst-case scenario for planning purposes if loading cannot be reduced through managerial methods. Efforts have been made previously to address the high organic loading at the facility, but recent sampling data shows that these efforts have not yet been entirely successful.

For the scenario of increased organic capacity, the treatment technologies evaluated included sequencing batch reactors (SBR), aerobic granular sludge (AGS), and a membrane bioreactor (MBR). For the scenario that keeps the current rated organic capacity, the recommendation is to implement the aeration changes noted in the 2019 Rerating Report. While the Town's permit for their current rated organic and hydraulic capacity was approved by CDPHE, they have not yet installed the changes required to meet that organic loading.

In addition to the secondary treatment alternative, the Town requested improvements to their solids stabilization and solids handling systems. The current aerated solids holding tanks (ASHTs) are not sufficiently sized to produce Class B biosolids. The dewatering centrifuge is also undersized. Digestion improvements and dewatering alternatives (screw vs. rotary fan press) were evaluated as a part of this Plan.

Additionally, there are several improvements to the existing WWTF that are recommended regardless of the selected secondary treatment alternative. These improvements would address the performance limiting factors identified in the existing conditions assessment.

RECOMMENDED ALTERNATIVE

It is important to note that the following secondary treatment alternatives are required to address the worst-case loading scenario. As discussed previously, the Town should make reducing the organic loading a top priority. However, for conservative planning purposes, the recommendations in this Plan are based on the worst-case scenario if loading cannot be reduced through managerial methods.

A weighted decision matrix was developed to rank the secondary treatment alternatives. Six categories were included in the decision matrix: Operability, Process Performance, Constructability, Footprint, Capital Cost, and Operations & Maintenance (O&M) Cost. Table 2 shows the score for each secondary alternative based on the six criteria on a scale of one to five (give being the most favorable) and weighted as shown. The highest priorities for the Town were operability and process performance, with capital cost as the third highest priority.

Table 2 – Decision Matrix for Secondary Treatment Alternatives

Criteria	Weight	Alternative 1 SBR	Alternative 2 AGS	Alternative 3 MBR
Operability	25%	5	4	3
Process Performance	30%	2	4	5
Constructability	5%	4	3	3
Footprint	15%	2	5	5
Capital Cost	20%	2	3	4
O&M Cost	5%	3	4	2
TOTAL	**100%**	**2.9**	**3.9**	**4.1**

Note: Scores are on a scale of 1 to 5, with 5 being the most favorable score

The decision matrix indicates that the MBR is the most favored secondary treatment alternatives for the Increased Organic Loading scenario. In addition to the secondary process, there are many other areas of the WWTF that require improvements. The Plan includes a “menu” of potential capital improvement projects, with priorities for Town consideration noted below in Table 3.

Table 3 – WWTF Improvement Options

Option	Project Total	Selection
Preliminary Processes	*Pick Any Number of Options*	
IPS Upgrades (Screen)	$1,050,000	
Wet Well Upsize	$560,000	
Splitter Box Rehab	$120,000	x
Redirect Side Stream Flows	$140,000	x
Secondary Treatment	*Pick One Option*	
SBR Expansion	$9,290,000	
AGS Expansion	$8,100,000	
MBR Expansion	$7,310,000	x
Consolidation	$20,200,000	
SBR Rerating Improvements	$1,560,000	

(table continues on next page)

Option	Project Total	Selection
Disinfection	*Pick Any Number of Options*	
Post EQ Basin Pumps Upgrades	$300,000	x
Replace and Upgrade UV System	$340,000	x
NPW System Relocate	$430,000	x
Digestion	*Pick One Option*	
Aerobic Digester Expansion	$7,660,000	x
ASHT Upgrades	$650,000	
Dewatering	*Pick One Option*	
Screw Press	$880,000	x
Fan Press	$1,760,000	
Miscellaneous	*Pick Any Number of Options*	
Replace Odor Control System	$1,040,000	x
New Instrumentation	$100,000	x
Backup Generator	$210,000	x
Total	**$18,530,000**	

The above table indicates which options JVA recommends for the Town based on the existing system condition assessment, discussions with operations staff, and combining priorities into a single project. The recommended improvements have been selected to balance cost and feasibility while positioning the WWTF to best be able to comply with the discharge permit and accommodate any anticipated future flow and loading. For example, although the SBR rerating improvements may be a lower capital cost option for the secondary treatment alternative, the capacity increases gained by these improvements may not be sufficient for a 20-year planning period, and another expansion project may be required within the 20-year planning period. This would result in high capital costs overall compared with implementing a long-term solution now. The Opinion of Probable Costs (OPC) for the selected improvements is $18.5 million. The OPC breakdown of each option is included in Appendix D. Each of the above recommendations are discussed in more detail in the Plan.

Funding Opportunities

A multi-funding source approach is recommended to implement the WWTF improvements. Significant funding amounts, through a combination of grants and low interest loans, may be received from the below funding options.

- Bipartisan Infrastructure Law
- State Revolving Fund – Low Interest Loans
- USDA, Rural Development
- Department of Local Affairs Energy and Mineral Impact Assistance Fund
    - Administrative Grants
    - Tier I Grants
    - Tier II Grants
    - Community Development Block Grants (CDBG)
- Small Systems Training and Technical Assistance (SSTA) Grants
- Water Quality Improvement Fund (WQIF) Grants

- Colorado Water Resources and Power Development Authority Grant Assistance Program (GAP) for Small Systems
- Colorado Water Conservation Board (CWCB)
    - Flood and Drought Response Fund
    - Water Project Loan Program
    - Colorado Water Plan Grants

A funding approach that uses multiple funding opportunities to maximize grant dollars and low interest loans to mitigate rate increases is recommended. The above funding opportunities are discussed in more detail in Section 6 of the Plan.

SECTION 1 – EXISTING CONDITIONS

PLANNING AND SERVICE AREA

The Town's adopted 2023 Comprehensive Plan (Comp Plan) will be used as a basis for the planning and service area of this Plan. The Comp Plan explains that the Lyons Primary Planning Area includes the incorporated Town of Lyons, North/South/East St. Vrain subareas, and unincorporated portions of Boulder County adjacent to the Town that are not contained in the above subareas. The Town's planning area is shown in Appendix B.

The existing service area spans across the Town of Lyons, and currently includes residential, commercial, and industrial customers. The Plan will base projections off the same service area locations, but with the addition of the Eastern Corridor development.

The Comprehensive Plan outlines the community's growth goals for the next 20 years; the planning period for the Plan will match this time period.

HISTORICAL POPULATION

Historical population estimates for Lyons were obtained from the United States Census (Census) reports and Colorado State Department of Local Affairs (DOLA). Table 4 summarizes these population data sources.

Table 4 – Historical Population from 2000 to 2022

Year	Lyons U.S. Census Data		Lyons Colorado DOLA Data	
	Population Estimate	Annual Growth Rate	Population Estimate	Annual Growth Rate
2000	1,585	2.25%	1,601	N/A
2001	-		1,642	2.56%
2002	-		1,635	-0.43%
2003	-		1,618	-1.04%
2004	-		1,621	0.19%
2005	-		1,642	1.30%
2006	-		1,774	8.04%
2007	-		1,821	2.65%
2008	-		1,972	8.29%
2009	-		2,005	1.67%
2010	2,033		2,037	1.60%
2011	-	0.83%	2,080	2.11%
2012	-		2,119	1.88%
2013	-		2,146	1.27%
2014	-		2,062	-3.91%
2015	-		2,118	2.72%
2016	-		2,145	1.27%
2017	-		2,158	0.61%

(table continues on next page)

Year	Lyons U.S. Census Data		Lyons Colorado DOLA Data	
	Population Estimate	Annual Growth Rate	Population Estimate	Annual Growth Rate
2018	-		2,193	1.62%
2019	-	0.83%	2,197	0.18%
2020	2,209		2,203	0.27%
2021	-	-	2,173	-1.36%
2022	-	-	2,145	-1.29%

A graph of the Lyons DOLA population estimate is shown in Figure 1 below. On average, the Town has experienced relatively moderate growth since 2014.

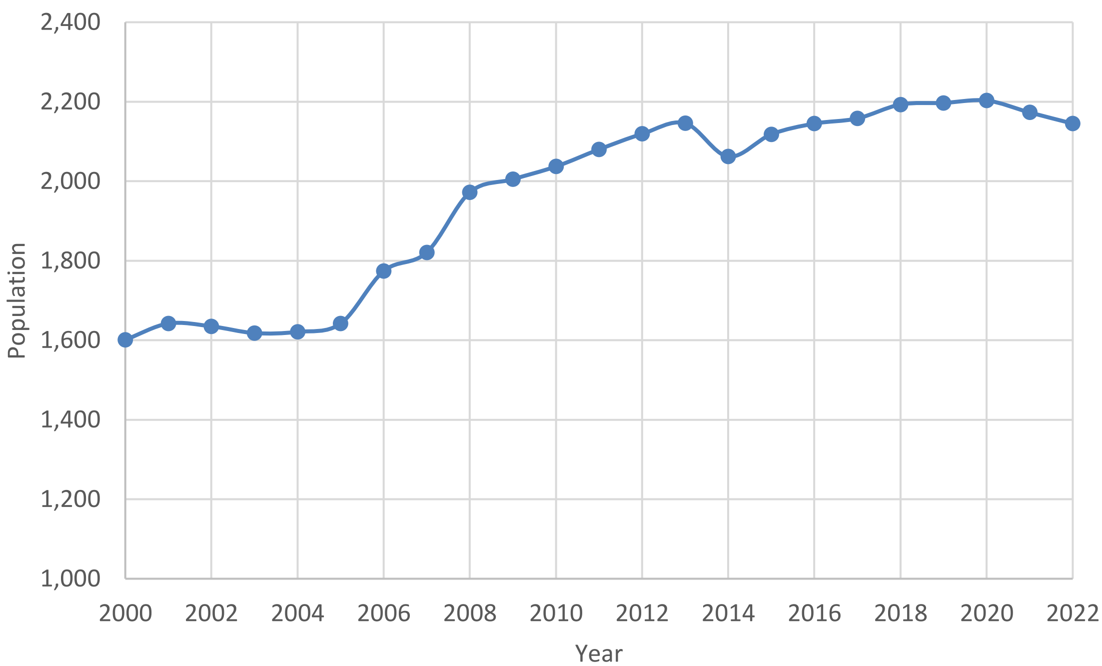

Figure 1 – Lyons Colorado DOLA Population Estimate from 2000 to 2022

The Town experiences a high transient population tied mostly to restaurant visits that is not reflected in the Census and DOLA population data. Upon discussion with the Town, it was agreed to exclude the transient population from the starting population of the 20-year planning period. The starting population used for the 20-year planning period is the 2022 DOLA population of 2,145 people.

Current Wastewater Flows and Loads

Existing Flows

Influent hydraulic flows to the WWTF are reported via Discharge Monitoring Reports (DMRs). This information is publicly available via the Environmental Protection Agency's (EPA) Enforcement and Compliance History Online (ECHO) database. Monthly average flows, as well as daily maximums, from June 2021 to May 2024 are summarized in Table 5. Flow data is presented in monthly averages and daily maximums as required in the Town's discharge permit.

Table 5 – WWTF Influent Flow from June 2021 thought May 2024

	30 Day Average (MGD)	Daily Max (MGD)
Average	0.128	0.181
Maximum	0.201	0.248*

*April 2023 outlier was removed

Flow data at the WWTF is measured by a 6-inch electromagnetic flow meter located on the common discharge pipe of the influent pumps. As seen in Figure 2, the WWTF has not exceeded the permitted 30-day average flow, except instance of a daily maximum flow exceedance in April 2023. The heavy rains seen in the spring of 2023 may have contributed to this abnormally high daily max influent flow, and thus data considered an outlier in the reported flow data. This is also reflected in the increased flow from May to September of 2023 as compared to previous years. The high flows seen during this time are not considered to be representative of the flow conditions typically seen at the WWTF. Given the current flows conditions, the WWTF is not expected to exceed its permitted capacity of 0.3065 MGD in the 20-year planning period.

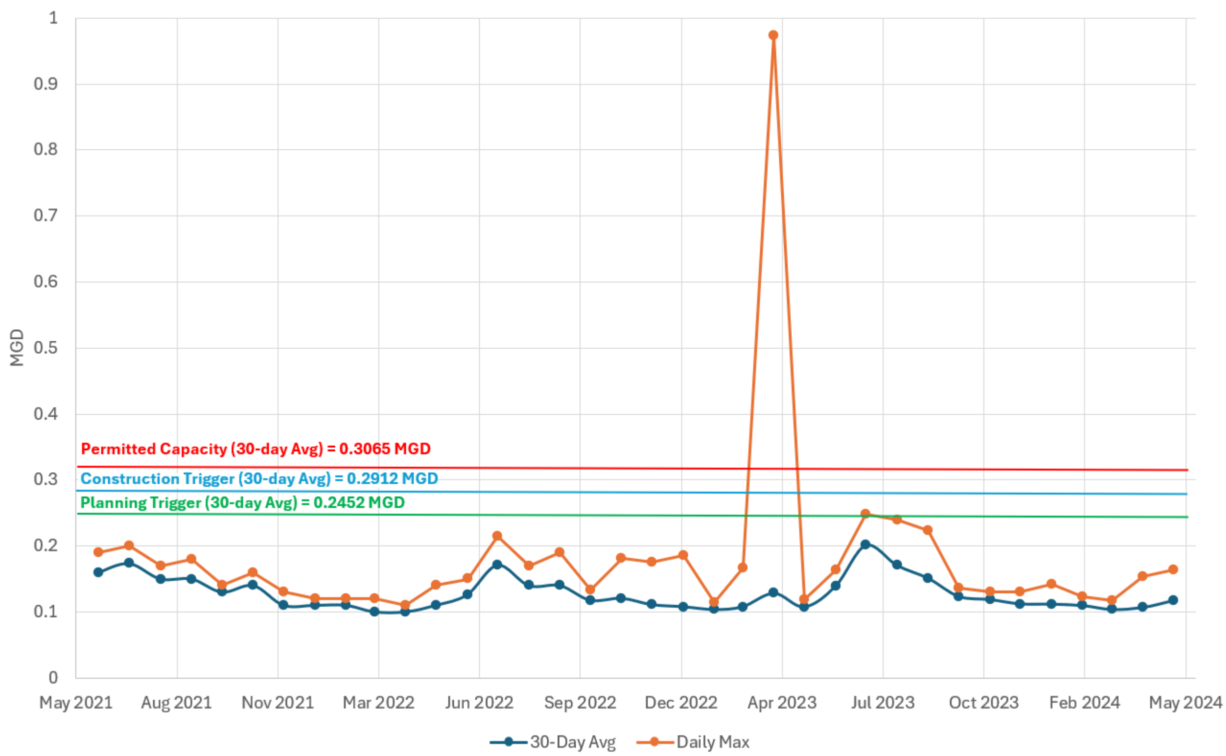

Figure 2 – WWTF Influent Flow from June 2021 through May 2024

The average monthly flow from 2021 to 2024 was 0.128 MGD. At the starting population of 2,145 people, this equates to about 60 gallons per capita per day (gpcd). This per capita flow is below the suggested minimum per capita wastewater flow of 75 gpcd as indicated in the Colorado Department of Public Health and Environment (CDPHE) Wastewater Design Criteria Policy (WPC-DR-1). The recommended minimum value of 75 gpcd was selected for design purposes;

this more conservative estimate helps capture the transient community flow discussed earlier, as well as eliminating the need for additional data collection and explanation to CDPHE to approve a lower per capita flow.

EXISTING LOADING

The historical average organic loading to the WWTF, as measured by BOD_5 and total suspended solids (TSS) from June 2021 to May 2024, is summarized in Table 6. The Town's discharge permit requires that concentration and loading are presented as both monthly averages and the maximum weekly average recorded during that month.

Table 6 – Influent Loading Summary from June 2021 to May 2024

	BOD_5 Concentration (mg/L)[1]	BOD_5 Loading (ppd)[1]	TSS Concentration (mg/L)[2]
Average (30 Day Average)	513	538	537
Maximum (30 Day Average)	880	881	906
Average (Max 7 Day Average)	692	723	709
Maximum (Max 7 Day Average)	1,371	1,226	1,225

[1]DMR only has available data from April 2021 to May 2024

[2]A outliner data point was removed due to an assumed DMR data typo

Figure 3 below shows the influent BOD_5 concentrations over the last three years. BOD_5 concentrations generally increased over this period.

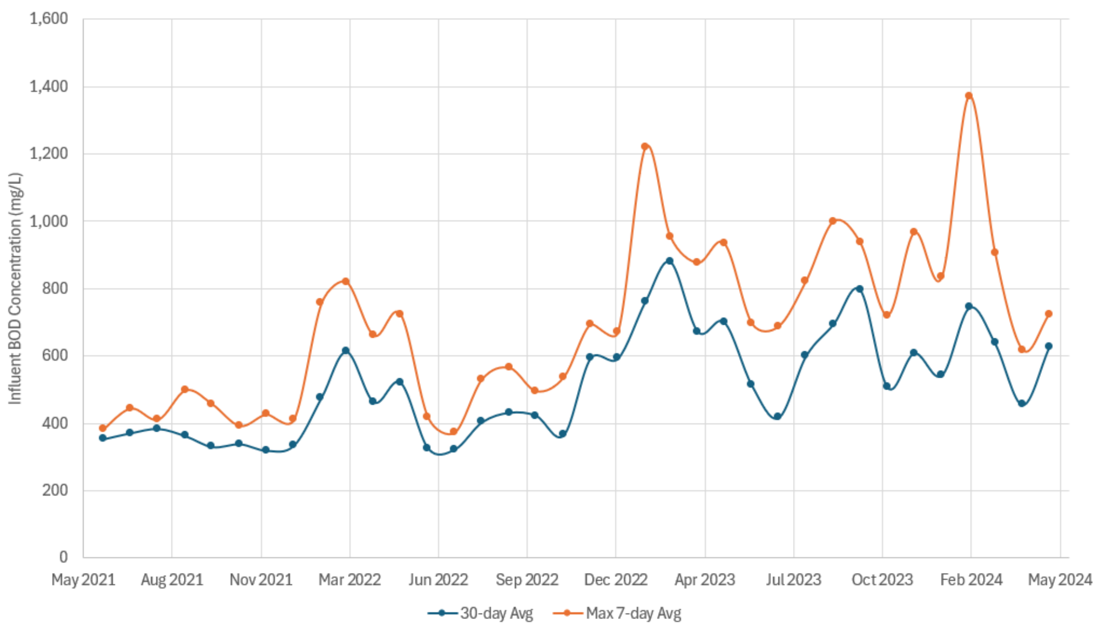

Figure 3 – Influent BOD_5 Concentration from June 2021 to May 2024

Figure 4 below shows the influent BOD_5 loading over the last three years. Loading is measured in pounds per day (ppd) and calculated by the multiplication of influent BOD_5 concentration and influent flow. Figure 4 shows more BOD_5 variability throughout each year, but still shows the overall increasing trend.

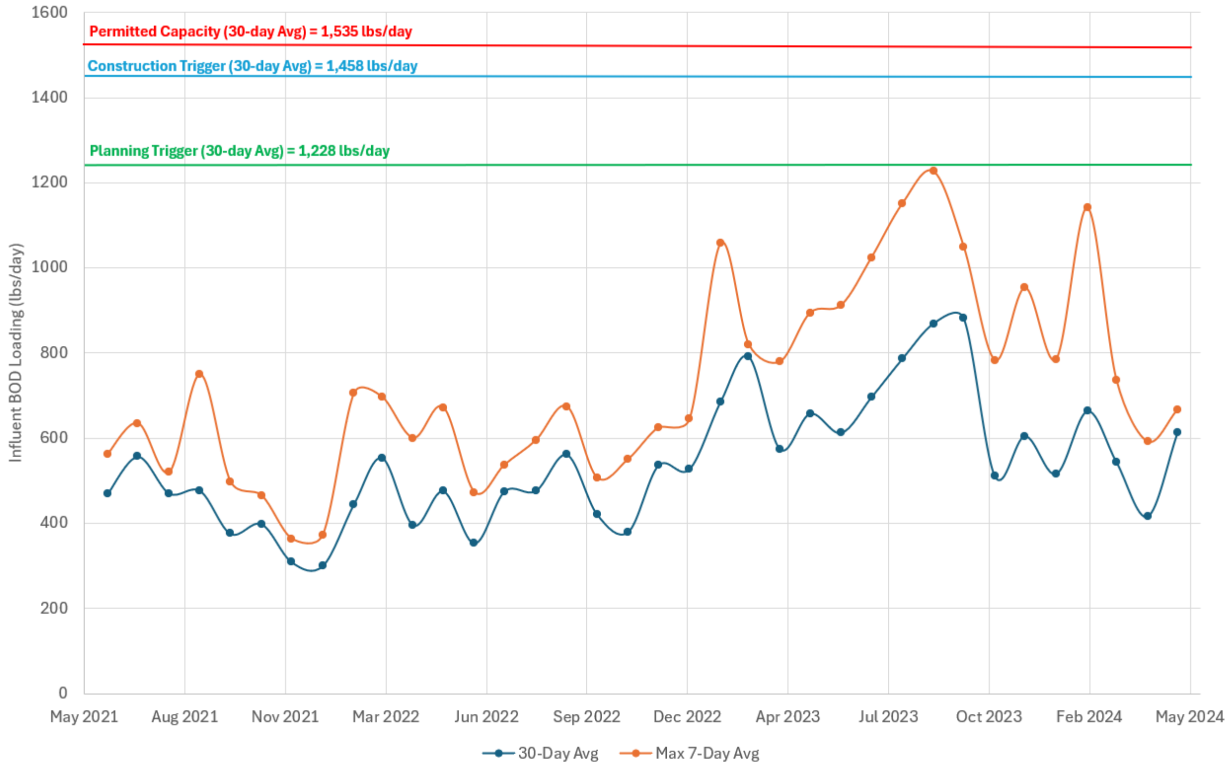

Figure 4 – Influent BOD_5 Loading from June 2021 to May 2024

As shown in Figure 5, TSS concentrations are more variable than the BOD_5 concentrations, but still exhibit a general upward trend. The high 7-day values for both TSS and BOD_5 are expected to be due to the high tranient loads seen by Lyons, relating to high tourism times and industrial dischargers.

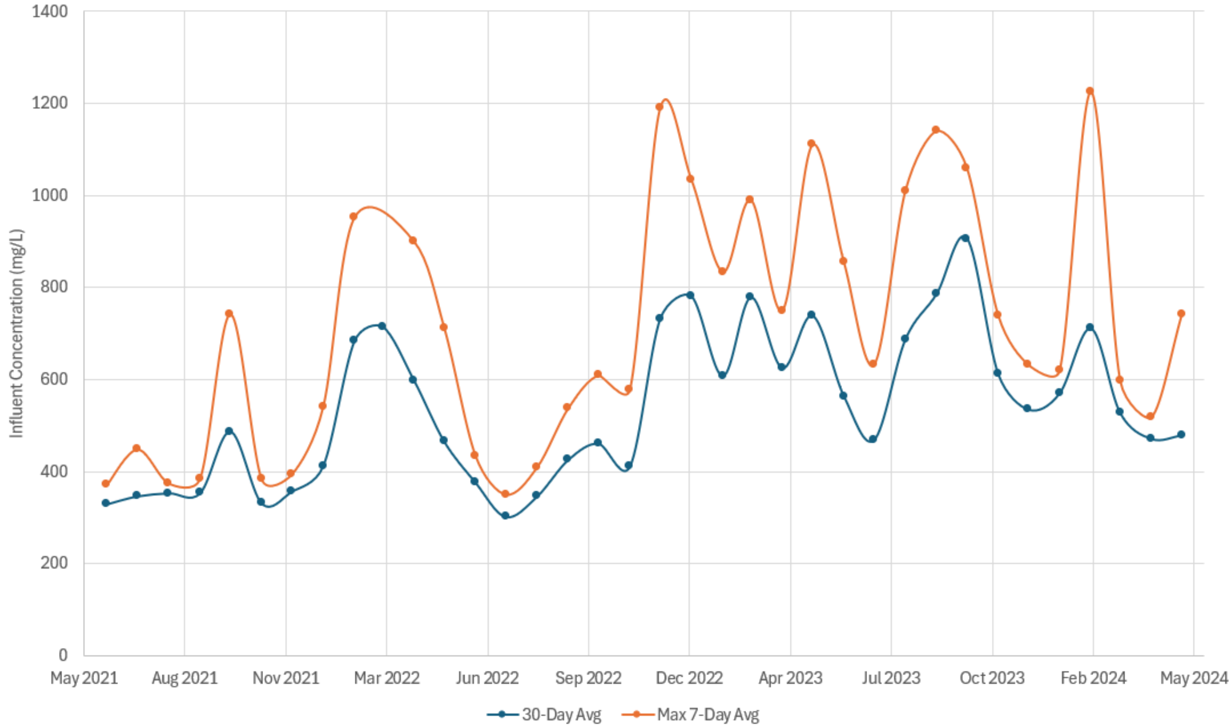

Figure 5 – Influent TSS Concentration from June 2021 to May 2024

The current three-year average for BOD_5 and TSS are 513 mg/L and 537 mg/L, respectively. Note that an outlier data point for the maximum 7-day concentration for TSS was removed due to an assumed typo in the DMRs.

The three-year average is not entirely representative of the existing conditions at the WWTF due to the consistently increasing influent values. Figure 6 depicts the annual average BOD_5 concentrations for each year, beginning in 2021. Please note that the 2021 and 2024 annual averages in the figures below only include data for half of the year and are not representative of the whole year. As seen in the graph, the DMR concentrations for BOD_5 have shown a clear increase annually since 2021.

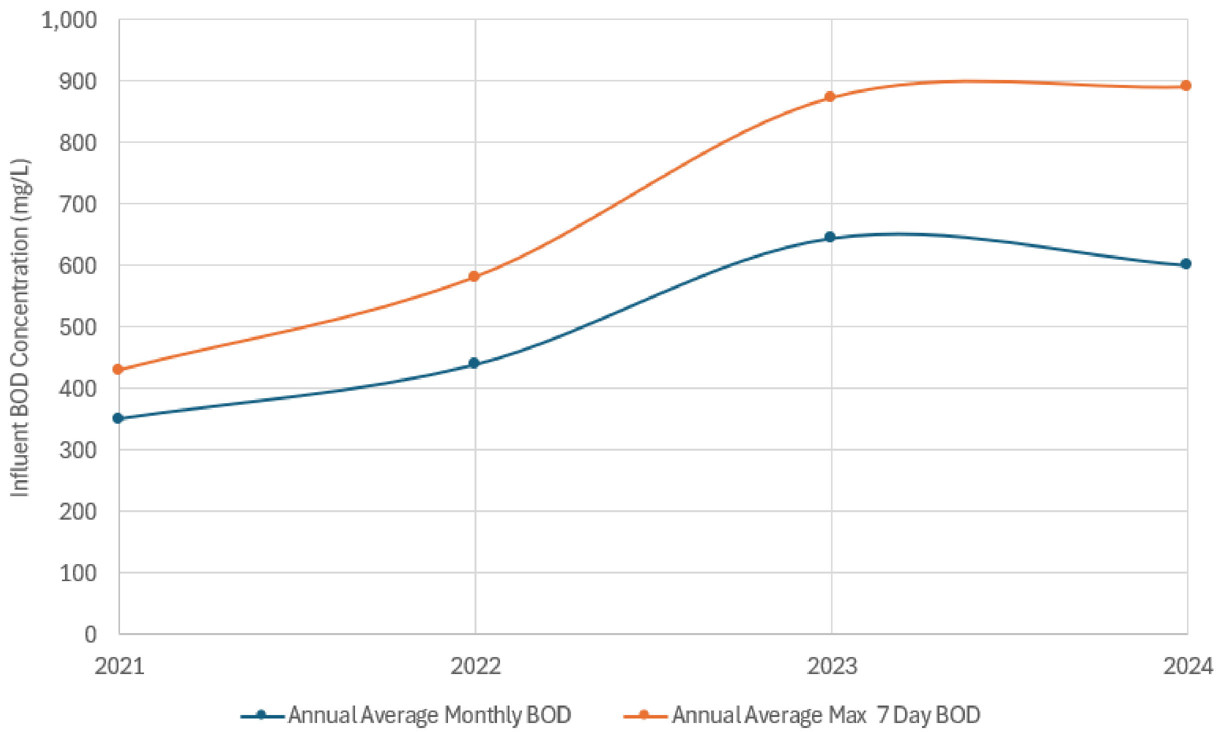

Figure 6 – Annual Average of BOD_5 Concentration

The Town has expressed concerns with higher influent BOD_5 concentrations to the WWTF, due to both high strength industrial dischargers and water conservation efforts. The current maximum month average monthly BOD is 880 mg/L (occurred March 2023). The current maximum month 7-day BOD_5 is 1,371 mg/L (occurred February 2024). To address the Town's concerns and observed data, the recommended design basis for BOD_5 concentration is 900 mg/L. This value is expected to be high enough to capture the current and future conditions due to additional industrial dischargers and reasonable seasonal peaks in max month values.

The 900 mg/L design basis is recognized to be conservative, and represents the worst-case scenario given the current loading seen at the WWTF. Reducing the organic loading to the WWTF should be a top priority as it is one of the primary drivers for significant facility improvements. The secondary treatment alternatives presented in this Plan are considered the worst-case scenario for planning purposes if loading cannot be reduced through managerial methods. Efforts have been made previously to address the high organic loading at the facility, but recent sampling data shows that these efforts have not yet been entirely successful.

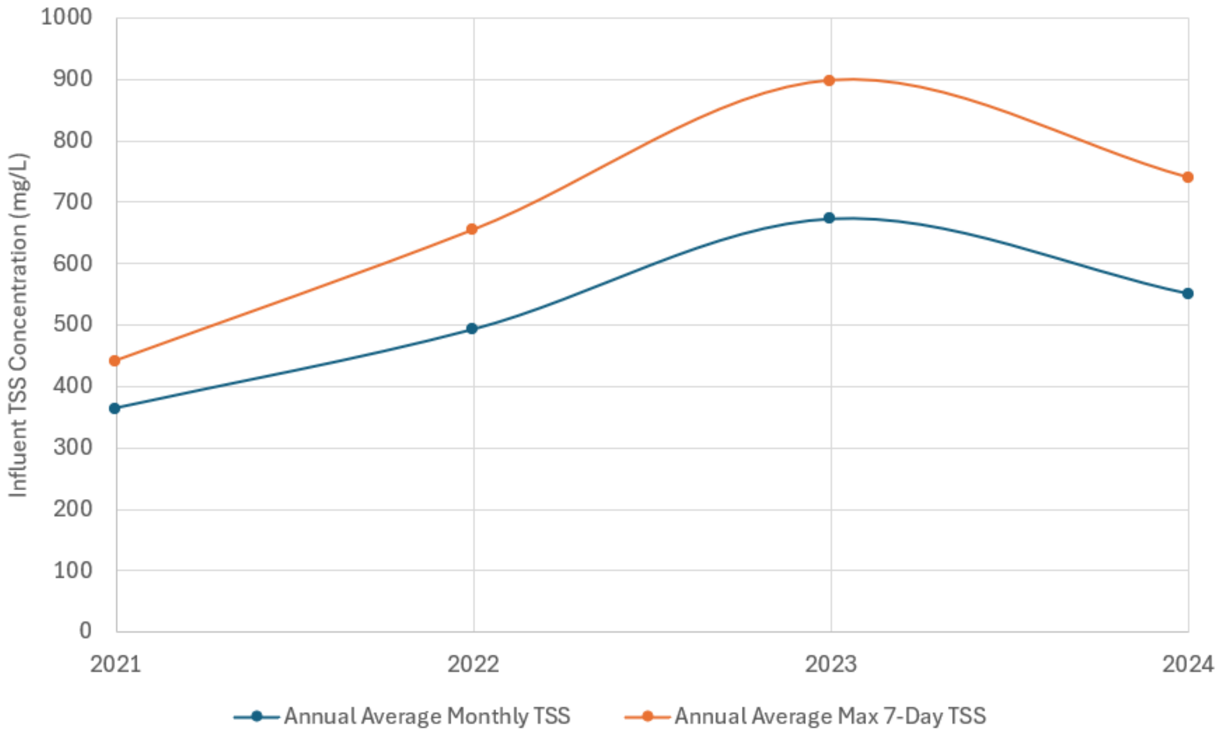

Figure 7 – Annual Average of TSS Concentration

Figure 7 depicts the annual average TSS concentrations for each year, beginning in 2021. TSS trends are similar to BOD, with a clear increase annually since 2021.

PERMIT COMPLIANCE

The Town has been issued two noncompliance violations since 2021. A summary of the compliance violation is shown in Table 7. The main noncompliance issues were related to effluent violations for E. coli and Nitrogen, ammonia total (as N).

Table 7 – Summary of Permit Violations

Date	Reported Violation	Percent Exceedance	Statistical Type
1/31/2023	Effluent Violation – E. coli	33%	Max 7-Day
3/31/2024	Effluent Violation – Nitrogen, ammonia total (as N)	39%	Monthly Average

There was only one occurrence of the above noted violations for each constituent. The WWTF has not seen reoccurring violations in the past three years and is in compliance with the discharge permit.

SECTION 2 – CONDITION AND PERFORMANCE ASSESSMENT

EXISTING WASTEWATER TREATMENT FACILITY LAYOUT AND DESCRIPTION

The Town's WWTF is located on 2nd Avenue along the St. Vrain Creek jogging path and Kayak Park, located at approximately 40°13'11.352" N and 105°15'50.6088" S. The WWTF was constructed in 1976 and has been upgraded several times. The original facility was replaced in 2014 with a new facility, approved under Regulation 22 Amendment of Site Location Approval No: ES.12.45343. The WWTF was approved for a capacity rerating in January 2020 and is currently operating under General Permit COG591156.

PRELIMINARY PROCESSES

Wastewater collected in the town is conveyed to the WWTF by an influent pump station (IPS) which is followed by flow metering and Headworks for preliminary treatment. Preliminary treatment processes are discussed in detail in the sections below.

Influent Flow Monitoring

The IPS wastewater flow rate is measured by a 6-inch magnetic flow meter located on common header off the three influent pumps all operated on variable frequency drives (VFDs). Metered influent flow is displayed, monitored, recorded, and logged via local transmitter integrated with the main WWTF programmable logic control (PLC) and Supervisory Control and Data Acquisition (SCADA) system.

Influent Sampling

The influent sample point is just downstream of the mechanical fine screen. The frequency, constituent, and type of influent sampling is in accordance with the Town's General Permit. During sampling events, the operation staff set up a refrigerated composite sampler that is hard wired to the main PLC for flow pacing the sample with the influent flow meter over a 24-hour period. The composite sample is removed from the composite sampler and packaged in ice and taken to Colorado Analytical for testing and analysis.

Headworks Room

The headworks room is rated as Class 1, Division 2 in accordance with NFPA 820. The headworks HVAC system provides 12 air changes per hour via gas fired make-up air unit integrated with an exhaust fan to maintain this classification. All electrical switchgear for the preliminary treatment equipment is in the separate unclassified MCC-1 / Blower area of the building. The preliminary treatment control panels (screening and grit removal) are fed from the MCC-1 and located in the adjacent mechanical unclassified room separated from the headworks process area. The local control panels communicate with the main WWTF PLC and SCADA system.

Mechanical Screening and Bypass Screen

From the IPS, pumped influent is discharged into a 20-inch-wide influent channel with an automatic inclined 6-mm fine screen with integral washer and compactor. In the event the automatic screen becomes inoperable or taken down for maintenance, there is a bypass channel in-line with a 1-inch manual bar screen. Flow can be diverted with the use of stop plates and overflow weirs. Under normal conditions, the influent is screened by the automatic mechanical screen. The screen washes, compacts, and bags screenings prior to discharge into a dumpster. Screenings that accumulate on the manual screen are manually removed, placed on a beach plate, and allowed to dewater prior to placing the screenings in the dumpster.

Grit Removal

A vortexing grit chamber removes grit from the raw influent wastewater. Wastewater tangentially enters the grit chamber to help induce a vortex within the chamber. A small hydraulic jet nozzle is used to further impart tangential vortex velocity and increase grit particle settling efficiency. Additionally, a small regenerative blower is used to diffuse air within the basin and aid in removal of particulates. A submersible grit pump installed in the grit hopper pumps accumulated grit slurry to a hydro cyclone mounted on the top of a grit classifier. The hydro cyclone concentrates the grit slurry and separates the water from the grit particles. Grit separated wastewater from the hydro cyclone and grit classifier is drained by gravity back to the influent channel. Washed and dewatered grit is augured to the discharge of the classification equipment via an inclined screw. The discharge of the classifier is fitted with a continuous bagging attachment that bags the classified grit prior to being placed in a dumpster for landfill disposal.

Scum Removal and Splitter Box

Following preliminary treatment, influent flows by gravity to a splitter box where it can be diverted to one or both ICEAS™ Sequencing Batch Reactors (SBRs) using weir plates that are installed behind an underflow baffle that is designed to keep scum and floatables out of the downstream SBR basins. The scum flows over a weir plate and enters a pipe that directly discharges into an aerated sludge holding tank.

SECONDARY TREATMENT

Following preliminary treatment, wastewater is split between two Sequencing Batch Reactor (SBR) basins. The SBR process provides compact, continuous flow biological treatment of the wastewater to achieve high levels of carbonaceous (BOD_5) and nutrient removal of highly variable flows and loads. The SBR system is manufactured by Sanitaire Intermittent Cycle Extended Aeration (ICEAS™) Advanced SBR system, which uses two process reactors in parallel to biologically treat wastewater and discharge high-quality effluent. The ICEAS SBR is a continuous flow system with react, settle and decant phases; it consists of a pre-react zone and a main aeration zone. All basins are monitored by an oxygen reduction potential (ORP) probe and dissolved oxygen (DO) probe, respectively. The main react zone cycles air on and off during the react phase to provide favorable conditions for simultaneous nitrification/denitrification, thereby reducing energy costs. A submersible mixer located in the main zone runs continuously during the react phase and is off during the settle and decant phases.

SBR Aeration and Mixing

The ICEAS process uses fine bubble membrane diffusers to provide oxygen to the pre-react zone and main zone. Air to the diffuser grids is supplied by three (two duty and one swing) screw compressor (hybrid) 20 HP blowers capable of 250 standard cubic feet per minute (scfm). They are located in the operations building. The intent of the diffused air in the pre-react zone is to provide just enough air for mixing and to maintain a low DO environment to enhance denitrification. The main zone also includes a submersible mixer that runs continuously during the react phase with on-off aeration to facilitate simultaneous nitrification/denitrification. The operation of the blowers is automatically controlled by the WWTF's control system via a combination of adjustable timers and online monitoring.

Effluent Equalization

An effluent equalization (EQ) tank is provided to allow the SBR tanks to decant secondary treated effluent and prepare for the next batch, as well as to reduce the peak flow and provide a steady flow rate to the disinfection system. Effluent equalization is common in SBR systems because decanting rates are typically much higher than the average design flow rate. The equalization tank is sized for the peak 2.4-hour cycle flow rate which is equivalent to a peak hour flow of 1.0 MGD. The decant phase that occurs during the peak cycle has a duration of 36 minutes and an associated decant flow rate of 1,411 gpm, resulting in a decanted volume of 50,800 gallons. The equalization process captures and retains the decanted effluent, then pumps the effluent at a constant rate to the ultraviolet (UV) disinfection channel until the low-level setting of the tank is met and decant cycle process repeats for each cycle.

Alkalinity Adjustment

To maintain sufficient alkalinity for nitrification, liquid magnesium hydroxide (MgOH) is dosed into the SBR influent splitter box. The liquid MgOH dosing system consists of 55-gallon drums storage and peristaltic chemical metering pumps that are integrated to the PLC and paced off the influent flow meter.

Disinfection and Non-Potable Water System

UV light is used to disinfect the secondary effluent prior to discharge to St. Vrain Creek. The UV system can achieve pathogen inactivation to comply with the effluent permit limits for E. coli. The disinfection system has sufficient hydraulic capacity to effectively treat the peak daily flow rate from the equalization basins for up to 0.6 MGD. The system is designed to meet an effluent E. coli effluent limit of 3,108 / 100 ml on a 7-day geometric mean, and an effluent E. coli limit of 1,441 / 100 ml on a 30-day geometric mean.

The Trojan 3000 PTP UV system is a horizontal lamp system with low pressure lamps oriented parallel to the effluent flow. The system is capable of modulating lamp intensity to provide sufficient disinfection based on effluent flow rate and transmittance. A manual lamp sleeve cleaning station is provided in the UV room which allows for mechanical and chemical cleaning of the quartz sleeves. When cleaning or replacement of a module is necessary, each module can be individually removed from the UV bank and the spare module inserted in its place while the bank remains in operation. To provide an indication of fouling, excessive effluent turbidity, or lamp age, a submersible UV sensor is mounted to one module within the bank to measure UV intensity.

SBR decant effluent flow is pumped into the channel upstream of the UV banks and then through the UV banks for disinfection. A serpentine weir at the effluent end of the UV channel maintains a constant level through the UV banks to allow for full submergence of the lamps and prevent short circuiting. Two UV banks in series provide treatment of the peak daily flow (PDF) rate of 0.6 MGD. A single bank is capable of disinfecting at the maximum month flow rate of 0.38 MGD. Emergency backup power is supplied to the UV system in the event of a power outage.

At the effluent end of the UV channel contains a small storage basin integral with the UV channel. Disinfected effluent is pulled from the basin for non-potable water (NPW) use. A single 7.5 NPW vertical turbine centrifugal pump supplies the NPW needs for the screening, grit classifier, dewatering, and odor control. The pump is operated off a VFD and hydro-pneumatic tank to maintain a set pressure range for the NPW system.

Solids Handling

The solids handling system consists of two submersible waste activated sludge (WAS) pumps (one for each SBR), two aerated sludge holding tanks (ASHT), two submersible sludge transfer pumps (one for each ASHT), a sludge balancing tank, one centrifuge feed pump, a polymer feed system, and a single centrifuge.

The operators set a WAS pump time interval for pumping wasting sludge to the ASHT to maintain a targeted MLSS concentration in the SBRs. WAS can be pumped to either ASHT and the ASHTs can be operated in series or parallel. ASHT #1 is equipped with a floating decanter pump system to pump clear liquid back to the IPS. ASHT #2 uses a telescoping valve to decant clear liquid back to the IPS. Supply air to the ASHTs is valved off the main air header for the SBRs and metered with thermal mass flow meters monitored via WWTF PLC and SCADA. After decanting, the thickened biomass from the holding tank is pumped to a solids balancing tank via a submersible solids transfer pump. The biosolids in the solids balancing tank are then pumped by a positive displacement feed pump, blended with activated emulsion polymer and delivered to the centrifuge. The dewatered cake concentration ranges from 14 to 17 percent solids. The dewatered cake produced from the centrifuge is discharged into a dumpster and then hauled off for contract disposal or processing.

ODOR CONTROL

Foul air generated from specific areas of the facility are ducted to a synthetic media bio trickling treatment process for treating organic and inorganic odor compounds. The odor control equipment receives foul air from the following sources: Influent lift station wetwell, space under screening channel covers in the headworks area, aerated sludge holding tanks, and the solids processing area. The requirements of the National Fire Protection Act (NFPA) Code and CDPHE regulations provide that an odor control design will, at a minimum, provide a safe working environment for personnel and minimize off site odors that negatively affect those persons located in proximity to the WWTF, and satisfy NFPA ventilation requirements for specific process areas.

The bio trickling synthetic media is used in conjunction with non-potable water to scrub the generated foul air. Foul air ducts push the foul air through the bottom of the filter as water is filtered through the top to facilitate growth of autotrophic and heterotrophic bacteria. The biofilter tank and foul air fans are located outdoors on a concrete equipment pad. Channel covers, wetwell covers, and enclosed rooms contain the odors and prevent fugitive odor from escaping these areas. The odor control system fans maintain a constant vacuum to further prevent fugitive odors from escaping.

POWER AND CONTROLS

The WWTF currently has two utility power sources available to it provided by the Town of Lyons (Primary) and City of Longmont (Backup). These power sources are fed into an Automatic Transfer Switch (ATS) to coordinate changeover to backup power.

Instrumentation was observed to be provided by reputable manufacturers. These consist of Rosemount for the Magnetic Flow Meters, Dissolved Oxygen and ORP by YSI, Endress & Hauser for level measurement, and others. Controls consist of multiple control panels including the Influent Pump Station (LCP-1000), Headworks (LCP-2000), among others. IPS is controlled by three wall mounted VFDs while other motor starters are in the MCC located in the main process building.

PERFORMANCE ASSESSMENT AND LIMITING FACTORS

PRELIMINARY PROCESSES

Condition and Performance Assessment

The IPS and preliminary treatment equipment is in good condition and is well maintained. No noticeable degree of concrete degradation was observed for the influent wet well and the headworks open channels. There is no mechanical screening prior to the IPS. As such, the influent pump station requires frequent cleaning to remove accumulated material and to minimize the pumps from clogging.

Performance Limiting Factors

The influent pump wet well is undersized for current operations and results in more frequent on/off influent pumping. The capacity of the pumps and VFDs is also limited for the system.

SECONDARY TREATMENT

Condition and Performance Assessment

The secondary treatment process equipment is in good condition and well maintained. The SBR membrane fine bubble diffusers are nearing the end of their useful life and should be replaced soon.

The splitter box is not equally distributing the influent flow to the SBR basins resulting in one basin getting more flows. The south SBR basin is the one getting a higher percentage of influent flow and loading. This results in less efficient treatment performance of the south SBR and requires a greater volume of WAS to be pumped out (compared to the north SBR) due to higher yield.

Side stream flows from the ASHTs decant and the centrate from the centrifuge is conveyed back to the IPS wet well which is before the influent sampling point resulting in a higher influent TSS, BOD_5, and nutrient loading. Operations staff must coordinate decant/dewatering with influent sampling.

The post equalization pumps run in an ON / OFF configuration and do not have VFDs, resulting in variable flows to the UV system due to changes in level of the post equalization tank.

Performance Limiting Factors

The capacity of the two SBR basins are not fully utilized due to the unequal split of flows. This lowers the overall treatment capacity of the WWTF and ability to accommodate a higher flow and loading future conditions.

Each of the existing blowers are sized for 250 standard cubic feet per minute (SCFM) at 8.5 pounds per square inch (psi). Previous modeling efforts in the 2019 Rerating Report and approved 2020 Site Application have shown that the blowers are insufficiently sized for the current permitted capacity.

DISINFECTION

Condition and Performance Assessment

The existing UV system is aging and reaching the end of its useful life. Due to the age of the system, Trojan no longer supports some of the replacements parts. The UV system has very simplified controls making it more challenging for operators to diagnose lamp outages and ballast failures. The UV system is designed for ON / OFF operation meaning that lamps will turn on at full wattage and are not capable of varying UV intensity based on flow rate. The UV lamps are cleaned manually and not fitted with an automatic wiper system.

Performance Limiting Factors

The NPW pump suction pipe is connected to the effluent end of the UV channel which is not adequately sized for the non-potable process needs of the WWTF. The volume of NPW storage is approximately 50 gallons and does not contain enough volume for the NPW supply system. Post SBR EQ pumping is intermittent, meaning that the non-potable pumps run out of supply water in a very short period. This causes major operational issues and results in the use of potable water for all non-potable uses.

The UV system lacks adequate diagnostics and alarm systems, and operators have reported encountering difficulty obtaining replacement parts in a timely manner. The ON / OFF operation of the UV system results in higher energy usage and shorter lifetime for the UV lamps.

SOLIDS HANDLING

Condition and Performance Assessment

During the operation of the centrifuge, it was observed that the capture efficiency was very poor resulting in approximately 45 to 50 percent of the solids being returned back to the head of the WWTF, resulting in additional solids loading to the SBR process.

The centrifuge is undersized and inefficient, resulting in poor solids capture. When the centrifuge is meeting operational requirements, cake is hauled by McDonald Farms twice per week. The dewatered biosolids do not meet Class B requirements under the Environmental Protection Agency (EPA) Part 503 Biosolids Rule and have to be hauled to a composting site for further processing. The frequent hauling of solids and additional disposal process results in increased costs.

The waste activated sludge (WAS) pumps are oversized, as they were originally designed for return activated sludge (RAS) pumping at the facility. The oversized pumps have led to operational challenges, including the potential for overwasting sludge from the SBRs, which disrupts the ability to maintain the desired mixed liquor suspended solids (MLSS) levels and impacts the efficiency of the secondary treatment system. Additionally, overwasting sludge with the WAS pumps is overloading the already undersized Aerated Solids Holding Tanks (ASHTs) and causing more frequent pump start and stops. This results in increased wear and tear on the pumps.

ASHT #1 contains a telescoping valve with 9-inches of travel for decanting. The travel distance of the valve is insufficient for effective decanting of supernatant. The operators do not use the telescoping valve for this reason. ASHT #2 was upgraded using a submersible pump with an electronic eye for decanting which has improved solids thickening inside ASHT #2, however operators have had issues of over decanting into the sludge blanket, resulting in higher solids loading being returned to the IPS.

Performance Limiting Factors

The centrifuge is undersized and is inefficient at times with poor capture efficiency. The centrifuge operates 5 days a week, 8 hours a day, which is cumbersome for operation staff and time consuming to monitor and clean. If the centrifuge is taken down for maintenance or repairs, liquid sludge from the ASHTs is hauled off for composting, which is very costly and time consuming.

The ASHTs tanks are currently significantly undersized. The total volume of the two basins is roughly 118,000 gallons. With some assumptions on solids concentration and influent loading, the required volume to achieve Class B biosolids is anywhere between 350,000 and 530,000 gallons. Additionally, to be considered an aerobic digester by CDPHE, the depth must be a minimum of 10 feet; the existing tanks are 9 feet deep.

The tanks also share air with the SBRs, meaning they do not receive enough air to meet Class B. The existing 3 blowers can generate 750 scfm total, while the digesters alone would require a minimum of 800 scfm to function effectively.

ODOR CONTROL

Condition and Performance Assessment

The Bioair odor control unit has been taken offline and is currently not functioning. Further evaluation is necessary to determine the reasons why the odor control unit is not operating and performing. Operators are dosing an organic additive to the ASHTs for controlling odors. Minimal improvement has been observed to date using this additive.

Performance Limiting Factors

The odor control system is not operating, resulting in odors inside the WWTF and its outside boundaries.

POWER AND CONTROLS

Condition and Performance Assessment

Instrumentation interior to structures appears to be in good, working condition. Any instrumentation and panels exterior to the structure has sustained sun damage and appears to be in less than satisfactory condition. The age of the instrumentation is approximately 10 years old and at the end of its useful lifetime. Replacement parts and instruments of the same vintage will become more difficult to obtain due to discontinuation of representing manufacturers.

For the SCADA system, Inductive Automation Ignition is installed in the facility but does not appear to have been programmed properly to achieve maximum functionality. For example, the IPS control panel does not have an active connection to the main Ignition gateway. Therefore, no remote-control functionality is available for the IPS.

The WWTF currently has two utility power sources, with the ATS to coordinate changeover to backup power. The Town and operations staff has stated that they have had issues with losing a phase of power and damaging equipment with no change-over to backup power. It is believed that this ATS may not have been programmed correctly as this issue should not occur.

Performance Limiting Factors

Electrical gear and instrumentation that is approaching end of life can operate inefficiently and have inaccuracy as well. Though the SCADA software is adequate, the lack of a properly programmed SCADA system can cause operational issues for the staff such as state reporting and general control. The likely poor design and programming for the ATS utilizing two utility power feeds has caused dropped power issues with the facility.

FLOODPLAIN ISSUES

The Town has adopted the Boulder County Colorado Hazard Mapping Program (CHAMP) floodplain maps that will update the current Federal Emergency Management Agency's (FEMA's) floodplain mapping in Fall 2024. The updated Boulder County CHAMP mapping locates the Town's WWTF in the 500-year floodplain of the St. Vrain Creek floodplain, as seen in the updated map in Appendix B.

Any alternatives that require new or expanded buildings should be designed to be located within the 500-year floodplain boundary. Any new infrastructure that is located in the regulatory floodway would require considerable civil engineering design and permitting efforts.

SECTION 3 – FUTURE CONDITIONS

POPULATION AND LAND USE PROJECTIONS

The Town's adopted 2023 Comp Plan and a January 2024 final draft of the Housing Future Plans provide more insight into the Town's goals, aspirations, and future development plans. These two documents detail the Town's current and future population and land use plans. Within those two documents, the following growth rates were determined:

- Low Growth = 0.8% (Comp Plan)
- Medium Growth = 0.8% until 2030, then 1.2% until end of planning period (from Comp and Housing Futures Plan)
- High Growth = 1.4% (Comp Plan)

All three growth rate scenarios will be used to project future population, flow, and loading to provide a holistic view on future conditions. However, for planning and design basis purposes, the medium growth of 0.8% until 2030, then 1.2% until the end of the planning period was selected as the basis for projections to discuss proposed alternatives and improvements.

A population projection for each of the three growth scenarios was calculated for the 20-year planning period and is summarized in Table 8.

Table 8 – Population Projection

Year	Low Growth (0.8%)	Medium Growth (0.8% → 1.2%)	High Growth (1.4%)
2022	2,145	2,145	2,145
2023	2,162	2,162	2,175
2024	2,179	2,179	2,205
2025	2,197	2,197	2,236
2026	2,214	2,214	2,268
2027	2,232	2,232	2,299
2028	2,250	2,250	2,332
2029	2,268	2,268	2,364
2030	2,286	2,286	2,397
2031	2,304	2,314	2,431
2032	2,323	2,341	2,465
2033	2,341	2,369	2,499
2034	2,360	2,398	2,534
2035	2,379	2,427	2,570
2036	2,398	2,456	2,606
2037	2,417	2,485	2,642
2038	2,437	2,515	2,679

(table continues on next page)

Year	Low Growth (0.8%)	Medium Growth (0.8% → 1.2%)	High Growth (1.4%)
2039	2,456	2,545	2,717
2040	2,476	2,576	2,755
2041	2,496	2,607	2,793
2042	2,516	2,638	2,833
2043	2,536	2,670	2,872
2044	2,556	2,702	2,912

All scenarios were based on a starting population of 2,145, as discussed previously. The selected population for the design basis will be 2,702 people under the medium growth scenario.

An Addendum to the Housing Future Plan was received during the final stages of this Plan. It highlighted that Lyons's population would grow by about a maximum of 50 people. After evaluating the planning capacity with this new information, it was determined that an adjustment in population did not greatly affect the analysis in this Plan, as the high organic concentration and loading is the primary driver behind the recommendations. The previously recommended improvements outlined in the 2019 Rerating Report could potentially be sufficient to satisfy a growth of at maximum 50 people. If the Town grew any more than 50 people or concentrations continued to increase, the WWTF would need to be expanded.

Wastewater Flow and Loading Forecasts

Peaking Factor

Preliminary treatment processes are required to be sized to the peak hourly flow (PHF), rather than the maximum monthly average daily flow (MMADF). Two methods were used to calculate a peak hour factor for the system given the available data.

The first method uses the hourly flows tracked by the WWTF's SCADA system. This method can be used if a facility has three years or more of trended hourly data. The peak hour factor is calculated by dividing the maximum recorded flow by the design flow. From recent three-year hourly SCADA flow data, the max recorded flow data is 511 gallons per minute (gpm). Dividing this max value by the permitted design flow of 212 gpm (0.3065 MGD) results in a peak hour factor of 2.4.

The second method relies on CDPHE WPC-DR-1 Figure 3.1, as referenced from the 2014 Edition of the "Recommended Standards for Wastewater Facilities" (10 State Standards). This method uses an equation to estimate a peak hour factor based on population. Using the 20-year estimated population of 2,702 people results in a calculated peak hour factor of 3.5.

Table 9 summarizes the two calculation methods and the recommended value.

Table 9 – Peak Hour Factor

Method	Peak Hour Factor
WWTF SCADA[1]	2.4
CDPHE WPC-DR-1[2]	3.5
Average	3.0

[1]From recent three-year hourly SCADA flow data, the max recorded flow data is 511 gpm

[2]$Peaking\ Factor = \frac{18+\sqrt{P}}{4+\sqrt{P}}$, P in thousands

The CDPHE WPC-DR-1 method uses the equation highlighted in Table 9 which is based on population. Based on the projected population at the end of the planning period of 2,702 people (please see the Section 2 for more details on population projections), the CDPHE method results in a peak hour factor of 3.5. The average peak hour factor between the methods is 3.0.

The current WWTF is designed with a peaking factor of 3.4. To accurately represent current conditions seen at the WWTF, it is recommended to use a peak hour factor of 3.0.

FLOW PROJECTIONS

To project the future wastewater generation during the 20-year planning period, the per capita flow of 75 gpcd was applied to the projected population. The selected per capita flow of 75 gpcd and the peak hour factor of 3.0 were used for future flow projections. The projected design and peak hour flows for the three growth scenarios are summarized in Table 10.

Table 10 – Projected Average and Peak Hour Influent Wastewater Flow

Year	Design Influent Wastewater Flow (MGD)			Peak Hour Influent Wastewater Flow (MGD)		
	Low Growth (0.8%)	Medium Growth (0.8% → 1.2%)	High Growth (1.4%)	Low Growth (0.8%)	Medium Growth (0.8% → 1.2%)	High Growth (1.4%)
2022	0.161	0.161	0.161	0.483	0.483	0.483
2023	0.162	0.162	0.163	0.486	0.486	0.489
2024	0.163	0.163	0.165	0.490	0.490	0.496
2025	0.165	0.165	0.168	0.494	0.494	0.503
2026	0.166	0.166	0.170	0.498	0.498	0.510
2027	0.167	0.167	0.172	0.502	0.502	0.517
2028	0.169	0.169	0.175	0.506	0.506	0.525
2029	0.170	0.170	0.177	0.510	0.510	0.532
2030	0.171	0.171	0.180	0.514	0.514	0.539
2031	0.173	0.174	0.182	0.519	0.521	0.547
2032	0.174	0.176	0.185	0.523	0.527	0.555
2033	0.176	0.178	0.187	0.527	0.533	0.562
2034	0.177	0.180	0.190	0.531	0.540	0.570
2035	0.178	0.182	0.193	0.535	0.546	0.578

(table continues on next page)

Year	Design Influent Wastewater Flow (MGD)			Peak Hour Influent Wastewater Flow (MGD)		
	Low Growth (0.8%)	Medium Growth (0.8% → 1.2%)	High Growth (1.4%)	Low Growth (0.8%)	Medium Growth (0.8% → 1.2%)	High Growth (1.4%)
2036	0.180	0.184	0.195	0.540	0.553	0.586
2037	0.181	0.186	0.198	0.544	0.559	0.595
2038	0.183	0.189	0.201	0.548	0.566	0.603
2039	0.184	0.191	0.204	0.553	0.573	0.611
2040	0.186	0.193	0.207	0.557	0.580	0.620
2041	0.187	0.196	0.210	0.562	0.587	0.629
2042	0.189	0.198	0.212	0.566	0.594	0.637
2043	0.190	0.200	0.215	0.571	0.601	0.646
2044	0.192	0.203	0.218	0.575	0.608	0.655

Using the medium growth scenario, the projected wastewater influent flow in 20 years is 0.203 MGD. CDPHE requires a municipality to start planning for a new WWTF when the flow hits 80 percent of the rated capacity and to start construction when it hits 95 percent. Under the current permitted flow of 0.3065 MGD, the rated capacity is significantly higher than projections indicate is required. Figure 8 depicts the projected flows against the CPDHE triggers based on the current permitted flow.

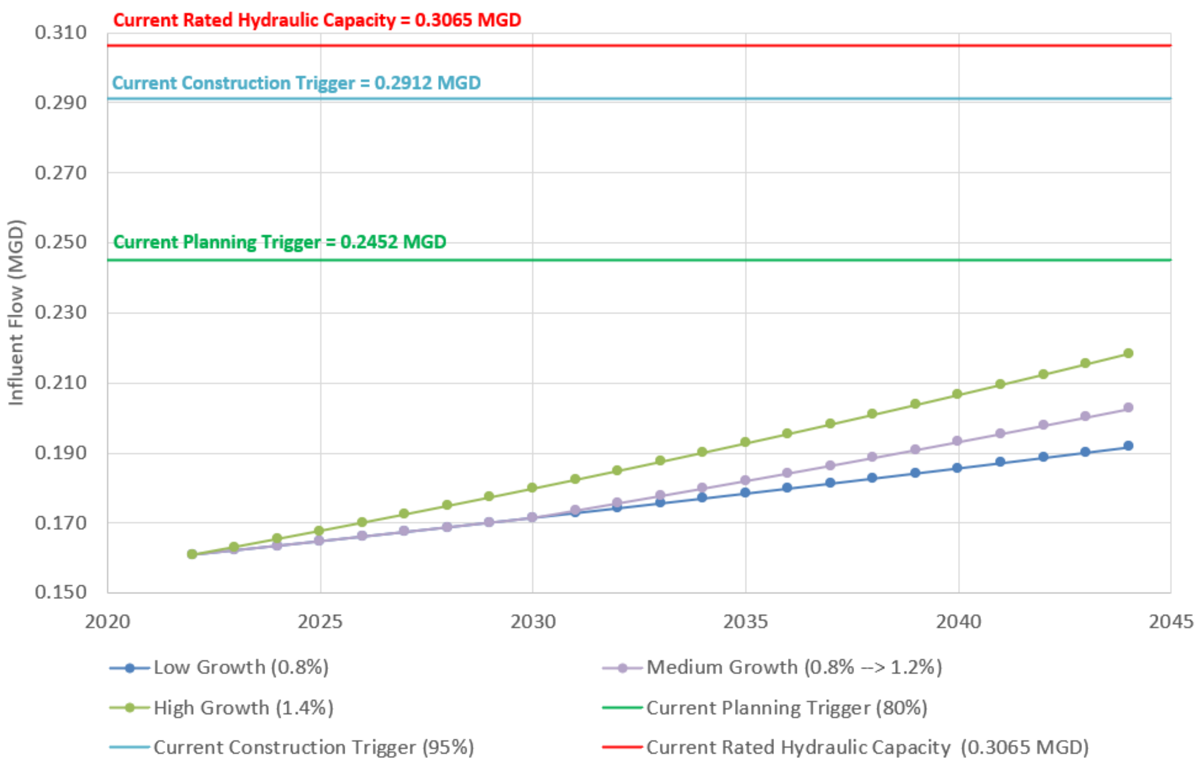

Figure 8 – Influent Wastewater Flow Projections Compared to Current Rated Capacity

As seen in Figure 8, even under the high growth scenario the projected flow at the end of the planning period will not even hit the planning trigger under current rated capacity. The current rated capacity is more than sufficient for the projected flows, and it is recommended that a new rated capacity be selected for the WWTF. This would allow for an increase in BOD_5 concentration, which is expected, without a large increase in loading due to overly high flow ranges.

It is recommended that the design capacity is selected to reach the 80 percent planning trigger at the end of the planning period. This will give the Town extra time before planning and engineering for expanding the WWTF is required. The recommended new rated hydraulic capacity for the system is 0.253 MGD. Please note that this new hydraulic capacity is a derating from the current permitted hydraulic capacity. A depiction of the influent flow projections compared to the proposed rated capacity is shown below in Figure 9.

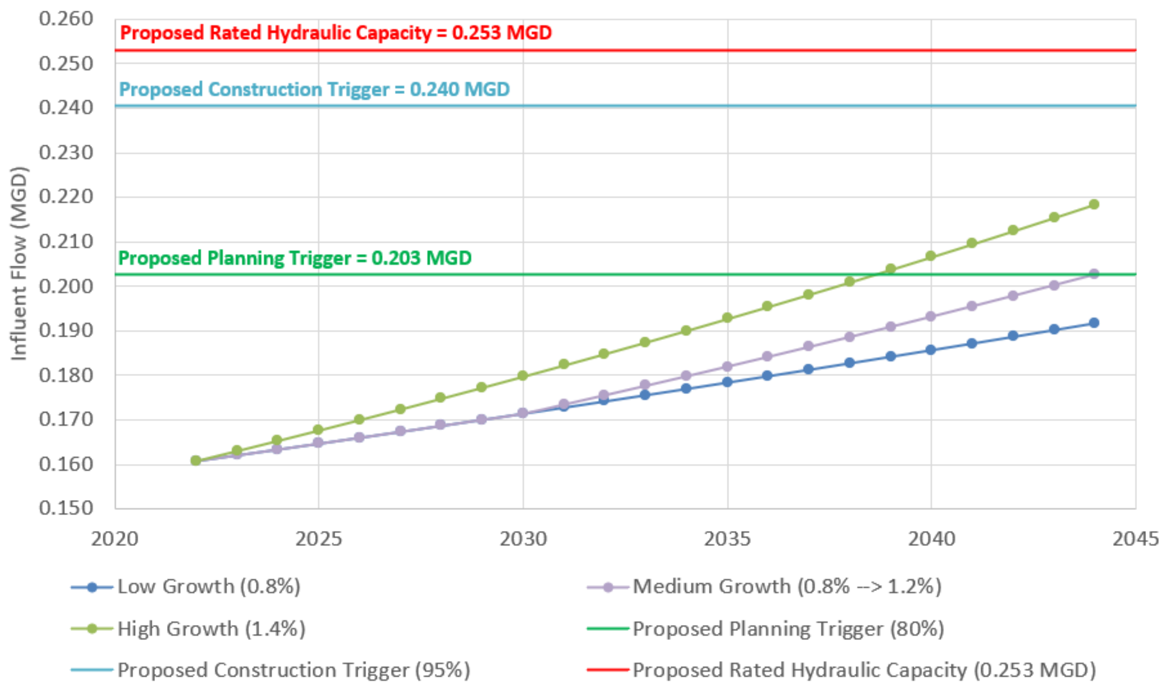

Figure 9 – Influent Flow Projections Compared to Proposed Rated Capacity

At the end of the planning period using the selected medium growth scenario, the projected flow of 0.203 MGD will hit the 80 percent planning trigger of the proposed new rated hydraulic capacity of 0.253 MGD.

Loading Projections

The projected future loading was calculated using the selected design basis BOD_5 concentration of 900 mg/L and the projected flows discussed above. Table 11 summarizes the loading projection for all three growth scenarios.

Table 11 – Loading Projections

Year	BOD_5 Loading Projections (ppd)		
	Low Growth (0.8%)	Medium Growth (0.8% → 1.2%)	High Growth (1.4%)
2022	1,208	1,208	1,208
2023	1,217	1,217	1,224
2024	1,227	1,227	1,242
2025	1,237	1,237	1,259
2026	1,247	1,247	1,277
2027	1,257	1,257	1,294
2028	1,267	1,267	1,313
2029	1,277	1,277	1,331
2030	1,287	1,287	1,350
2031	1,297	1,302	1,368
2032	1,308	1,318	1,388
2033	1,318	1,334	1,407
2034	1,329	1,350	1,427
2035	1,339	1,366	1,447
2036	1,350	1,382	1,467
2037	1,361	1,399	1,488
2038	1,372	1,416	1,508
2039	1,383	1,433	1,529
2040	1,394	1,450	1,551
2041	1,405	1,467	1,573
2042	1,416	1,485	1,595
2043	1,427	1,503	1,617
2044	1,439	1,521	1,640

The loading projections are calculated by multiplying the BOD_5 concentration by the projected flow. At the end of the planning period, the loading is projected to be 1,521 ppd under the selected medium growth scenario. With the new proposed rated capacity of 0.253 MGD and selected 900 mg/L BOD_5 concentration, the required organic capacity is calculated to be about 1,900 ppd. A depiction of the loading projections compared to the proposed organic capacity is shown below in Figure 10.

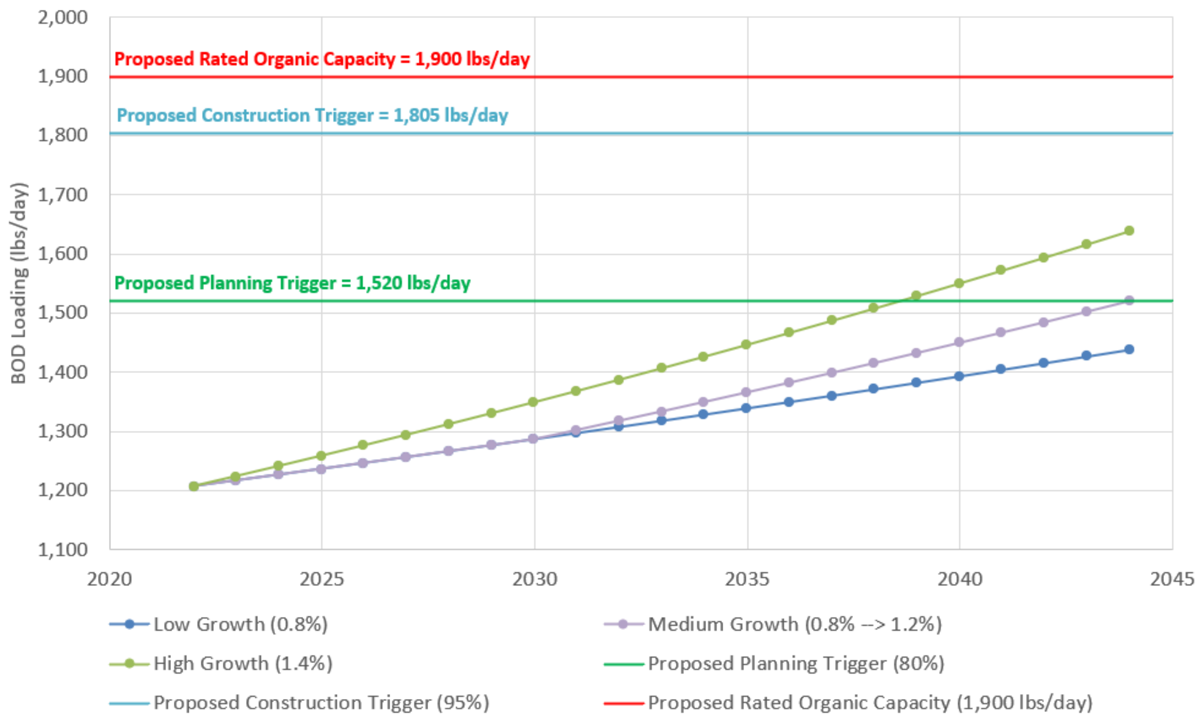

Figure 10 – Loading Projections Compared to Proposed Organic Capacity

Similar to the projected flow, at the end of the 20-year planning period, the loading is projected to hit the 80 percent planning trigger.

Alternative Organic Capacity

While the conservative rated organic capacity of 1,900 ppd is recommended to better reflect the current conditions seen at the WWTF, there is a potential alternative organic capacity. The WWTF was approved for the rerated capacity of 0.3065 MGD at 1,535 ppd under the current discharge permit. This organic loading was based off the recommended improvements outlined in the 2019 Rerating Report. These improvements have not yet been implemented, but the facility was able to obtain approval for the rerating in 2020.

An assumed BOD_5 concentration of 600 mg/L was the design basis in the 2019 Rerating Report. The 2021 to 2024 DMR data has shown that the Town is rapidly exceeding even that high design value from the previous report.

To maintain the currently approved organic capacity of 1,535 ppd at the selected new derated hydraulic capacity of 0.253 MGD, the assumed BOD_5 concentration would be 727 mg/L. While not as conservative as the 900 mg/L (which accounts for the currently observed max month of 880 mg/L), 727 mg/L is still higher than the current annual average BOD_5 concentration. This method of rating the WWTF allows for the secondary treatment improvements to align with the recommendation outlined in the 2019 Rerating Report, rather than needing a new secondary treatment process.

Within this report, there are two approaches to the design basis for BOD_5 concentration and rated organic capacity to highlight the options available to the Town. The two approaches are summarized in Table 12.

Table 12 – Design Basis Approaches

Design Basis	Analysis Performed
#1 Derated Hydraulic Capacity: 0.253 MGD BOD_5 Concentration: 900 mg/L Rated Organic Capacity: 1,900 ppd	Secondary treatment upgrades: alternative assessment of three secondary treatment technologies Solids handling upgrades: alternative assessment of digester and dewatering improvements/expansion
#2 Derated Hydraulic Capacity: 0.253 MGD BOD_5 Concentration: 727 mg/L Rated Organic Capacity: 1,535 ppd	Secondary treatment upgrades: include secondary process improvements previously recommended in the 2019 Rerating Report Solids handling upgrades: alternative assessment of digester and dewatering improvements/expansion

Design Basis #1 is the more conservative approach. This design basis will be used to perform an alternative assessment of three secondary treatment technologies, as well as digester and dewatering improvements.

Design Basis #2 is based on the current permitted organic capacity. As the recommended improvements for this option are unchanged from the 2019 Rerating Report, Design Basis #2 will be used only to evaluate the sizing for associated digester and dewatering improvements. Note that even if the Town elects to not pursue any of the recommendations in this Plan, the improvements described in the 2019 Rerating Report are required to meet the conditions accepted in the Town's updated discharge permit.

Future Regulations

The current permit was issued in December 2022. It is a general permit under the latest COG591 designation. It is expected that this permit will be a relatively good indicator of near-term future limits, as the expected changes will not modify how Lyons is viewed under the general permit.

There are potential limit changes, based on experience with nearby facilities with newer permits. Total inorganic nitrogen is currently at 15 mg/L and could drop to 10 mg/L to meet water supply requirements. Arsenic is already listed as dropping starting in 2028; it is unclear if the system is currently meeting this, as the detection limit appears to be above the permit limit.

Nitrite is currently listed as a report only; this usually precedes an actual limit. Regulation 38 suggests a limit of 0.5 mg/L is possible for Nitrite.

Phosphorus is not listed. While not explicitly called out for the area, phosphorus has been a priority for the state, as demonstrated by the Policy 17 Voluntary Nutrient Incentive Program. A limit of 1.0 mg/L is possible, with 0.7 mg/L being a long-term possibility.

SECTION 4 – WASTEWATER TREATMENT ALTERNATIVES ANALYSIS

As a part of this report, JVA investigated various improvements to the WWTF, including three different alternatives for improvements to the secondary treatment process at the WWTF, as well as two alternatives for improvements to the solids handling system. Consolidation of wastewater service with the City of Longmont was also analyzed as an alternative to improvements at the WWTF. Each option is described in further detail below.

CONSOLIDATION WITH LONGMONT

Consolidation of wastewater service with the City of Longmont has been investigated by the Town and in the previous 2011 *Wastewater Feasibility Study*. The feasibility study analyzed consolidation in detail and discussed the design of the gravity sewer, potential environmental impacts of consolidation, land requirements, construction risks, maintenance and operations considerations, and capital costs associated with consolidation. The 2011 Feasibility Study is included in Appendix A.

The design of the gravity sewer trunk main would be very similar to what is outlined in the 2011 Feasibility Study. It is anticipated that 41,000 linear feet of 12-inch sewer main at an average slope of 0.75 percent will be required to connect the City's wastewater collection system to the existing Trunk Main 8 M04109, which is 18-inch PVC.

The capital cost estimates for consolidation have been updated since the 2011 study and an Opinion of Probable Costs (OPC) is included in Appendix D. In addition to the capital costs associated with construction, there will be costs associated with permitting and easements, connection fees, and recurring monthly user charges. Longmont's Municipal Code and Regulations, Section 14.08.640 states that metered water users pay a monthly service charge and a volumetric charge based on the volume of wastewater discharged. Table 13 summarizes the costs estimates for consolidation.

Table 13 – Cost Summary of Consolidation

Type of Cost	Amount
Construction Cost	$14,340,000
Building Permit Wastewater Development Fee[1]	$200,000
30' Wide Strip Easement from Cemex Site to Longmont in Railroad[2]	$1,904,000
Existing Collection System Fee[2]	$2,215,000
Treatment Capacity Fee[2]	$1,533,000
Total Consolidation Costs	**$20,200,000**

(table continues on next page)

Type of Cost	Amount
Monthly Service Charge[3]	$31,073
Monthly Volume Charge[4]	$59,354
Total Recurring Monthly Costs	**$90,427**

[1]City of Longmont Planning & Development Servies Fee Manual Fiscal Year 2024
[2]Base on previous 2011 Feasibility Study (adjusted for inflation)
[3]Based on 2025 estimated costs of $11.50 per Metered User from Longmont's Municipal Code and Regulations Section 14.08.640 and design basis population of 2,702 people
[4]Assumed 30 days in a month at 0.253 MGD design flow at the conservative $7.82 per 1,000 gallons (volume charge cost indicated in Section 14.08.640)

The 2024 estimated opinion of probable cost for consolidation is $20,200,000, which is more than double the estimated cost from the 2011 study. The total monthly costs for consolidation, which consist of monthly service and volume charges, are estimated to be $90,427 per month.

Estimated costs for this alternative are estimated roughly based on information available on the City of Longmont's website, as well as updated costs from the 2011 study. If the Town would like to pursue this alternative, it is recommended that the Town set up a meeting with the City of Longmont to discuss tap fees, development fees, and other costs associated with consolidation to better understand actual projected costs.

Due to the high capital costs and ongoing monthly costs associated with consolidation with Longmont, this option was not investigated further as a part of this report.

Secondary Treatment Alternatives

Sequencing Batch Reactor (SBR) Expansion

The existing secondary treatment system is an intermittent cycle extended aeration system (ICEAS) sequencing batch reactor (SBR) process. Two additional SBR basins are required for the increased organic loading of 1,900 ppd. The existing SBR manufacturer indicated that the existing two SBR basins could handle a flow of 0.253 MGD, but to treat the expected future loading more volume is needed. They propose installing two additional basins of the same size and configuration as the existing basins.

To implement this alternative, additional space would be needed to accommodate the two new SBR basins and equipment. The WWTF site will need to be expanded past its current fence line to place the new basins. Based on information from the Boulder County Assessor's office, it is assumed that the area to the east of the existing SBR basins is part of the Town's property and can be used for WWTF expansion. Secondary clarification would not be required, as this is accomplished in the "settle" stage of the SBR process. The existing two basins could remain online during construction. Figure 11 below shows a preliminary site layout of the SBR alternative. Appendix A includes the manufacturer's budgetary quote.

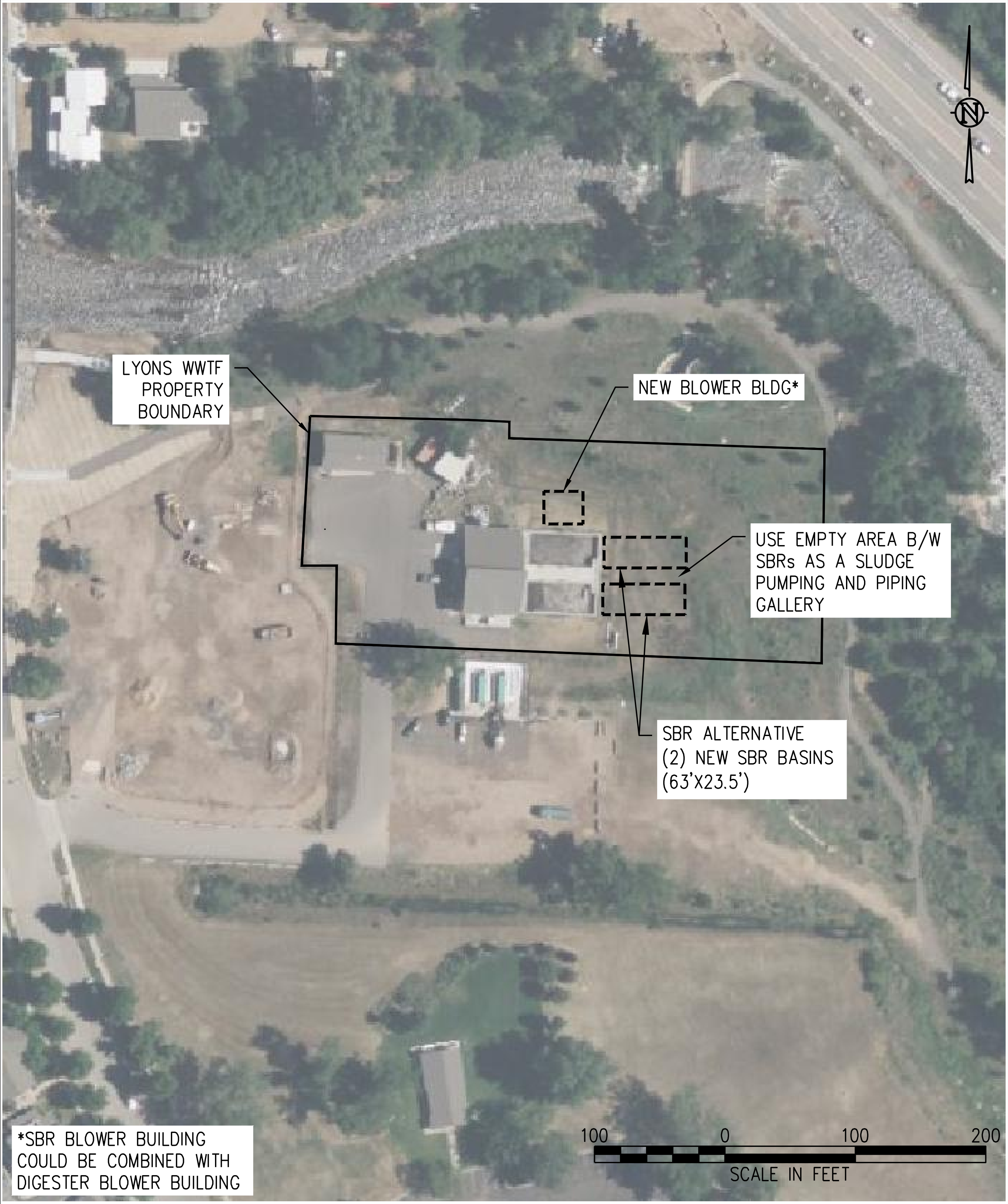

FIGURE 11 - SBR ALTERNATIVE - SITE LAYOUT
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SEPTEMBER 2024

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Boulder, CO 80302
303.444.1951
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This alternative would be a full 4-basin system to handle the expected future flow and loading. The system can be operated to handle the design flow with just three basins when a basin needs to be taken out of service for maintenance. The two additional SBR basins can be placed in the open land to the East of the existing basins.

New blowers are needed to accommodate the additional basins. There will be three larger blowers (25HP, two duty, one stand-by) in addition to the three existing ones for the new system. A new building would be needed to house the additional blowers. Note that the new blower building could be combined with the aerobic digester footprint. It is assumed that the existing effluent equalization tank is suitable for the new system. The OPC for SBR expansion is $9.3 million. The detailed OPC breakdown for the SBR alternative is in Appendix D.

Advantages

- Familiar treatment technology, requiring minimal operator training
- ICEAS SBR is currently meeting treatment requirements

Disadvantages

- SBRs typically have a higher solids production than similar secondary treatment systems
- Highest power consumption and costs
- Highest capital costs
- Additional design and permitting considerations for buildings located in the regulatory floodway

AEROBIC GRANULAR SLUDGE (AGS)

The aerobic granular sludge (AGS) process uses granular biomass to achieve biological treatment in one tank. The system operates in a batch flow mode, similar to a typical SBR; cycles include fill/draw, react, then settling. The sludge granules are typically much larger than typical activated sludge particles, and include aerobic, anoxic, and anaerobic zones within the granule itself. A simplified process flow diagram of the AGS process is shown in Figure 12.

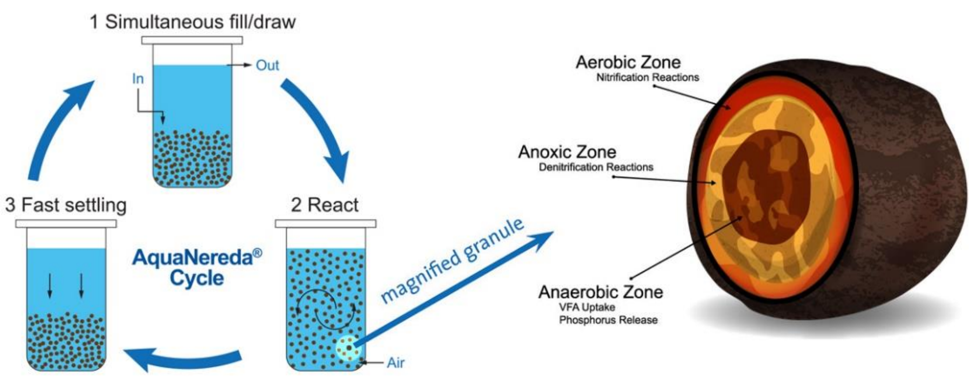

Figure 12 – Process Flow Diagram for AGS

During the simultaneous fill/draw phase of the cycle, the sludge granules settle to the bottom of the tank and flow is introduced from the bottom of the tank through an influent manifold header to encourage plug flow upward in the tank. The water level in the tank rises with influent and begins to decant clarified effluent (supernatant) over a network of effluent weirs. The effluent weirs are typically equipped with scum baffles to prevent any floatables from exiting the tank during the fill/draw phase. The amount of flow introduced during the simultaneous fill/draw phase is calculated to ensure that screened influent does not short-circuit and overtop the effluent weirs. The sludge granules typically have a low sludge volume index (SVI) of approximately 5 to 10 which helps keep the granules settled and avoids mixing of the sludge granules within the tank. Further, the influent piping network is designed such that the influent comes in at a low velocity and does not mix the sludge layer into the supernatant. The fill rate is higher than the design flow because this phase may vary from approximately 15 percent to 35 percent of the total cycle time. There is typically a high food to microorganism (F/M) ratio during the fill/draw phase, and some phosphorous release occurs.

During the react phase, aeration provides mixing and delivers oxygen to achieve simultaneous nitrification and denitrification, BOD, and TSS reduction. Nitrates are transported by diffusion into the granule layers to achieve denitrification, and phosphorous uptake also occurs in the granules. As the granules feed on BOD, they periodically “slough” off during mixing via aeration, which includes phosphorous accumulating organisms (PAO). These sloughed particles do not exhibit a low SVI like the sludge granules and are wasted in the subsequent phase. No external mixers are provided with this system. The react phase may vary from approximately 60 percent to 75 percent of the total cycle time.

During the fast-settling phase, aeration is stopped, and the granules will typically settle within the first 5 to 10 minutes of the phase. Following settling, the WAS pumps waste the non-granular and “sloughed” sludge from a location near the center of the tank to a sludge thickening tank during the next 5 to 15 minutes of the phase. The TSS probes monitor the supernatant and stop the WAS pumping once the TSS has reached the desired value. The settling phase may vary from approximately 7 to 15 percent of the total cycle time.

High settling rates allow for the tank to be operated at a mixed liquor suspended solids (MLSS) concentration of approximately 8,000 mg/L. If the system were run at a higher MLSS, the granules would typically increase in size. Controls include DO, pH (and ORP if desired), and TSS probes. If denitrification is not occurring to the extent desired, operators would reduce the target DO or ORP concentration in the reactor to encourage further denitrification. The full-scale reference installations generally achieve a total phosphorus (TP) in the effluent of less than 1 mg/L without chemical addition. However, if lower effluent TP concentrations are required or are not being achieved, metal salts can be added to the process for coagulation. The settling characteristics of coagulant containing phosphorous are expected to be slower than the granules, and this material would be wasted during the fast-settling phase. This evaluation assumes that metal salt addition is not required for the AGS process. Similar to SBRs, no secondary clarification would be needed. The WAS concentration may typically range from 1,500 mg/L to 4,000 mg/L. WAS is thickened via additional settling in the sludge buffer/thickener prior to pumping to aerobic digestion.

The manufacturer recommends running an 8,000 mg/L MLSS concentration in the bioreactors. The existing pre-react basin, SBR basins, ASHTs, and equalization tank are used for the AGS system. A preliminary site layout for the AGS Alternative is shown in Figure 13. The budgetary quote for the AGS alternative is included in Appendix A.

The manufacturer indicated that a 6-mm perforated plate-style screening and grit removal is required ahead of the AGS system. The current system can meet that requirement. The AGS system requires an influent buffer basin, that functions like a pre-equalization tank. This is because the AGS is a batch system, so storage of influent is required. The existing pre-react basins would be converted to influent buffer basins. The existing effluent equalization tank would remain as effluent equalization to handle AGS decant prior to disinfection. The existing SBR basins would be converted into the AGS reactors, which would involve a large amount of piping modifications within the basin.

A sludge buffer basin is also required; the WAS from AGS is a fairly low concentration, and the sludge buffer basin allows for additional settling time for some additional concentration. One of the existing ASHTs could be used as the sludge buffer basin. Note that the placement of the sludge buffer basin in the ASHT assumes that a new aerobic digester is installed. An additional tank would be required if this is not the case. New process piping between the basins will be needed. Additionally, new blowers are needed to deliver sufficient airflow for treatment and would replace the existing blowers. The OPC for the AGS alternative is $8.1 million. The detailed OPC breakdown for the AGS alternative is in Appendix D.

Advantages

- Effective treatment – can meet current and future anticipated discharge limits
- Potential to meet anticipated future TP limits without chemical addition

Disadvantages

- High solids production
- New treatment system unfamiliar to operators
- Only one existing installation in Colorado

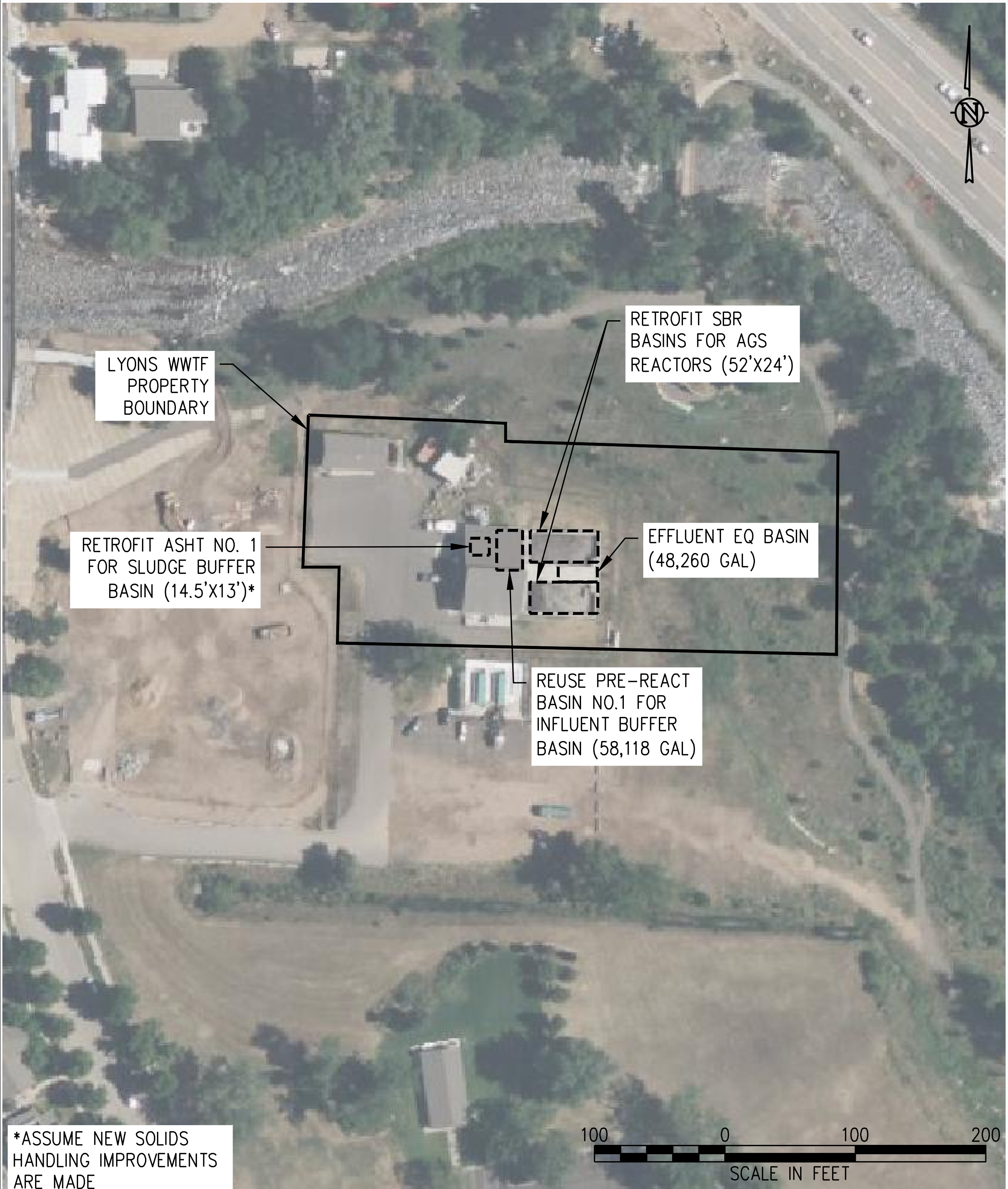

FIGURE 13 - AGS ALTERNATIVE - SITE LAYOUT

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MEMBRANE BIOREACTOR (MBR)

A membrane bioreactor (MBR) operates with an anoxic zone followed by an aerobic zone, similar to a conventional activated sludge system. The mixed liquor is then sent to membrane tanks for solid-liquid separation, which provides a physical barrier prior to discharge. A typical process flow schematic of the MBR process is provided in Figure 14.

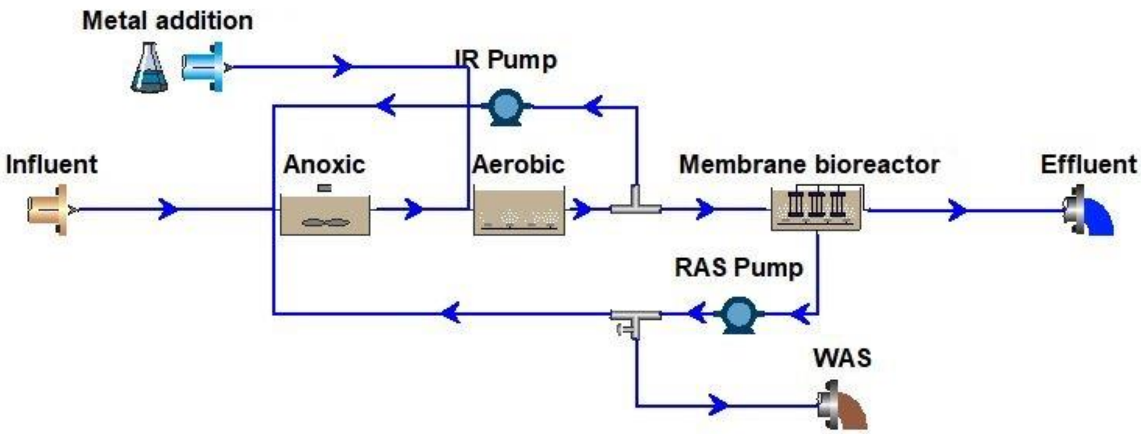

Figure 14 – Process Flow Schematic for MBR

The membranes are typically ultrafiltration membranes (0.04 micrometer (µm) nominal pore size), and are provided as either flat sheet, hollow fiber, or a hybrid. Flat sheet membranes offer a crossflow configuration across a membrane surface, where influent flows parallel to the surface of the membrane while clean water permeates through. This configuration is promoted to minimize fouling, as the influent flowing along the membrane provides some scouring action. Flat membrane sheets are also promoted as potentially allowing for reduced screening requirements (flat sheet membranes require between a 2 and 5-mm screen, while hollow fiber membranes require between a 1 and 2-mm screen). However, the WWTF currently has a 6-mm screen, which is not planned to be replaced as part of this project. Flat sheet membranes may be the only allowable membrane type if a screen replacement is not included, but the proposal received requires a 2-mm screen.

Hollow fiber membranes offer an outside-in configuration where water passes through the membrane wall, and permeate flows through the inside of the membrane tube. Hollow fiber membranes claim to require less air than typical flat sheet membranes, thereby reducing overall power usage. However, this is not supported by the received manufacturer proposals. They do have a smaller operating footprint than flat sheet membranes; the cassettes are smaller, allowing for more flexibility in arrangement and installation.

An MBR system can meet stringent water quality standards and does not require secondary clarification. The existing tankage is utilized slightly differently depending on the specific manufacturer selected. Based on information from the recommended manufacturer, a preliminary site plan is shown in Figure 15. The selected manufacturer budgetary quote is included in Appendix A.

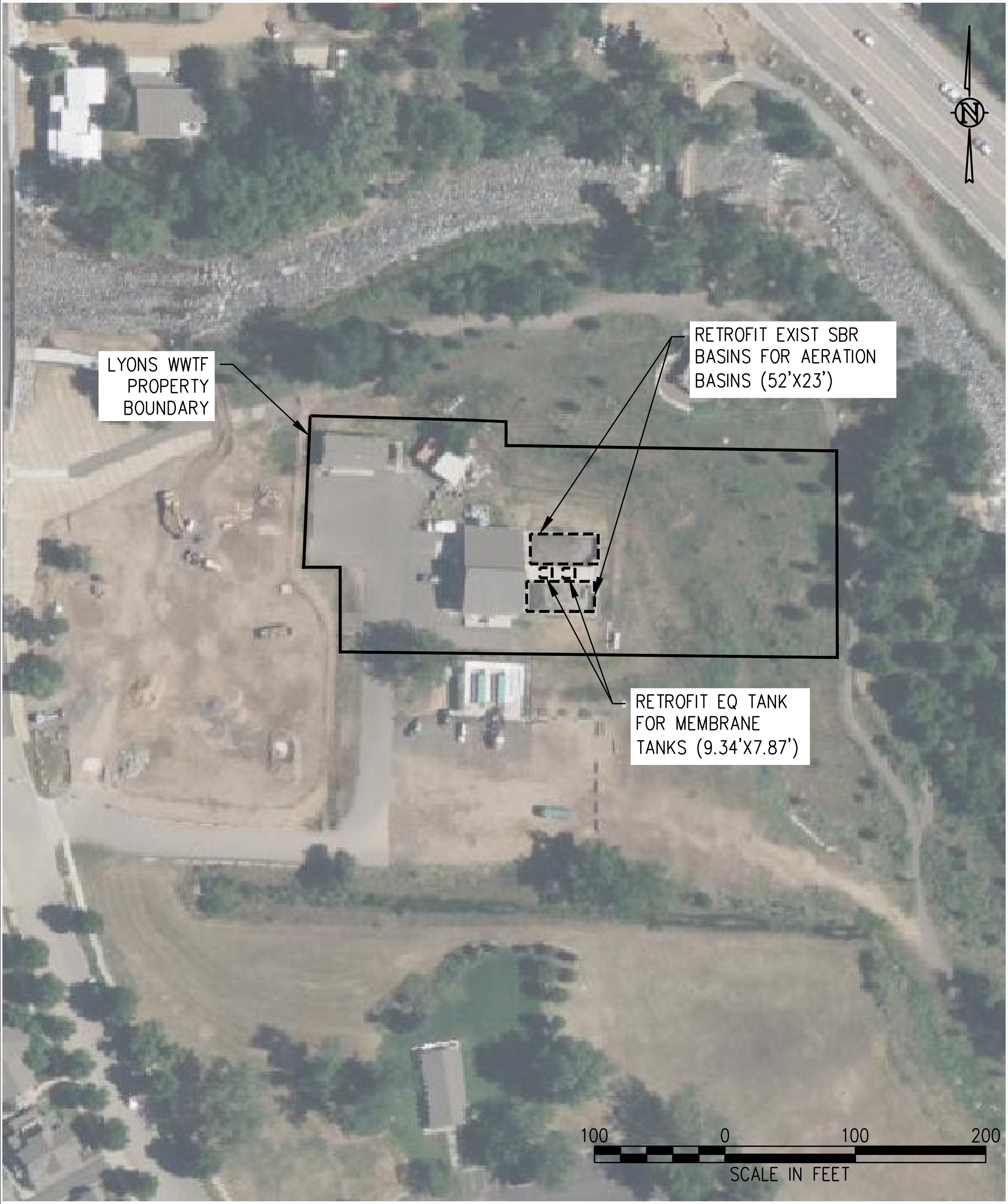

FIGURE 15 - MBR ALTERNATIVE - SITE LAYOUT
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As a requirement of the MBR alternative, the membrane pre-screening would require a 2-mm perforated screen that the current system does not have. A new 2-mm screen would need to be installed for this alternative.

Both the existing SBR basins and the equalization tank are suitable for the required aeration basins and membrane tanks for the MBR alternative. The existing basins will need to be retrofitted to fit the requirements of the new MBR system. New process piping between the basins will be needed.

Chemical usage will be required for this alternative and the existing chemical storage in the MCC/Blower room can be utilized for the new system. Also, new blowers are needed for the system and will replace the existing blowers in the existing blower room. The OPC for the MBR alternative is $7.3 million. The detailed OPC for the MBR alternative is in Appendix D.

Advantages

- Effective treatment – can meet current and future anticipated discharge limits
- Low power consumption
- Lowest capital costs

Disadvantages

- Membrane replacement is required every five to ten years
- Cannot meet anticipated future TP limits without chemical addition

DIGESTION IMPROVEMENTS

The existing aerated solids holding tank is insufficiently sized for current and future WAS loadings from the secondary process. There is also a potential the space could be repurposed for other uses, depending on which secondary treatment alternative is selected.

The Town would like their solids to be treated to a Class B level. Class B is a designation from EPA 503 (CDPHE Regulation 64) that clarifies the level of treatment required for different allowable disposal methods.

Aerobic digestion converts the organic matter wasted from the secondary treatment process to water, carbon dioxide, nitrate, nitrogen gas, and recalcitrant materials. Aerobic digestion achieves these reductions by aerating solids holding basins, typically with coarse bubble aeration, over a minimum of 60 days for a sludge temperature of 15 degrees Celsius. Aerobic digestion reduces the volatile suspended solids (VSS) and the sludge mass from the wasted organic material, which reduces the quantity of solids sent to the dewatering process and the associated dewatering processing and eventual hauling costs. Additionally, VSS destruction significantly reduces vector attraction, which can lead to a Class B biosolids.

Conventional aerobic digesters perform well for WWTF under 5 MGD that use extended aeration type systems for secondary treatment (i.e no primary clarification or treatment), and the Town is generally familiar with this type of digestion process. When compared to anaerobic digesters, aerobic digesters typically have much lower capital cost, but high operation and maintenance costs due to the blower operation. However, aerobic digesters are much more common in facilities under 5 MGD.

The WWTF currently has two ASHTs that are undersized for Class B biosolids, even at current flows and loads. To meet the expected future loading of 1,900 ppd, the aerobic digester needs to have a volume of 455,000 gallons; at the current permitted load of 1,535 ppd, the volume needs to be 390,000 gallons. The digester would have a water depth of 16 feet in order to meet minimum depth requirements per CDPHE design criteria, and to achieve better settling and decanting. A site plan showing the digester with an estimated footprint of 77 feet by 50 feet is shown in Figure 16.

In addition to the volume increase, the current aeration system is significantly undersized. The current ASHTs bleed air off the SBR blower system. The three blowers can produce 250 scfm each, although one of the blowers is intended as a spare only. To meet the expected future loading of 1,900 ppd, the aerobic digester needs 600 scfm; at the current permitted load of 1,535 ppd, it needs 485 scfm. New blowers would be required to provide sufficient aeration for a true aerobic digester. The OPC for the digestion improvements is $7.7 million. The detailed OPC breakdown for the digestion improvements is in Appendix D.

FIGURE 16 - DIGESTION IMPROVEMENT - SITE LAYOUT
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Dewatering Alternatives

As discussed in the existing facilities evaluation, the existing centrifuge is insufficiently sized for both current and future WAS loadings from the secondary process. To improve the dewatering performance and solids capture rate, the centrifuge should be replaced. Two technology alternatives were explored, including a screw press and a rotary fan press. As discussed in the future conditions section, two design bases will be used for the dewatering alternatives. The two technologies are fairly similar; they have similar dewatering performance, polymer usage, and power consumption. A decision between the two would come down to operator preference and pricing. The contract operators are familiar with rotary fan presses from other installations.

Screw Press

A screw press is a simple, slow-moving device that dewaters sludge by first draining water via gravity at the inlet section and then by squeezing water out of the sludge as it is conveyed to the discharge end of the screw under gradually increasing pressure and friction. The resultant cake is transferred to a bin or truck for additional treatment or disposal. The proposed screw press system can dewater aerobic sludge at 65 gpm (470 lb/hr) to produce a cake with an estimated solids concentration of 16 percent. The screw press has an estimated capture rate of well over 90 percent with an estimated polymer consumption between 25 and 40 lb active/dry ton. The pressate, or water that is removed from the sludge, would be returned to the secondary process for additional treatment. The OPC for a selected manufacturer screw press is $880,000. A budgetary quote from a selected screw press manufacturer is included in Appendix A and detailed OPC breakdown for the screw press is in Appendix D.

Rotary Fan Press

A rotary fan press utilizes pressure and friction to dewater sludge. The sludge is fed into a system where a series of rotating fan-like blades distribute the sludge against filter screens. Prior to the press, the sludge is injected with a polymer. The centrifugal force from the rotation initially drives liquid through the screens. As sludge moves slowly through a tapered channel and is compressed against rotating filter screens, the pressure and friction increases. The intensified pressure/friction compacts the sludge and further squeezes out the liquid. The pressate passes through the screens and is collected, while the remaining dewatered solids/cake are discharged separately for disposal. The proposed rotary fan press can dewater sludge at least 65 gpm (470 lb/hr) to produce a cake with an estimated solids concentration of 16 percent. The rotary fan press has an estimated capture rate of 93 percent with an estimated polymer consumption at around 20 lbs/dry ton. The pressate would be returned to the secondary process for additional treatment. The OPC for a selected manufacturer rotary fan press is about $1.8 million. A budgetary quote from a selected rotary fan press manufacturer is included in Appendix A and detailed OPC breakdown for the rotary fan press is in Appendix D.

WWTF Improvements

Based on the WWTF's conditions assessment and performance limiting factors, there are a variety of improvements to the facility that could be made to the WWTF regardless of which secondary treatment alternative is selected. These improvements aim to address the current challenges observed at the facility and optimize the existing treatment performance to meet projected flow and loading to the WWTF.

Preliminary Processes

IPS Upgrades

Operators have noted that frequent cleaning of the IPS is required to remove accumulated material and to prevent the pumps from clogging due to the lack of mechanical screening prior to the IPS. A possible solution would be to install a mechanical screen prior to the IPS to reduce the clean out frequency.

In addition, several upgrades to the influent pumps and VFDs in the IPS are needed to achieve a steadier wet well level.

Wet Well Upsize

It recommended to increase the volume of the influent wet well, as it is currently undersized, resulting in more frequent pump cycling. A larger wet well would reduce the energy consumption of the pumps, increase the lifespan of the pumps, and better accommodate future flow conditions.

Splitter Box Rehab

Rehabilitation of the splitter box to allow equal distribution of influent flows to the SBR basins is needed to correct short circuiting, provide equal flow to both SBRs, and increase treatment capacity. Having equal split of flows, the two basins will be fully utilized and accommodate a higher flow and loading.

Redirect Side Stream Flows

Currently, the decant and centrate sides streams from the solids handling processes are returned back to the IPS, which is upstream of the influent sampling point. The side streams are mixed with the influent flows and pumped from the IPS to the Headworks. As a result, the sampled influent is not representative of the actual influent concentrations due to constituents present in the side streams. It is recommended that the side stream flows be redirected downstream of the influent sampling point.

Secondary Treatment

Aeration Capacity Upgrades

The previous modeling efforts in the 2019 Rerating Report indicate that the blowers are insufficiently sized for the current permitted capacity (Site Application Approval 4289). It was recommended to replace the blowers or increase the blower motor size to meet the aeration requirements. The associated SBR blower air piping, discharge piping size, and diffusers should also be upgraded in tandem with the blowers to meet the aeration demands. This recommendation is not needed if the 1,900 ppd rate organic capacity is selected and the secondary process is expanded.

Disinfection

Post EQ Basin Pumps Upgrades

Due to the post EQ pump configuration, the UV system gets variable flows. To address this concern, it is recommended that VFDs and level controls be installed with the post EQ pumps. The addition of VFDs to the pumps along with a level transducer and back-up float switches would allow for better attenuation of flow to the UV system.

Replace and Upgrade UV System

The age, condition, and configuration of the existing UV system causes a variety of operational challenges. The replacement of the existing UV system with newer Trojan 3000 plus models is recommended. This should increase the operational ease and flexibility of the UV system.

NPW System Relocate

It was noted by the operational staff that the current NPW volume is not sufficient, resulting in major operational issues. Operators are required to use potable water for all non-potable uses. The source of supply for the NPW system needs to be relocated to the post EQ tank to increase volume and meet the demands for the WWTF NPW needs.

Solids Handling

Replace Centrifuge

It is recommended to replace the existing centrifuge with either a screw press or rotary fan press to address poor solids capture efficiency and achieve a higher cake output.

ASHT Upgrades

The existing ASHT system needs to be expanded and improved. The existing ASHT volume is not adequate for the WAS produced, requiring operators to run the centrifuge 5 days a week to meet the solid demands. The ASHT decanting system needs to be replaced to increase thickening within the tanks, which will allow for more storage capacity. This upgrade should also decrease the frequency of solids hauling required and reduce operation costs.

Odor Control

Further evaluation of the odor control system is needed to troubleshoot the causes of the system failure and to determine what is needed to replace and/or modify the system back to its original operating conditions. Due to the age and operational challenges of the existing odor control system, it is recommended a new odor control system be installed.

POWER AND CONTROL

Given the age and condition of the instrumentation at the WWTF, replacement of outdoor instrumentation that has been sun damaged is recommended. Furthermore, it is recommended that the Town install a backup generator utilizing diesel natural gas instead of a secondary utility power to address the dropped power issues with the WWTF.

SECTION 5 – RECOMMENDED ALTERNATIVE

The recommended alternative is selected based on both quantitative and qualitative factors. Capital costs are provided for all presented treatment alternatives and improvements. While cost is important, there are additional factors that also impact selection. A decision matrix comparing qualitative factors such as operability and constructability is presented below.

OPINION OF PROBABLE COST

The estimated costs for the secondary treatment process alternatives, dewatering alternatives, and WWTF improvements are detailed in Appendix D. Cost estimates have been prepared to a nominal accuracy of +/- 30 percent. The supporting documentation used in the preparation of the estimates includes previous project experience, relevant recent construction project bids, input from the Town, and vendor budgetary quotes on major equipment items.

The scope of each improvement has been quantified as much as possible within the level of design completed to date to identify the required work and to provide preliminary planning estimates. Depending on the level of information available, quantities may have been developed based on the following:

- Take-off from preliminary design;
- Estimated take-offs from preliminary plans, sketches, general arrangement drawings or previous experience;
- Factored from previous projects based on capacity; and
- Order-of-magnitude allowance.

Indirect costs include total project contingency, contractors overhead and profit, and professional design fees (engineering, geotechnical, and surveying). Project contingency is based on the level of confidence in the scope of work, quantities, and complexity of the project. Contingency is intended to cover anticipated variances between the direct costs in the base estimates and the final actual project cost for the total estimated values to represent the most likely outcomes. The contingency sum does not cover changes to the stated design (scope changes) or the listed qualifications and exclusions. The expectation is that all contingency monies would be spent in the execution of the project. A total project cost is provided for each alternative.

EVALUATION OF ALTERNATIVES

A weighted decision matrix was developed to rank the secondary treatment alternatives. Six categories were included in the decision matrix:

- <u>Operability:</u> This ranks how simple the system is to operate. It considers operator familiarity with the technology and the complexity of the standard operational procedures. It also factors in the amount of mechanical equipment, instruments, and controls needed to run the process, which also require periodic maintenance throughout the life cycle of the system.

- Process Performance: Performance at reference installations, and how easily/quickly process upsets can be resolved
- Constructability: This criterion ranks how simple the system will be to construct. It looks at the amount of retrofitting required to modify the existing tankage into the required configuration, as well as ancillary processes that may be required to provide a complete, operational system.
- Footprint: Space required for the technology. Although the Town has ample space for the new treatment facility, space in the Town is limited and the WWTF site can be used for other purposes.
- Capital Cost: This criterion ranks the technologies based on the lowest capital cost.
- Operation & Maintenance (O&M) Cost: This criterion ranks the technologies based on the lowest O&M cost. This includes estimates of power usage, chemical consumption, cleaning costs, and equipment replacement costs.

Table 14 shows the score for each alternative based on the above criteria on a scale of one to five (five being the most favorable) and weighted as shown. The highest priorities for the Town were operability and process performance, with capital cost as the third highest priority.

Table 14 – Decision Matrix for Secondary Treatment Alternatives

Criteria	Weight	Alternative 1 SBR	Alternative 2 AGS	Alternative 3 MBR
Operability	25%	5	4	3
Process Performance	30%	2	4	5
Constructability	5%	4	3	3
Footprint	15%	2	5	5
Capital Cost	20%	2	3	4
O&M Cost	5%	3	4	2
TOTAL	**100%**	**2.9**	**3.9**	**4.1**

Note: Scores are on a scale of 1 to 5, with 5 being the most favorable score

The decision matrix indicates that the AGS and the MBR systems are the most favored secondary treatment alternatives. However, there are several options the Town can consider. A "menu" of potential capital improvement projects is presented below. The goal is to aid the Town in selecting the best combination of options to better position themselves for continued treatment and optimized performance.

Menu of Options

Table 15 below summarizes the various improvement options and technology alternatives presented in this report. They have been divided up by process area. Several of the process areas have options to address the performance limiting factors discussed earlier in this report. The Town can select any number of those improvements, based on the total budget available as well as perceived importance. Three of the process areas (secondary treatment, digestion, and dewatering) are limited to selecting one treatment alternative.

Table 15 – WWTF Improvement Options

Option	Project Total	Selection
Preliminary Processes	*Pick Any Number of Options*	
IPS Upgrades (Screen)	$1,050,000	
Wet Well Upsize	$560,000	
Splitter Box Rehab	$120,000	x
Redirect Side Stream Flows	$140,000	x
Secondary Treatment	*Pick One Option*	
SBR Expansion	$9,290,000	
AGS Expansion	$8,100,000	
MBR Expansion	$7,310,000	x
Consolidation	$20,200,000	
SBR Rerating Improvements	$1,560,000	
Disinfection	*Pick Any Number of Options*	
Post EQ Basin Pumps Upgrades	$300,000	x
Replace and Upgrade UV System	$340,000	x
NPW System Relocate	$430,000	x
Digestion	*Pick One Option*	
Aerobic Digester Expansion	$7,660,000	x
ASHT Upgrades	$650,000	
Dewatering	*Pick One Option*	
Screw Press	$880,000	x
Fan Press	$1,760,000	
Miscellaneous	*Pick Any Number of Options*	
Replace Odor Control System	$1,040,000	x
New Instrumentation	$100,000	x
Backup Generator	$210,000	x
Total	**$18,530,000**	

Table 15 indicates which options JVA recommends as the basis of design moving forward to satisfy Design Basis #1. Recommendations are discussed in more detail in the next section. Note that these are recommendations only and can be modified by the Town at their discretion.

RECOMMENDATIONS

Each of the recommended WWTF improvements are described below, organized by process area. The below list indicates which options JVA recommends for the Town based on the existing system condition assessment, discussions with operations staff, and combining priorities into a single project. The recommended improvements have been selected to balance cost and feasibility while positioning the WWTF to best be able to comply with the discharge permit and accommodate any anticipated future flow and loading. For example, although the SBR rerating improvements may be a lower capital cost option for the secondary treatment alternative, the capacity increases gained by these improvements may not be sufficient for a 20-year planning period, and another expansion project may be required within the 20-year planning period. This would result in high capital costs overall compared with implementing a long-term solution now. The Opinion of Probable Costs (OPC) for the selected improvements is $18.5 million. The OPC breakdown of each option is included in Appendix D.

Preliminary Processes

- Splitter box rehab – This will allow equal distribution of influent flows to the SBR basins to correct short circuiting and provide equal flow to both SBRs. Having equal split of flows, the two basins will be fully utilized and accommodate a higher flow and loading.
- Redirect side stream flows – Currently, the decant and centrate side streams from the solids handling processes are pumped back to the influent pump station (IPS), which is upstream of the influent sampling point. As a result, the sampled influent is not representative of the actual influent concentrations due to constituents present in the side streams. It is recommended that the side stream flows be redirected downstream of the influent sampling point to obtain more accurate influent loading from the sanitary sewer.

Secondary Treatment

- Membrane Bioreactor Retrofit – The existing SBR basins are recommended to be retrofitted to accommodate a new MBR process. The features of the MBR system (e.g., highest process performance, lowest capital cost) closely align with the priorities of the Town and are reflected in the MBR's highest score in the decision matrix. Therefore, the recommended secondary treatment technology is the MBR system.

Disinfection

- Post EQ Basin Pumps Upgrades – Due to the post EQ pump configuration, the UV system gets variable flows. To address this concern, it is recommended that variable frequency drives (VFDs) and level controls be installed with the post EQ pumps. The addition of VFDs to the pumps along with a level transducer and back-up float switches would allow for better attenuation of flow to the UV system.
- Replace and Upgrade UV System – The age, condition, and configuration of the existing UV system causes a variety of operational challenges. The replacement of the existing UV system with newer Trojan 3000+ models is recommended. This should increase the operational ease and flexibility of the UV system.
- NPW System Relocate – It was noted by the operational staff that the current NPW volume is not sufficient, resulting in major operational issues and lack of water. Without the proper volume of disinfected effluent water, operations staff must use potable water for non-potable uses. The NPW system requires more storage to provide NPW water to the headworks and odor control system.

Digestion

- Aerobic Digester Expansion – The Town would like their solids to be treated to a Class B level. Class B is a designation from EPA 503 (CDPHE Regulation 64) that clarifies the level of treatment required for different allowable disposal methods. However, the existing aerated solids holding tanks are insufficiently sized for current and future waste activated sludge loadings from the secondary process and for Class B biosolids. To meet the Town's goals for Class B biosolids, it is recommended that an expanded digestion system (e.g., new aerobic digester, new blowers) be installed.

Dewatering

- Screw Press – It is recommended to replace the existing centrifuge with a screw press to address poor solids capture efficiency and achieve a higher cake output.

Miscellaneous

- Replace Odor Control System – Further evaluation of the odor control system is needed to troubleshoot the causes of the system failure and to determine what is needed to replace and/or modify the system back to its original operating conditions. Due to the age and operational challenges of the existing odor control system, it is recommended a new odor control system be installed. With any biological odor control system, the NPW pumping system needs to be replaced to provide NPW.
- New Instrumentation – Given the age and condition of the instrumentation at the WWTF, replacement of outdoor instrumentation that has been sun damaged is recommended. Furthermore, it is recommended that the Town install a backup generator utilizing diesel or natural gas instead of secondary utility power to address past power issues with the WWTF when the secondary power supply isn't energized.

Implementation Schedule

The Town's Utilities Board reviewed the final draft of the Plan in August. The Plan was presented to the Town's Board of Trustees for their review and consideration in late August.

Section 6 – Funding Opportunities

A multi-funding source approach is recommended when implementing the WWTF improvements project. Significant funding amounts, through a combination of grants and low interest loans, may be received from many different governmental agencies. Funding sources can be used to not only pay for construction services, but also any required feasibility studies or reports, conceptual through final engineering design, and construction administration. The following sources were identified for potential funding of the WWTF improvements. These sources are generic funding options which would need to be finalized after selecting a route forward. The final selected improvements will affect the best funding pathway.

Bipartisan Infrastructure Law

The Bipartisan Infrastructure Law (BIL) was signed into law in November 2021 and will invest more than $50 Billion over the next five years in water and wastewater infrastructure programs.

The supplemental funding will be managed through the applicable State Revolving Funds and will be repeated annually. Eligibility, the application process, and loan requirements are generally described in the State Revolving Section below. Access to loan principal forgiveness is subject to funding availability, and the Colorado Water Resources and Power Development Authority Board has the discretion to establish a maximum amount of loan principal forgiveness a community or project may receive. However, conversations with the CDPHE Grants and Loans Unit indicate that the maximum allowable loan forgiveness may be up to $5M, or 49 percent of the total project cost.

The primary change to loan requirements is the *Build America, Buy America* provision, which will apply to all State Revolving Fund (SRF) funded projects. A summary of requirements is below:

- All iron and steel, manufactured products, and construction materials are produced in the United States.
    - Produced In the United States means all iron/steel products from the initial melting stage through the application of coatings occurred in the U.S. Manufactured products must have a total component cost greater than 55 percent produced or manufactured in the U.S.
- Construction materials includes non-ferrous metals, plastic products, composite building material, glass, lumber, and drywall.
- Exclusions include cement, aggregates, and aggregate binding agents or additives.
- Waivers are available when eligible. Waivers include production of a material or product that increases the overall project cost by more than 25 percent or when sufficient/ reasonably available quantities of a material or product is not available.

State Revolving Fund – Low Interest Loans

The SRF Program provides low interest loans to governmental entities for the construction of water and wastewater projects for public health and compliance purposes. The Water Pollution Control

Revolving Fund (WPCRF) provides low interest loans to governmental entities for the construction of wastewater, stormwater, and non-point source projects. The WPCRF can support the following types of projects:

- New Wastewater Treatment Facilities
- Improvement / Expansion of Wastewater Treatment Facilities
- Eliminate Individual Sewage Disposal Systems
- Improvement / New Biosolids Handling Facilities
- Infiltration / Inflow Correction
- Sewer Replacement / Rehabilitation
- New Collector Sewers and Appurtenances
- New Interceptor Sewers and Appurtenances
- Stormwater Projects
- Urban Non-Point Source Projects (Including Best Management Practices, Land Purchase, etc.)

The CDPHE Water Quality Control Division (WQCD), Department of Local Affairs (DOLA), and the Colorado Water Resources and Power Development Authority (Authority) jointly administer the SRF program. The WQCD administers environmental reviews; engineering and design approval; and overall project management. The Authority manages the finances and loan approvals. DOLA staff works with applicants on credit reviews and reports.

There are several milestones that must be met for a project to be eligible for the WPCRF:

- The entity must be included on the most current Intended Use Plan
- A Prequalification Application must be submitted to the Grants and Loans Unit
- A Preapplication meeting with the WQCD, DOLA, and the Authority must be held
- Eligibility for a $10,000 Planning Grant is determined at the Preapplication meeting
- A Project Needs Assessment (PNA) and Environmental Determination for the project must be submitted to the WQCD Engineering Section for review
- WQCD will provide an Environmental Determination (Categorical Exclusion or Environmental Assessment)
- If necessary, an Environmental Assessment shall be submitted and reviewed. If a Finding of No Significant Impact (FNSI) is determined it shall be published with a 30-day comment period
- PNA and Environmental Approval must be obtained.
- Eligibility for a Design and Engineering Grant is determined after approval of the PNA
- A Technical, Managerial, and Financial (TMF) Capacity review must be completed and submitted to the WQCD a minimum of 30 days prior to the loan application.
- A public meeting must be held with a 30-day notice period, notifying the public of the project.
- The loan application shall then be submitted.
- The Authority will then approve the loan.

USDA, Rural Development

United States Department of Agriculture (USDA), Rural Development provides funding to rural areas and Towns with populations of 10,000 people or less through a combination of grant and loan packages. Funding can be used for drinking water sourcing, treatment, storage, distribution and sewer collection, treatment, transmission, and disposal. Depending on funding cycles, grants have contributed up to 70 percent of the USDA funding package with the remaining amount as a low interest 40-year loan. Prior to receiving funding for construction, a Preliminary Engineering Report, and if applicable, an Environmental Report must be completed. This Engineering effort could be funded by a report development SEARCH Grant, which typically covers the estimated $30,000 cost for completing this effort.

Department of Local Affairs Energy and Mineral Impact Assistance Fund

The purpose of the Energy and Mineral Impact Assistance Program (EIAF) is to assist political subdivisions that are socially and/or economically impacted by the development, processing, or energy conversion of minerals and mineral fuels. Funds come from the State severance tax on energy and mineral production and from a portion of the state's share of royalties paid to the federal government for mining and drilling of minerals and mineral fuels on federally owned land.

The kinds of projects that are funded include, but are not limited to, water and sewer improvements, road improvements, construction/improvements to recreation centers, senior centers and other public facilities, fire protection buildings and equipment, and local government planning. The EIAF grants are categorized into Administrative Grants, Tier I, Tier II, and Tier III. Application deadlines for each category are on April 1st, August 1st, and December 1st of each year.

Administrative Grants

Administrative Grants are available for planning, preliminary engineering and architectural design projects. The application process requires the local government to submit a detailed letter to the appropriate DOLA Regional Manager and signed by the Chief Elected Official. The letter should include information such as the project description, budget, financial need, why the project is necessary, urgency of the project, how soon the project can begin, and how soon it can be completed. The maximum award for an Administrative Grant is $25,000, and the total project cost should not exceed $100,000. A dollar-for-dollar match is required for this grant.

Tier I Grants

Tier I grant funds can be used for a variety of public purposes including planning, engineering and design studies, and capital projects requiring a limited level of financial assistance. A Tier I grant awards up to $200,000. Applications for grant consideration will be expected to include a minimum match of 50 percent. Larger matching amounts are generally more competitive. Applications will be reviewed and recommended for funding by DOLA staff. The Executive Director will make funding decisions three times per year.

Tier II Grants

The Tier II grant program is intended to support a wide variety of community development projects to improve quality of life in communities. A Tier II grant awards greater than $200,000 up to $750,000. Applications for grant consideration will be expected to include a minimum match of 50 percent. Larger matching amounts are generally more competitive. Applications will be reviewed and recommended for funding by DOLA staff. The Executive Director will make funding decisions three times per year.

Community Development Block Grants (CDBG)

The United States Department of Housing and Urban Development (HUD) administers the CDBG Program. The Department of Local Affairs (DOLA) administers the program for the State of Colorado. The CDBG Program is divided into thirds: housing, economic development, and public facilities projects. The primary objective of the CDBG Program is to develop viable communities by providing the following, principally to persons of low and moderate income:

- Decent housing
- A suitable living environment
- Expanded economic opportunities

HUD distributes funds to each state based on a statutory formula that considers population, poverty, incidence or overcrowded housing, and age of housing. All activities must meet one of the following national objectives for the program:

- Benefit low and moderate-income persons
- Prevent or eliminate slums or blight
- Fulfill community development needs that have a particular urgency because existing conditions pose a serious and immediate threat to the health or welfare of the community.

Small Systems Training and Technical Assistance (SSTA) Grants

The SSTTA grant program is in place to assist small systems with the costs associated with the planning and design of water system improvements. Grants in the amount of up to $20,000 are available to communities with populations under 10,000 and MHI of less than 80 percent of Colorado, or current/post project water monthly rates are equal to or greater than the state average. Applications for this grant are due at the end of April each year.

Water Quality Improvement Fund (WQIF) Grants

The WQIF program is in place to improve water quality in Colorado by providing grant funds for water quality improvement projects using civil penalties from water quality violations. House Bill 11-1026 amended the statute to authorize grants for stormwater management training and best practices training to prevent or reduce the pollution of state waters. Grants in the amount of up to

$100,000 are available to communities with populations under 10,000 and MHI of less than 80 percent of Colorado. Applications for this grant are due at the end of April each year.

Colorado Water Resources and Power Development Authority Grant Assistance Program (GAP) for Small Systems

The GAP is a grant program in place for small systems that are “project ready” and in need of assistance with the costs associated with constructing the designed improvements. Depending on available funds, grants in the amount of up to $400,000 are available with a minimum 20 percent required match. This grant is available to communities with populations under 10,000 and MHI of less than 80 percent of Colorado average, or current/post project water monthly rates are equal to or greater than the state-wide average. Applications for this grant are due in June of each year.

Colorado Water Conservation Board (CWCB)

Flood and Drought Response Fund

The Flood and Drought Response Fund is an as-needed program for flood and drought response. Funds may also be used for activities related to preparedness, mitigation, and recovery for floods and droughts. There is no formal application for the Flood and Drought Response Fund and funds are available on a rolling basis.

Water Project Loan Program

The Water Project Loan Program provides low interest loans for design and construction of agricultural, municipal, and hydro projects in Colorado. Municipal loan rates are 2.55 percent for low-income areas, 3.00 percent for middle income areas, and 3.40 percent for high income areas. The standard loan term is 30 years; however, rates are reduced by 0.25 percent for 20 year loans and by 0.6 percent for 10 year loans. Rates are increased by 0.25 percent for 40-year loans. A minimum loan request of $100,000 is recommended. Loans under $10 million can be submitted throughout the year while loans over $10 million must be submitted by August 1st to be available the following July 1st.

APPENDIX A – SUPPORTING DOCUMENTS

Fwd: Lyons WWUP - Request for Budgetary Quote - Sanitaire ICEAS SBR

Frank Henderson <fhenderson@cogentcompanies.com>

Tue 6/18/2024 6:10 PM

To:Joe Z. Ning <jning@jvajva.com>

4 attachments (4 MB)

2024.06.18 Dual Mode SBR Proposal Lyons CO (32083-24A).pdf; Sanitaire - Standard Detail Drawing.pdf; 2024.06.18 CO Install list.pdf; Decanter Details.pdf;

Frank Henderson, P.E.
307.460.0125 Mobile
fhenderson@cogentcompanies.com
cogentcompaines.com
Inline image 1

Local Office
14452 W. 44th Ave, Golden
Golden, CO 80403

Don't Forget, We RENT!

---------- Forwarded message ---------
From: **Odishoo, Daphne - Xylem** <Daphne.Odishoo@xylem.com>
Date: Tue, Jun 18, 2024 at 5:12 PM
Subject: RE: Lyons WWUP - Request for Budgetary Quote - Sanitaire ICEAS SBR
To: fhenderson <fhenderson@cogentcompanies.com>
CC: Feltz, Brian - Xylem <Brian.Feltz@xylem.com>

Hi Frank,

I apologize for the delay in getting this back to you and I do appreciate the clarification from Joe on the items I inquired about yesterday.

Based on the high loading for the proposed influent design criteria we recommend adding on to the existing Sanitaire ICEAS system as follows:

1. Keep existing 2 basin ICEAS SBR and add 2 identical basins (same size and configuration)
   a. The full 4-basin system will run in a DUAL Mode where the standard operation is a true batch SBR that can handle the expected future loading
   b. The system can run in a 3-basin ICEAS (Continuous flow) mode when a basin needs to be taken out of service for maintenance.
2. We propose providing (4) new influent valves, one for each of the existing two basins and one for each of the proposed new basins
3. Equipment in the new basins (mixers, blowers, WAS pumps, sensors) will match that of the existing basins
4. Controls will need to be upgraded to run in Dual mode. The existing 2 basin control system will need to have the old PLC upgraded to a remote I/O with new code

Budgetary pricing for 2 new, identical SBR basins is **$971,525** and includes:

Pricing includes equipment and service below, freight to jobsite, and standard warranty.

<u>Xylem Sanitaire Dual Mode SBR/ICEAS (NDNP) Equipment for additional (2)-Basin, 63 ft (equivalent basin length) x 23.5 ft x 18 ft TWL</u>

(3) (25) HP Positive Displacement ICEAS Blowers (two duty, one stand-by)

(6) Fine Bubble Aeration Grids (three per Tank; 1 pre-react + 2 main react grids per tank)

(2) (7.5 ft) SS Decanters with ¼ HP Actuator Drive Unit (one per ICEAS tank)

(2) (6”) Automated Air Control Valves

(2) 2.4 HP Flygt Waste Sludge Pumps (one per ICEAS tank)

(1) OSCAR Package, including the following features

- Main Control Panel with HMI, Motor Starters and VFDs
- DO Control
- ORP Control
- Remote HMI Accessibility

(1) Upgraded existing PLC with new code for Dual Mode operation to coordinate existing and new tanks

(15) Days of Service - Including Commissioning and Process Training

<u>Excludes</u>

SCADA

Current lead times are as follows:

Certified Mechanical engineered equipment drawings:	8-12 weeks
Certified Electrical engineered equipment drawings:	12-16 weeks
Equipment Shipment (after release for fabrication):	16-20 weeks

Let us know if you have any questions.

Thank you,

Daphne Odishoo (she, her, hers)

Application Engineer – Western United States

Xylem
N19 W23993 Ridgeview Pkwy STE 200

Waukesha, WI 53188

O: +1.414.365.5996 M: +1.262.433.0450

DESIGN PROPOSAL

Town of Lyons, CO Sanitaire #32083-24a

		Max Month*		Max Month	
Operating Mode					
Normal Cycle Flow	MGD	0.25		0.25	
Max Normal Cycle Flow	MGD	0.57		0.57	
Minimum Cycle Flow	MGD	0.76		0.76	
		mg/l	lb/day	mg/l	lb/day
BOD_5 (20°C)		900	1899	900	1899.02
Suspended Solids		400	844	400	844.008
TKN		70	148	70	147.701
Total Phosphorus		20	42	20	42
Max Wastewater Temperature	°C	20		20	
Min Wastewater Temperature	°C	12		12	
Ambient Air Temperature	°F	20 - 90		20 - 90	
Site Elevation	ft	5,318		5,318	

*** - Maximum 30 day period mass flow**

Table B: SBR EFFLUENT QUALITY (MONTHLY AVERAGE)

BOD_5 (20°C)	mg/l	30	10
Suspended Solids	mg/l	30	10
NH_3-N	mg/l	3	1
TIN (Future)	mg/l	10	10
Total Phosphorus (Future)	mg/l	1.0	1.0

*Requires chemical precipitation

Table C: SBR PROCESS DESIGN CRITERIA

		SBR Mode	ICEAS Mode
Operating Basins		4	4
Operating Top Water Level	ft	18.00	17.36
F / M	BOD5/DAY/MLSS	0.074	0.074
SVI (after 30 minutes settling)	ml/g	150	150
MLSS at Bottom Water Level	mg/l	4,511	4,511
Waste Sludge Produced (Approx.)	lb/day	923	923
Volume of Sludge Produced (Approx., 0.85% solids)	GPD	13,000	13,000
Max Month ADF Decant Rate	GPM	395	395
Peak hourly Flow Decant Rate	GPM	527	527
Hydraulic Retention Time	Days	2.90	2.85
Sludge Age	Days	27.3	27.3
Sufficient Alkalinity must be provided to maintain basin pH of 6.8			
Chemical Dosage (as Alum)	mg/l	72	72

Bold, italicized text indicate assumptions made by Sanitaire

Cycle Timing

		SBR Mode		ICEAS Mode	
		Normal	Min	Normal	Min
Air-On	min	120	90	120	90
Air-Off	min	48	36	48	36
Settle	min	48	36	48	36
Decant	min	72	54	72	54
Total	min	288	216	288	216

Table D: KEY SBR DESIGN DETAILS

Top Water Level	ft	18.00
Basin Width (Inside)	ft	23.5
Basin Length (Inside)	ft	63.0
Bottom Water Level	ft	15.43

SBR EQUIPMENT(Addition)						Motor HP	No. Req.
Decanter Mechanism	7.5	' Weir length					2
Decanter Drive Unit						1/4	2
SBR Blower	245	SCFM		8.8	PSIG	25	3
SBR Fine Bubble Aeration System	264	Disc Diffusers/Basin					2
Air Control Valve	6	"					2
Waste Sludge Pump	110	GPM				2.4	2
Submersible Mixer						8.3	2
SBR Controls							1
SBR Influent Valve							4

SBR POWER REQUIREMENTS Max I Max Month					(At Average Aeration Depth)			Kwh/Day
Decant Drive Unit	0.2	BHP	4	run	@	6	Hrs/day	3.6
SBR Air Blowers	20.7	BHP	4	run*	@	20	Hrs/day	1,234.2
								0.0
Waste Sludge Pump	1.9	BHP	2	run	@	0.5	Hrs/day	1.4
Submersible Mixer	6.6	BHP	2	run	@	4	Hrs/day	39.6
						KWH/DAY		1,278.8
					AVERAGE	KWH/HR		53.28

* Shared SBR Blowers

SANITAIRE SBR Aeration Design Calculations

BOD Removal, Nitrification, and De-Nitrification Process

SANITAIRE Project #32083-24a

Town of Lyons, CO

Carbonaceous Oxygen Demand

$$AOR1 = A \times \frac{Q \times BODin}{1{,}000{,}000} \times 8.34 = 1.20 \times \frac{63{,}250 \times 900}{1{,}000{,}000} \times 8.34 = \textbf{570 lb/day/basin}$$

where AOR1 = Actual Oxygen Required for BOD oxidation (lb/day/basin)
A = O2 / BOD
Q = Average flow (gal/day/basin)
BODin = Influent BOD received (mg/l)
1,000,000 = Conversion (g x mg)
8.34 = Conversion (lb x gal)

Nitrification Oxygen Demand

$$AOR2 = TKNox \times 4.60 = 18.4 \times 4.60 = \textbf{84 lb/day/basin}$$

where AOR2 = Actual Oxygen required for Ammonia Oxidation (lb/day/basin)
TKNox = Nitrogen available for oxidation(lb/day/basin)

Constants

Coefficient	Value	Symbol
VSS/TSS	0.7474	
Sludge N	0.1	Ns
Effluent Dissolved Organic Nitrogen, mg/l	1	EDON
Expected Effluent Ammonium concentration	1	$TENH_3$

$$TKN_{ox} = (TKN - EDON - TENH_3 - N_{assim} - N_{part}) \times Q \times 8.34 \div 1{,}000{,}000$$

$$TKN_{ox} = (70 - 1 - 1 - 32.46 - 0.75) \times 63{,}250 \times 8.34 \div 1{,}000{,}000 = \textbf{18.4 lb/day/basin}$$

where N_{assim} = Nitrogen assimilated into biomass, (mg/l)

$$N_{assim} = BOD_{in} \times N_s \times Y_{obs} \times VSS/TSS = 900 \times 0.1 \times 0.486 \times 0.75 = \textbf{32.46 mg/l}$$

where Y_{obs} = Observed Sludge Yield, (MLSS produced / BOD removed)

$$N_{part} = TESS \times N_S \times VSS/TSS = 10 \times 0.1 \times 0.75 = \textbf{0.75 mg/l}$$

where N_{part} = Nitrogen bound to VSS portion of effluent TSS (mg/l)
TESS = Anticipated Effluent Total Suspended Solids (mg/l)

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Denitrification Oxygen Credit

$$O_{2denit} = 2.9 \times NO3\text{-}Ndenit = 2.9 \times 18 = \mathbf{52\ lb/day/basin}$$

where O_{2denit} = Oxygen mass credit from denitrification (lb/day/basin)

NO3-Ndenit = Mass of NO3-N denitrified (lb/day/basin)

$$NO_3\text{-}N_{denit} = \mu_{DN} \times VSS/TSS \times BMOB \times ART = 0.00125 \times 0.75 \times 6{,}433 \times 3.01 = \mathbf{18\ lb/day/basin}$$

where μ_{DN} = Denitrification rate at 12°C (NO3/MLVSS/hr)

BMOB = Basin biomass (lb/basin)

ART = Anoxic Retention Time, (hrs/day)

Total Actual Oxygen Transfer

$$AOR = AOR1 + AOR2 - O_{2denit} = 570 + 84 - 52 = \mathbf{601\ lb/day/basin}$$

where AOR = Total Actual Oxygen Required (lb/day/basin)

Total Standard Oxygen Transfer

$$SOR = \frac{AOR}{AOR / SOR} = \frac{601}{0.3884} = \mathbf{1{,}549\ lb/day/basin}$$

$$\frac{AOR}{SOR} = \frac{\alpha \times \theta^{(TSite - 20)} \times (\beta \times C^{*}sat_{20} \times Psite / Pstd \times Csurf_{T} / Csurf_{20} - D.O.)}{C^{*}sat_{20}}$$

$$\frac{AOR}{SOR} = \frac{0.65 \times 1.024^{(20 - 20)} \times (0.95 \times 10.64 \times 12.15 / 14.70 \times 9.07 / 9.07 - 2.0)}{10.64} = \mathbf{0.3884}$$

where SOR = Standard Condition Oxygen Requirement (lb/day/basin)

α = Alpha factor

θ = Temperature coefficient

Tsite = Water temperature (°C)

β = Beta factor

Psite = Site Atmospheric Pressure

Pstd = Standard atmospheric pressure (psig)

$C^{*}sat_{20}$ = Dissolved oxygen solubility at standard conditions (mg/l)

$Csurf_{T}$ = Dissolved oxygen solubility at site water temperature (mg/l)

$Csurf_{20}$ = Dissolved oxygen solubility at 20°C (mg/l)

D.O. = Residual dissolved oxygen concentration (mg/l)

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Aeration System Standard Oxygen Transfer Rate

$$SOTR = \frac{SOR}{TA} = \frac{1,549}{10} = \textbf{155 lb/hr/basin}$$

where SOTR = Standard oxygen transfer rate (lb/hr/basin)
TA = Aeration Time, (hrs/day)

Aeration Depth

Average Aeration Depth

$$AADad = \frac{Q \times NCT}{2 \times 1,440 \times 7.48 \times BA} + BWL$$

$$AADad = \frac{63,300 \times 4.8 \times 60}{2 \times 1,440 \times 7.48 \times 1,480} + 15.43 = \textbf{16.00 ft}$$

where AADad = Average Aeration Depth at Average Dry Weather Flow (gpd)
Q = Average Dry Weather Flow (gpd/basin)
NCT = Normal Cycle Time (hr)
NDT = Normal Decant Time (min)
NST = Normal Settling Time (min)
BA = Basin Area (ft^2)
1440 = Conversion (min/day)
2 = Calculate Aeration Depth at Middle of Normal Reaction Phase (NCT - NST - NDT)
7.48 = Conversion (gal/ft^3)

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Maximum Aeration Depth

$$MADpw = \frac{PWWF \times SCT}{1{,}440 \times 7.48 \times BA} + BWL$$

$$MADpw = \frac{189{,}750 \times 3.6 \times 60}{1{,}440 \times 7.48 \times 1{,}480} + 15.43 = \mathbf{18.00\ ft}$$

where MADpw = Maximum Aeration Depth at Peak Wet Weather Flow (gpd)
PWWF Peak Wet Weather Flow (gpd/basin)
SCT = Storm Cycle Time (hr)
SDT = Storm Decant Time (min)
SST = Storm Settle time (min)
MAD = Maximum Aeration Depth (ft)

MAD is larger of MADad and MADpw

MAD = **18.00 ft**

Air Flow Requirement

$$\text{Process Air} = \frac{SOTR \times 10{,}000}{\rho \times SOTE \times Opw \times 60} = \frac{155 \times 10{,}000}{0.075 \times 30.32 \times 23.2 \times 60} = \mathbf{489\ scfm}$$

where Process Air = Process air flow requirement (scfm)
ρ = Air density (0.075 lb/day/ft³)
SOTE = Standard Oxygen Transfer Efficiency @ Submergence of 15.00 ft
Opw = Fraction of Oxygen in air by Weight
10,000 = Conversion (100% * 100%)
60 = Conversion (min/hr)

Mixing Air = MI x BA = 0.13 x 1,480 = **185 scfm**

where Mixing Air = Mixing air flow requirement (scfm)
MI = recommended air flow per unit area of basin (scfm/ft²)

Blower Unit Capacity

Blower unit capacity (BUC) is the larger of the process air requirement and the mixing air requirement.

Process Air 489 scfm

Mixing Air 185 scfm

Use 2 blowers per tank

BUC = **245 scfm**

Blower Pressure

psig = MAD x 0.432 + H_L = 18.00 x 0.432 + 1.00 = **8.8 psig**

where psig = blower pressure (rounded to next psig)
0.432 = water density (psi/ft)
H_L = Cumulative piping and diffuser headloss (psig)

Average Blower Power

Blower power based on vendor curves, BUC, and Average Aeration Depth (15.00 ft)

$Power_{avg}$ = **20.7 bhp**

Project Name: Town of Lyons, CO SBR
Sanitaire Number: 32083-24A

SBR 4-Basin NDNP Normal Cycle 288 mins (4.8 hours)

Basin #1

0	24	48	72	96	120	144	168		116			288
AIR OFF (24 min Mix)	AIR ON (0-24 min)	AIR ON (0-24 min)	AIR ON (0-24 min)	**AIR OFF (24 min Mix)	AIR ON (0-24 min)	AIR ON (0-24 min)	SETTLE (48 min)		DECANT (72 min)			

Basin #2

144	168		116			288/0	24	48	72	96	120	144
AIR ON (0-24 min)	SETTLE (48 min)		DECANT (72 min)			AIR OFF (24 min Mix)	AIR ON (0-24 min)	AIR ON (0-24 min)	AIR ON (0-24 min)	**AIR OFF (24 min Mix)	AIR ON (0-24 min)	

Basin #3

72	96	120	144	168		116			288/0	24	48	72
AIR ON (0-24 min)	**AIR OFF (24 min Mix)	AIR ON (0-24 min)	AIR ON (0-24 min)	SETTLE (48 min)		DECANT (72 min)			AIR OFF (24 min Mix)	AIR ON (0-24 min)	AIR ON (0-24 min)	

Basin #4

116			288/0	24	48	72	96	120	144			116
DECANT (72 min)			AIR OFF (24 min Mix)	AIR ON (0-24 min)	AIR ON (0-24 min)	AIR ON (0-24 min)	**AIR OFF (24 min Mix)	AIR ON (0-24 min)	AIR ON (0-24 min)	SETTLE (48 min)		

★ Recommended Chemical Addition Points if Needed.

Notes:
Each basin fills from minute 0 to 72. Basins #1 and #2 share blowers and Basins #3 and #4 share blowers.
"Air On" periods in the react phase are programmable from 0 to 24 minutes.
** "Air Off" periods that do not overlap with the other basin can be aerated if needed.
Sludge wasting occurs during the decant phase, pump run time is programmable.

Project Name: Town of Lyons, CO SBR
Sanitaire Number: 32083-24A

SBR 4-Basin NDNP High Flow Mode 216 mins (3.6 hours)

Basin #1

0	18	36	54	72	90	108	126	162	216
AIR OFF (18 min Mix)	AIR ON (0-18 min)	AIR ON (0-18 min)	AIR ON (0-18 min)	**AIR OFF (18 min Mix)	AIR ON (0-18 min)	AIR ON* (0-18 min)	SETTLE (36 min)	DECANT (54 min)	

Basin #2

108	126	162	216/ 0	18	36	54	72	90	108
AIR ON* (0-18 min)	SETTLE (36 min)	DECANT (54 min)	AIR OFF (18 min Mix)	AIR ON (0-18 min)	AIR ON (0-18 min)	AIR ON (0-18 min)	**AIR OFF (18 min Mix)	AIR ON (0-18 min)	

Basin #3

54	72	90	108	126	162	216/ 0	18	36	54
AIR ON (0-18 min)	**AIR OFF (18 min Mix)	AIR ON (0-18 min)	AIR ON* (0-18 min)	SETTLE (36 min)	DECANT (54 min)	AIR OFF (18 min Mix)	AIR ON (0-18 min)	AIR ON (0-18 min)	

Basin #4

162	216/ 0	18	36	54	72	90	108	126	162
DECANT (54 min)	AIR OFF (18 min Mix)	AIR ON (0-18 min)	AIR ON (0-18 min)	AIR ON (0-18 min)	**AIR OFF (18 min Mix)	AIR ON (0-18 min)	AIR ON* (0-18 min)	SETTLE (36 min)	

Notes:
Each basin fills from minute 0 to 54. Basins #1 and #2 share blowers and Basins #3 and #4 share blowers.
"Air On" periods in the react phase are programmable from 0 to 18 minutes.
** "Air Off" periods that do not overlap with the other basin can be aerated if needed.
Sludge wasting occurs during the decant phase, pump run time is programmable.
During the storm cycle, the time segments are reduced by 25% to accommodate additional flow.

Project Name: Town of Lyons, CO ICEAS
Sanitaire Number: 32083-24A

SANITAIRE
a xylem brand

ICEAS (Dual mode) 4-Basin NDNP Normal Cycle 288 mins (4.8 hours)

Basin #1

0	24	48	72	96	120	144 ★	168	116
AIR OFF (24 min Mix)	AIR ON (0-24 min)	AIR ON (0-24 min)	AIR ON (0-24 min)	**AIR OFF (24 min Mix)	AIR ON (0-24 min)	AIR ON (0-24 min)	SETTLE (48 min)	DECANT (72 min)

End: 288

Basin #2

144 ★	168	116	288/0	24	48	72	96	120
AIR ON (0-24 min)	SETTLE (48 min)	DECANT (72 min)	AIR OFF (24 min Mix)	AIR ON (0-24 min)	AIR ON (0-24 min)	AIR ON (0-24 min)	**AIR OFF (24 min Mix)	AIR ON (0-24 min)

End: 144

Basin #3

72	96	120	144 ★	168	116	288/0	24	48
AIR ON (0-24 min)	**AIR OFF (24 min Mix)	AIR ON (0-24 min)	AIR ON (0-24 min)	SETTLE (48 min)	DECANT (72 min)	AIR OFF (24 min Mix)	AIR ON (0-24 min)	AIR ON (0-24 min)

End: 72

Basin #4

116	288/0	24	48	72	96	120	144 ★	
DECANT (72 min)	AIR OFF (24 min Mix)	AIR ON (0-24 min)	AIR ON (0-24 min)	AIR ON (0-24 min)	**AIR OFF (24 min Mix)	AIR ON (0-24 min)	AIR ON (0-24 min)	SETTLE (48 min)

End: 116

★ Recommended Chemical Addition Points if Needed.

Project Name: Town of Lyons, CO ICEAS
Sanitaire Number: 32083-24A

ICEAS Dual mode 4-Basin NDNP High Flow Mode 216 mins (3.6 hours)

Basin #1 (0 – 216)

0	18	36	54	72	90	108	126 – 162	162 – 216
AIR OFF (18 min Mix)	AIR ON (0-18 min)	AIR ON (0-18 min)	AIR ON (0-18 min)	**AIR OFF (18 min Mix)	AIR ON (0-18 min)	AIR ON* (0-18 min)	SETTLE (36 min)	DECANT (54 min)

Basin #2 (108 – 216/0 – 108)

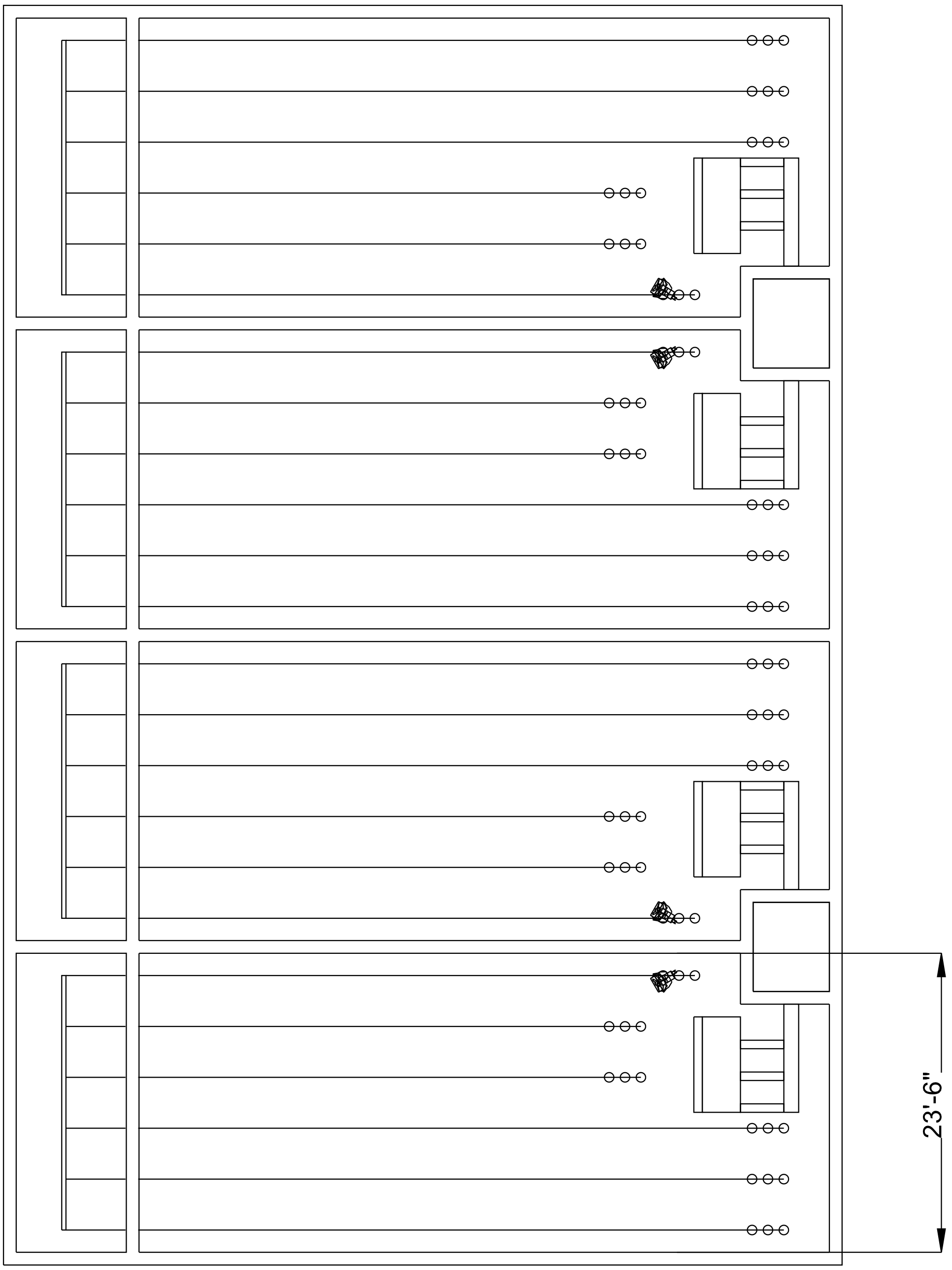
108	126 – 162	162 – 216/0	0	18	36	54	72	90
AIR ON* (0-18 min)	SETTLE (36 min)	DECANT (54 min)	AIR OFF (18 min Mix)	AIR ON (0-18 min)	AIR ON (0-18 min)	AIR ON (0-18 min)	**AIR OFF (18 min Mix)	AIR ON (0-18 min)

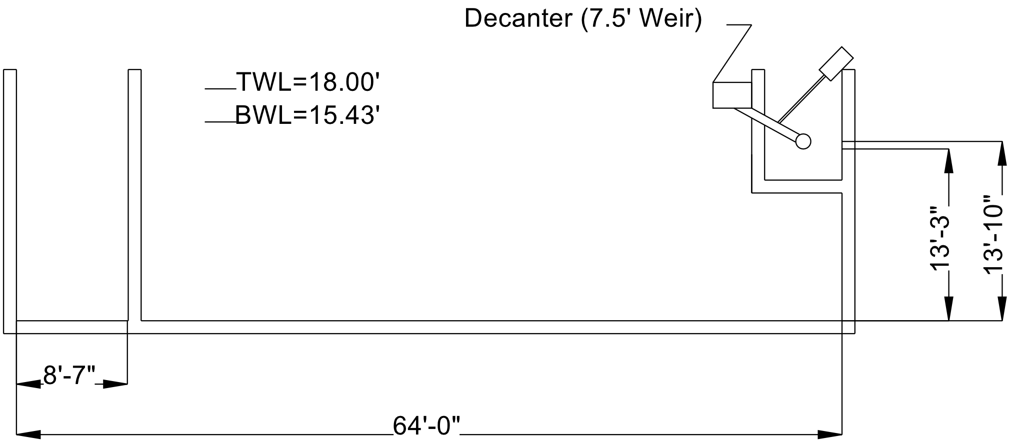
Basin #3 (54 – 216/0 – 54)

54	72	90	108	126 – 162	162 – 216/0	0	18	36
AIR ON (0-18 min)	**AIR OFF (18 min Mix)	AIR ON (0-18 min)	AIR ON* (0-18 min)	SETTLE (36 min)	DECANT (54 min)	AIR OFF (18 min Mix)	AIR ON (0-18 min)	AIR ON (0-18 min)

Basin #4 (162 – 216/0 – 162)

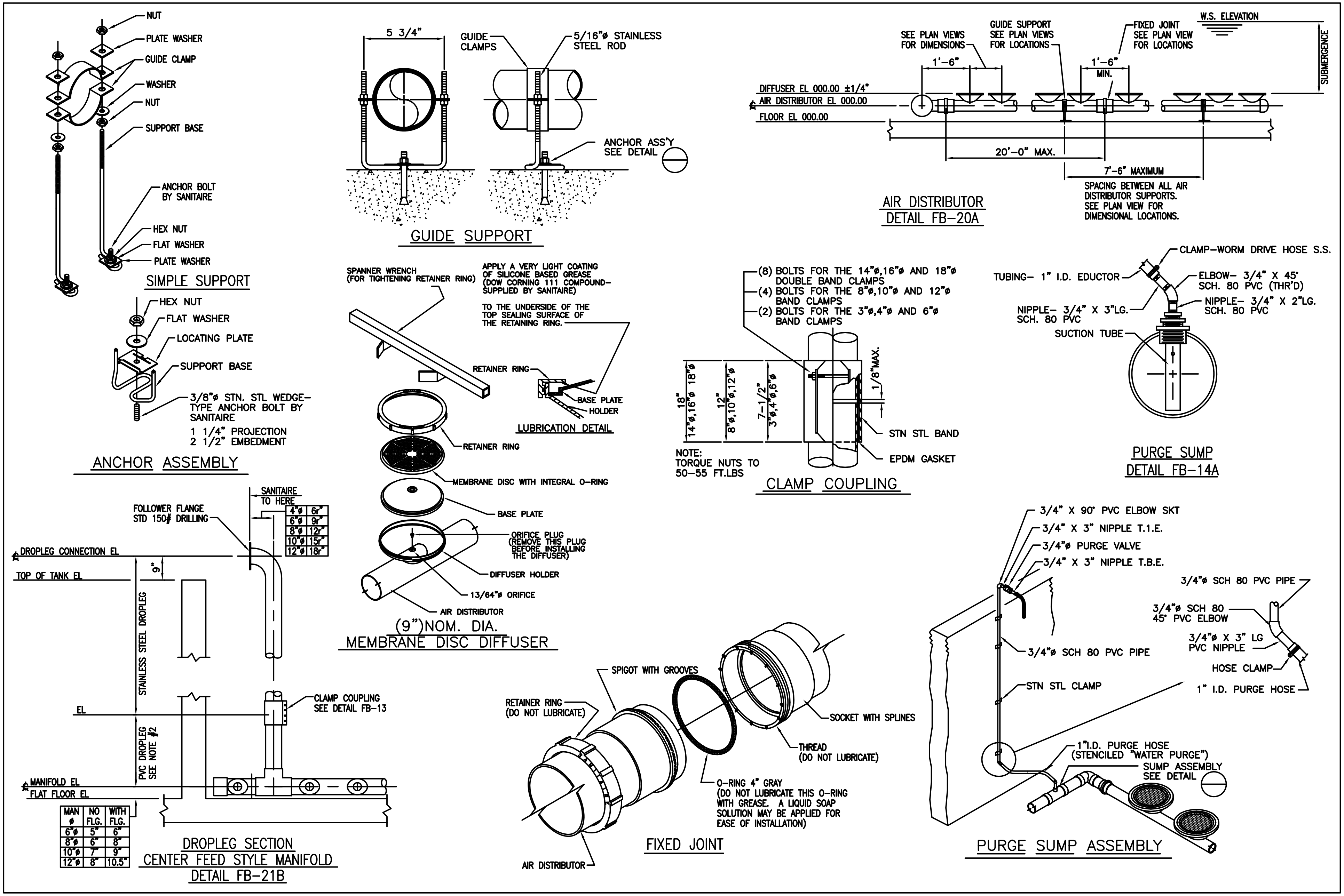
162 – 216/0	0	18	36	54	72	90	108	126 – 162
DECANT (54 min)	AIR OFF (18 min Mix)	AIR ON (0-18 min)	AIR ON (0-18 min)	AIR ON (0-18 min)	**AIR OFF (18 min Mix)	AIR ON (0-18 min)	AIR ON* (0-18 min)	SETTLE (36 min)





PRELIMINARY - THIS DRAWING IS NOT INTENDED FOR CONTRACT DOCUMENTS, SUBMITTALS, OR CONSTRUCTION

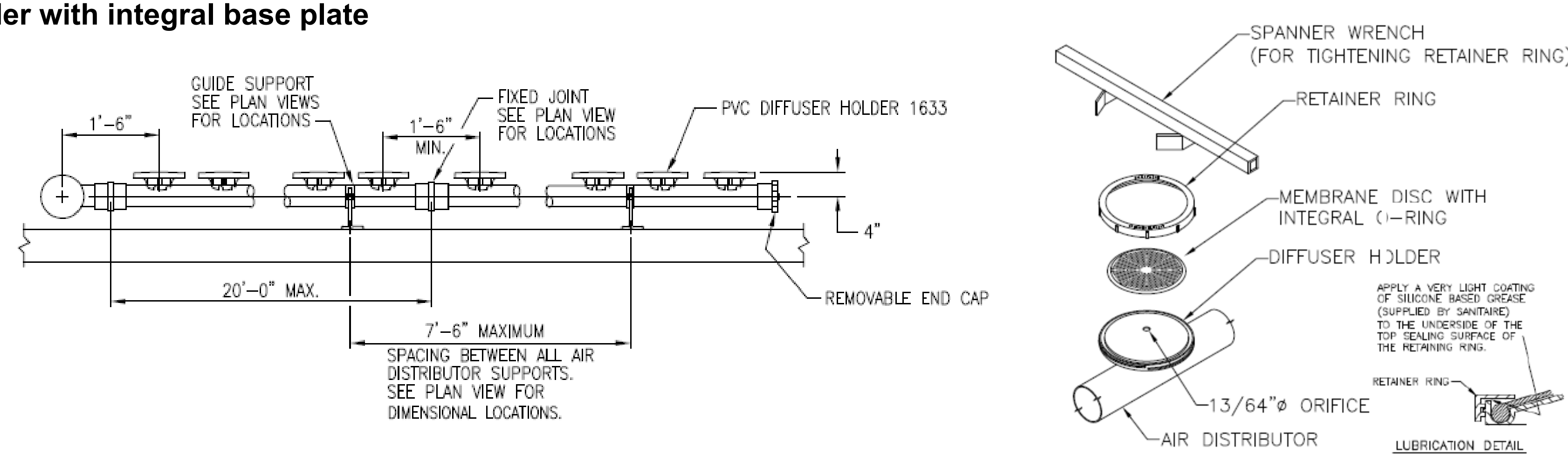
Sanitaire a xylem brand BROWN DEER, WISCONSIN 53223	CUST NO. / DWG NO.	THIS DRAWING IS THE PROPERTY OF XYLEM AND IS SUBMITTED IN CONFIDENCE. IT IS NOT TO BE DISCLOSED, USED OR DUPLICATED WITHOUT PERMISSION OF XYLEM.	Town of Lyons, CO PRELIMINARY LAYOUT ICEAS System	DRAWN BY DO / CHKD BY / APPVD BY	DATE 6/18/24 / DATE / DATE	JOB 32083-24a / SHEET



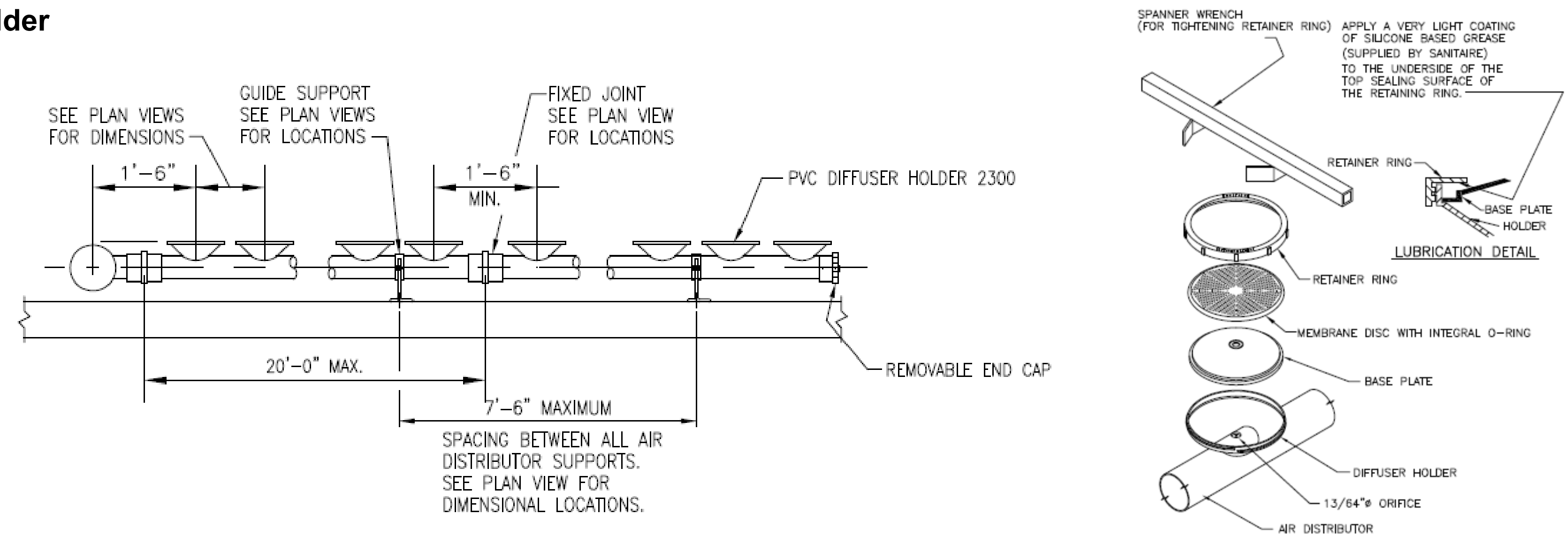
4"ø	6r"
6"ø	9r"
8"ø	12r"
10"ø	15r"
12"ø	18r"

MAN ø	NO FLG.	WITH FLG.
6"ø	5"	6"
8"ø	6"	8"
10"ø	7"	9"
12"ø	8"	10.5"

1633 Diffuser holder with integral base plate



2300 Diffuser holder



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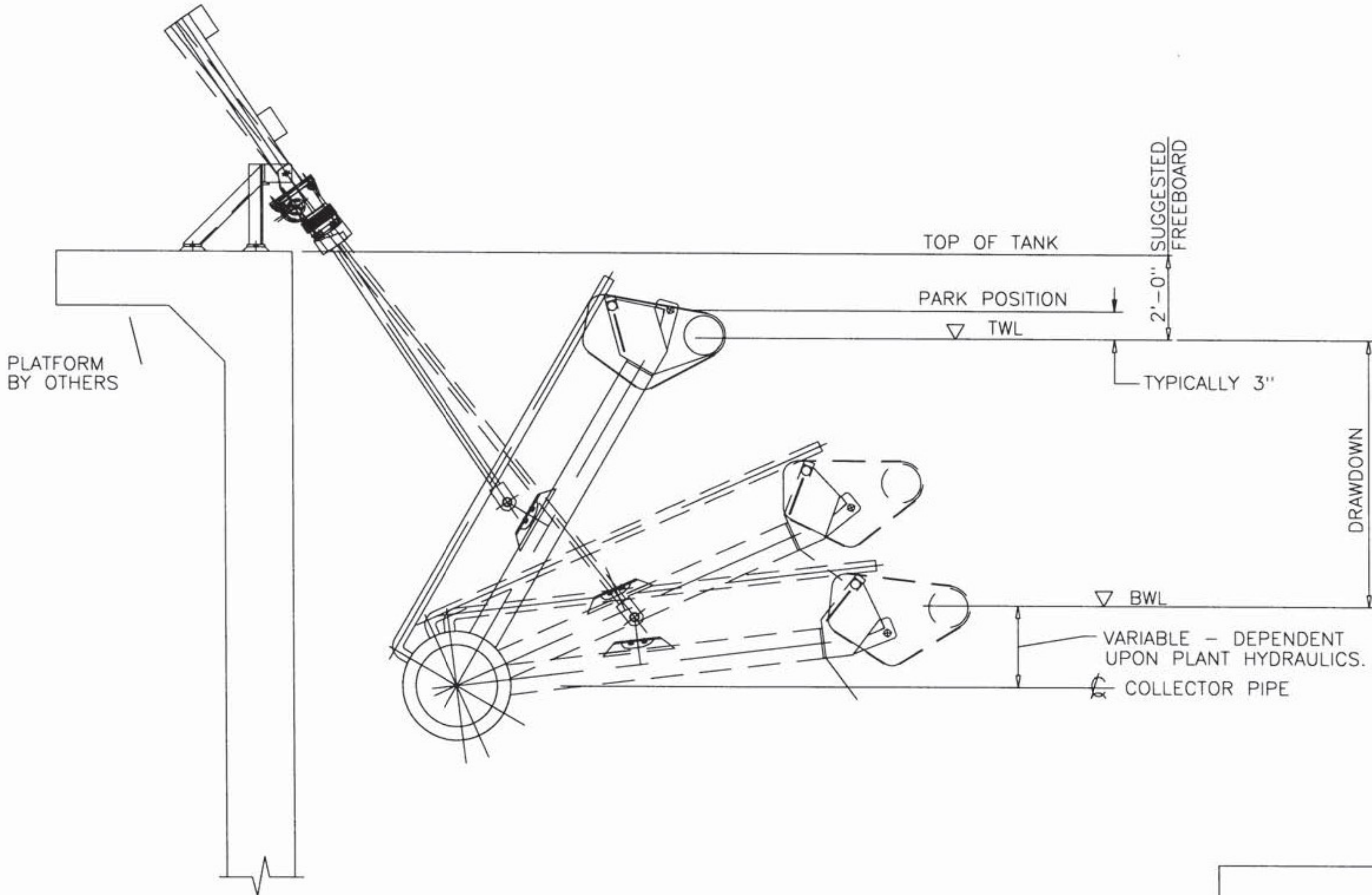


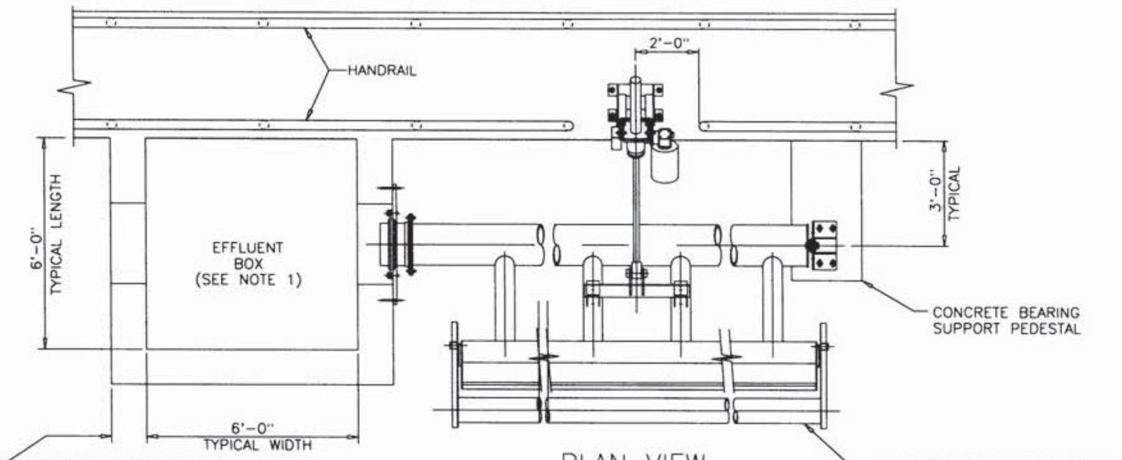
DECANTER OPERATING POSITIONS

ABJ® SANITAIRE
a xylem brand
BROWN DEER, WISCONSIN 53223

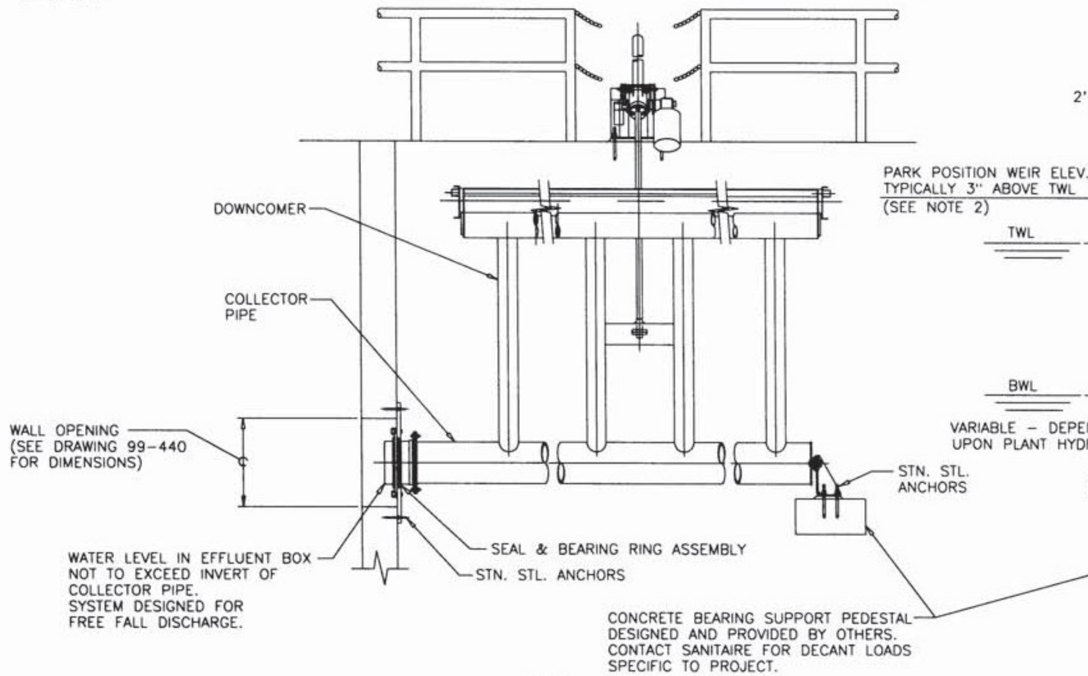
DWG. 99-400

NOTES:

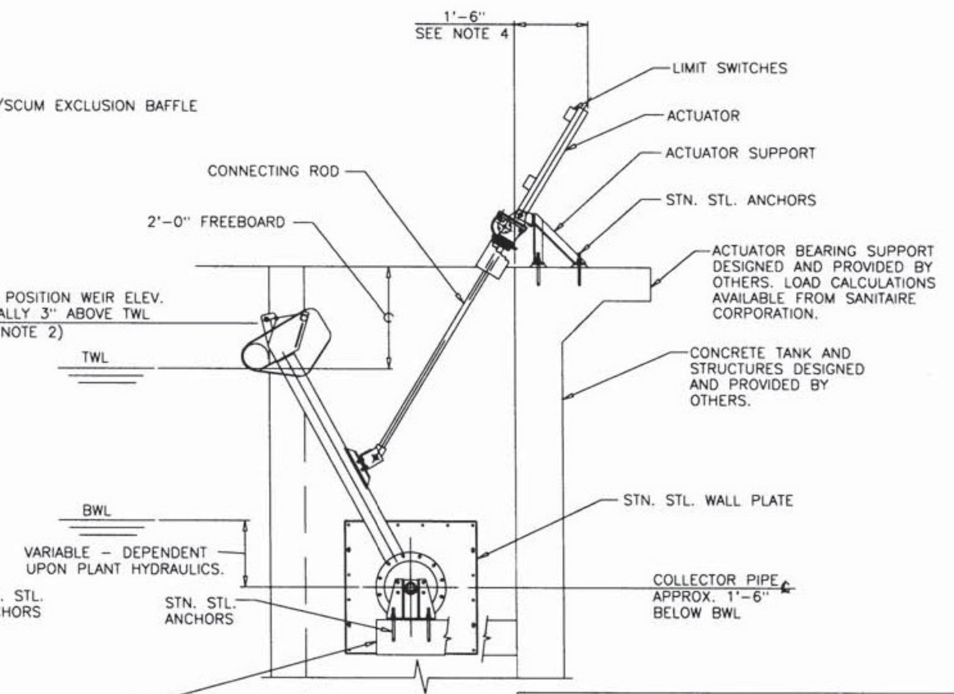
1. EFFLUENT BOX SHOULD BE DESIGNED WITH THE FOLLOWING CONSIDERATIONS:
   - LARGE ENOUGH PLAN AREA TO ACCOMMODATE INSTALLATION AND MAINTENANCE OF THE DECANTER WALL PLATE.
   - DEEP ENOUGH TO KEEP THE PEAK WATER LEVEL AT OR BELOW THE COLLECTOR PIPE INVERT AT ALL TIMES.
2. PARK POSITION ELEVATION TO BE SET TO KEEP THE DECANTER FLOAT ABOVE THE WATER LEVEL DURING AERATION.
3. ALL SUBMERGED METALLIC MATERIALS ARE STAINLESS STEEL.
4. ACTUATOR EQUIPMENT PLATFORM SHOULD BE LARGE ENOUGH TO ALLOW FOR INSPECTION AND SERVICE AND PROPERLY GUARDED FOR SAFETY AS NEEDED.



PLAN VIEW



ELEVATION



MULTIPLE DOWNCOMER
DECANTER/ACTUATOR
MAIN ASSEMBLY

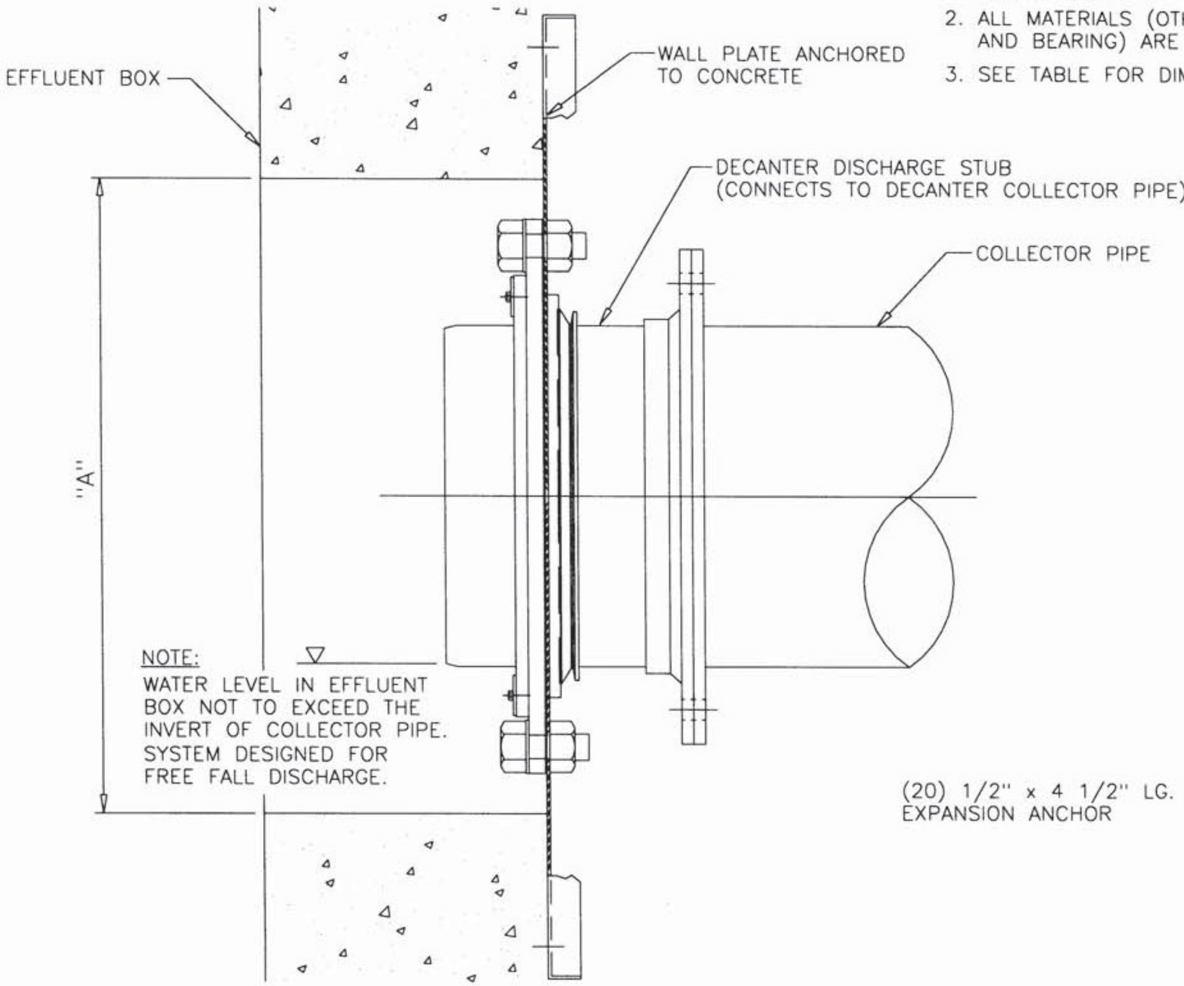
ABJ® SANITAIRE
a xylem brand
BROWN DEER, WISCONSIN 53223

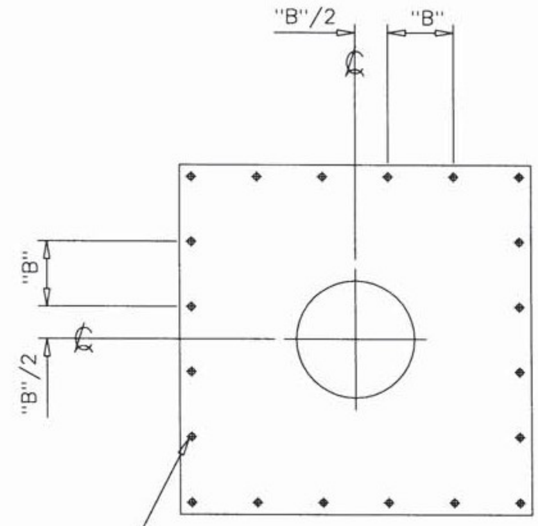
DWG. 99-420

NOTES:

1. THIS ASSEMBLY USES A DUAL SEAL SYSTEM.
2. ALL MATERIALS (OTHER THAN SEALS AND BEARING) ARE STAINLESS STEEL.
3. SEE TABLE FOR DIMENSIONS

COLLECTOR PIPE SIZE	"A"	"B"
14"	26"	7 1/4"
18"	30"	8 1/2"
24"	40"	10 3/8"



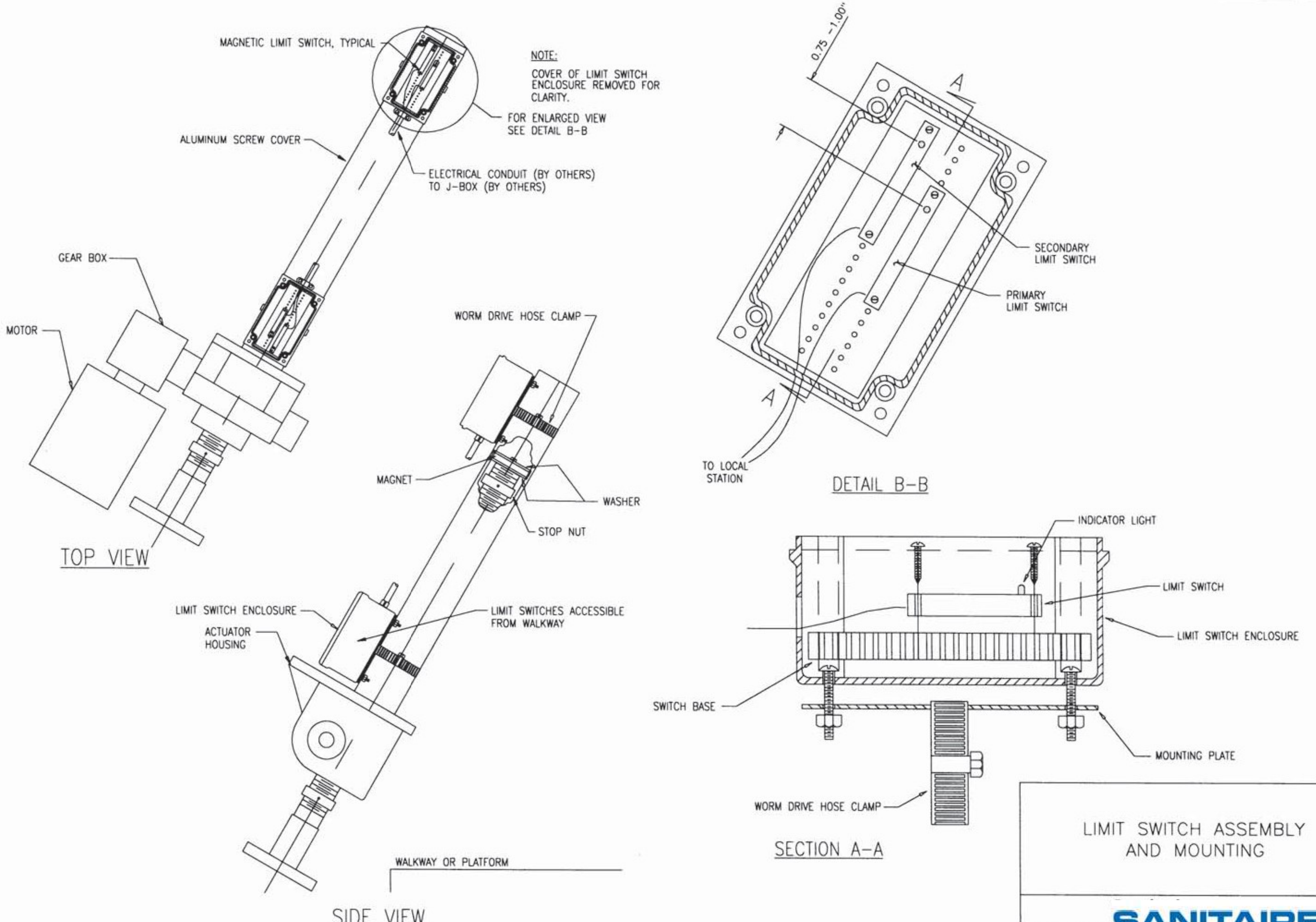


WALL PLATE DETAIL

DECANTER WALL PLATE, SEAL AND BEARING RING ASSEMBLY

ABJ® SANITAIRE a xylem brand
BROWN DEER, WISCONSIN 53223

DWG. 99-440



LIMIT SWITCH ASSEMBLY AND MOUNTING

ABJ® SANITAIRE a xylem brand

BROWN DEER, WISCONSIN 53223

DWG. 99-450

FW: Lyons Town of WWTP, CO 100005E / 69981 Preliminary AquaNereda Design

Josh Queen <jqueen@goblesampson.com>

Wed 6/12/2024 3:16 PM

To:Joe Z. Ning <jning@jvajva.com>
Cc:Andrew C. Sparn <asparn@jvajva.com>;John P. McGee <jmcgee@jvajva.com>;Michael A. LaDue <mladue@jvajva.com>;
Melissa Whitmore <mwhitmore@jvajva.com>

1 attachments (4 MB)

2024-06-11 Preliminary Nereda Design 175727.pdf;

All,
Please see attached from Aqua Aerobic along with the following notes:

Please see attached preliminary design report for the Lyons Town of WWTP, CO project.

Based on the request, we have completed the AquaNereda® design. This system consists of two (2) 52'x24'x19'TOW Nereda reactors, one (1) 58,200-gallon influent buffer and one (1) 48,300-gallon post-EQ. The dimension and hight of the Nereda basins were decided so these can fit into the existing basins. Please let us know if you have specific dimension and/or TOW that we should use.

Please note that the following:
- As requested, BOD5/TSS/TKN/TP = 900/400/70/20 were used for influent and BOD5/TSS/NH3/TIN/TP = 30/30/3/10/1 were used for effluent requirements.
- Fixed fine bubble diffusers will be used.
- Pumps for the influent buffer and post-EQ are not included in our scope.
- Screening (by others) is required ahead of the AquaNereda® system, with an opening of 6mm depending upon the characteristics of the screen. Punched hole or wire mesh up to 6 mm is preferred.
- We have assumed all VFDs (blowers, pumps, etc.) are provided by others in a separate motor control center (MCC).
- Basins are to be provided by others.
- Equipment selection is based on our standard materials of construction and assumes non-classified electrical equipment.

The preliminary price for equipment, which includes freight to the jobsite and our standard start-up supervision services, is $1,790,470.

Please let me know if you have any questions as you review.

Thanks!

Josh Queen

GOBLE SAMPSON

303.770.6418 (office) | 303.815.8257 (cell)
6355 Ward Rd., Suite 200 | Arvada, CO 80004
www.goblesampson.com

AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

Process Design Report

LYONS TOWN OF WWTP CO

Design# 175727

Option: Preliminary AquaNereda Design

AquaNereda®

Aerobic Granular Sludge Technology

June 11, 2024

Designed By: Takuya Sakomoto

6306 N. Alpine Rd Loves Park, IL 61111
(815) 654-2501 www.aqua-aerobic.com

Design Notes

Upstream Recommendations

- For primary influent designs, ¼ inch (6 mm) perforated plate-style screening and grit removal, consisting of 95% removal at 140 mesh, is required ahead of the AquaNereda system. For primary effluent designs, screening requirements may be relaxed at the discretion of Aqua-Aerobic Systems. If alternative screening and grit removal methods are planned ahead of the AquaNereda system, please discuss screening with Aqua-Aerobic Systems to understand the impacts of the approach.

- Neutralization is required ahead of the biological system if the pH is expected to fall outside of 6.5-8.5 for significant durations.

- Flow equalization is required ahead of the biological process.

- Elevated concentration of hydrogen sulfide can be detrimental to both civil and mechanical structures. If anaerobic conditions exist in the collection system, steps should be taken to eliminate hydrogen sulfide prior to the treatment system.

- Fats, oils, and grease (FOG) removal may be necessary (by others) if the wastewater contains significant amounts of FOG. Historical data suggests levels less than 60 mg/l on a daily average basis (based on a 24 hour composite sample), along with a maximum of 90 mg/l is appropriate for biological treatment. If FOG levels above this are anticipated, please discuss with Aqua-Aerobic Systems to understand the impacts of elevated FOG on the system performance.

Flow Considerations

- The maximum flow, as shown on the design, has been assumed as a hydraulic maximum and does not represent an additional organic load.

- When flows are in excess of the maximum daily flow of 0.5 MGD, the biological system has been designed to modify cycles in order to process a peak hydraulic flow of 0.76 MGD.

- Depending upon the magnitude and duration of the peak flow, effluent quality may be degraded.

- The estimated return flows shown in the design report are based on the summation of supernatant returns from the plant's dewatering system (assuming 20% dewatered sludge concentration and 95% solids capture efficiency), return flows for water level correction, supernatant return from the sludge buffer(s), and any backwash returns from tertiary filter(s) (if applicable).

- The system has been designed to account for diurnal variations throughout the day. Our working assumption (engineer to verify) is as follows: for systems with a flow rate below 10 MGD, a flow factor of 1.5 is applied.

Aeration

- The aeration system has been designed to provide 1.25 lbs. O2/lb. BOD5 applied and 4.6 lbs. O2/lb. TKN applied at the design average loading conditions, while maintaining a residual DO concentration of 2.0 mg/l.

- A common standby blower will be shared among the biological reactor.

- Depending on the actual yard piping from the blowers to the diffuser system and the heat losses associated with the yard piping, additional provisions for cooling of the air (i.e. incorporating heat exchangers) and/or modification of in-basin piping and/or diffuser sleeve material may be required. Aqua-Aerobic Systems, Inc. may need to modify the following equipment offering to ensure compatibility of all in-basin components with actual air temperatures.

Process/Site

- The following parameters have been assumed, as displayed on the design (engineer to verify): Elevation, in basin temperatures, ambient temperatures.

- The anticipated effluent nitrogen requirement is predicated upon an influent waste temperature of 8 °C or greater. While lower temperatures may be acceptable for a short-term duration, nitrification and (if required) denitrification below 10 °C can be unpredictable, requiring special operator attention.

- Sufficient alkalinity is required for nitrification, as approximately 7.1 mg alkalinity (as CaCO3) is required for every mg of NH3-N nitrified. If the raw water alkalinity cannot support this consumption, while maintaining a residual concentration of 50 mg/l, supplemental alkalinity shall be provided (by others).

- The average, maximum and peak design flow and loading conditions, shown within the report, are based on maximum month average, maximum day and peak hour conditions, respectively.

Post-Secondary Treatment

-The following processes follow the Biological process:
- Effluent flow equalization.

Equipment

- Changes in basin geometry may require alterations in the equipment recommendation.

- The basins are not included and shall be provided by others.

- The influent enters the basin near the reactor floor. Adequate hydraulic capacity shall be made in the headworks to prevent backflow from one reactor to the other during transition of influent.

- Based on the process requirements and selected equipment, the reactor wall height should be at least 19 ft.

- Scope of supply includes freight, installation supervision and start-up services.

- Equipment selection is based upon the use of Aqua-Aerobic Systems' standard materials of construction and electrical components, suitable for non-classified electrical environments.

- The Nereda system has been designed to fit within existing basin dimensions.

- The basin dimensions of influent buffer and post-EQ reported on the design have been assumed based upon the required volumes and assumed basin geometry. Actual basin geometry may be circular, square or rectangular with construction materials including concrete or steel.

- The control panel does not include motor starters or VFDs, which should be provided in a separate MCC (by others).

- Provisions should be made, by others, for overflows in each of the recommended basins.

- Aqua-Aerobic Systems, Inc. is familiar with various “Buy American” Acts (i.e. BABA, AIS, ARRA, Federal FAR 52.225, EXIM Bank, USAid, PA Steel Products Act, etc.). As the project develops Aqua-Aerobic Systems can work with you to ensure full compliance of our goods with various Buy American provisions if they are applicable/required for the project. When applicable, please provide us with the specifics of the project’s “Buy American” provisions.

Influent Buffer - Design Summary

INFLUENT BUFFER DESIGN PARAMETERS

Avg. Daily Flow:	= 0.25 MGD	= 958 m3/day
Max. Daily Flow:	= 0.50 MGD	= 1,893 m3/day
No. of AGS Reactors:		= 2

INFLUENT BUFFER VOLUME DETERMINATION

The volumes determined in this summary reflect the minimum volumes necessary to achieve the desired results based upon the input provided to Aqua. If other hydraulic conditions exist that are not mentioned in this design summary or associated design notes, additional volume may be warranted.

INFLUENT BUFFER BASIN DESIGN VALUES

No./Basin Geometry:	= 1 Rectangular Basin(s)				
Diameter of Basin:	= 29.0 ft	= (8.8 m)			
Width of Basin:	= 30.0 ft	= (9.1 m)			
Min. Water Depth:	= 0.0 ft	= (0.0 m)	**Min. Basin Vol. Basin:**	= 0 gallons	= (0.0 m³)
Max. Water Depth:	= 8.9 ft	= (2.7 m)	**Max. Basin Vol. Basin:**	= 58,118.0 gallons	= (220.0 m³)

INFLUENT BUFFER EQUIPMENT CRITERIA

Mixing Energy with Mixers:	= 10 HP/MG	= (2.0 W/m³)
Min. Basin HP Recommended	= 0	
Max. Flow Rate Required Basin:	= 1,609 GPM	= (365 m³/hr)
Avg. Power Required:	= 25 kWhr/day	

AquaNereda® - Aerobic Granular Sludge Reactor - Design Summary

DESIGN INFLUENT CONDITIONS

Avg. Design Flow	= 0.25 MGD	= 958 m3/day
Max Design Flow	= 0.50 MGD	= 1,893 m3/day
Peak Design Flow	= 0.76 MGD	= 2,877 m3/day

DESIGN PARAMETERS

	Influent	mg/l	Effluent Required	<= mg/l	Effluent Anticipated	<= mg/l
Bio/Chem Oxygen Demand:	BOD5	900	BOD5	30	BOD5	30
Total Suspended Solids:	TSS	400	TSS	30	TSS	30
Total Kjeldahl Nitrogen:	TKN	70	TKN	--	TKN	--
NH3-N	--	--	NH3-N	3.0	NH3-N	3.0
Total Inorganic Nitrogen:	--	--	TIN	10	TIN	10
Phosphorus:	Total P	20	Total P	1.0	Total P	1.0

SITE CONDITIONS

	Maximum		Minimum		Elevation (MSL)
Ambient Air Temperatures:	90 F	32.0 C	25 F	-4.0 C	5,300 ft
Influent Waste Temperatures:	68 F	20.0 C	46 F	8.0 C	1,615.0 m

AGS BASIN DESIGN VALUES

No./Basin Geometry:	2 Rectangular Basin(s)	
Freeboard (from PWL):	3.5 ft	(1.1 m)
Length of Basin:	24.0 ft	(7.3 m)
Width of Basin:	52.0 ft	(15.8 m)

	Water Depth		Basin Vol./Basin	
Process Level (PWL):	15.5 ft	(4.7 m)	0.14 MG	(548 m³)
Discharge Level (DWL):	17.1 ft	(5.2 m)		
Top of Wall (TOW):	19.0 ft	(5.8 m)		

PROCESS DETAILS

Cycle Duration:	= 7.0 Hours/Cycle	
Food/Mass (F/M) ratio:	= 0.098 lbs. BOD5/lb. MLSS-Day	
MLSS Concentration:	= 8000 mg/l	
Hydraulic Retention Time:	= 1.14 Days	
Solids Retention Time:	= 17.60 Days	
Est. Net Sludge Yield:	= 0.57 Lbs. WAS/lb. BOD5	
Est. Dry Solids Produced:	= 1078.0 lbs. WAS/Day	= (489.0 kg/Day)

AERATION DETAILS

Lbs. O2/lb. BOD5	= 1.25	
Lbs. O2/lb. TKN	= 4.60	
Peak O2 Factor:	= 1.00	
Actual Oxygen Required:	= 3053 lbs./Day	= (1384.8 kg/Day)
Max. Discharge Pressure:	= 8.28 PSIG	= (57 KPA)
Max. Air Flowrate/Basin:	= 773 SCFM	
Min. Air Flowrate/Basin:	= 193 SCFM	
Max. Simultaneous Air:	= 1,196 SCFM	
Min. Simultaneous Air:	= 431 SCFM	

RETURN FLOW ESTIMATES

Daily Estimated Return Flow:	= 0.08 MGD
Max. Instantaneous Return Flow:	= 189 GPM

POWER CONSUMPTION

Average Aeration Power Consumption: = 715 kWh/day (at 80% design load)

Sludge Buffer - Design Summary

SLUDGE BUFFER DESIGN VALUES

No./Basins Geometry:	= 1 Rectangular Basin(s)	
Minimum Level:	= 1.0 ft	= (0.3 m)
Max. Level:	= 13.5 ft	= (4.1 m)
Max. Basin Volume:	= 18,860 gallons	= (71.0 m^3)
Length of Basin:	= 14.5 ft	= (4.4 m)
Width of Basin:	= 13.0 ft	= (3.9 m)

SLUDGE BUFFER VOLUME DETERMINATION

The sludge buffer volume has been determined based on the sludge production and the concentration of sludge from the AquaNereda reactors. The Sludge from this basin will be pumped to the sludge handling system, and the supernatant back to the head of the plant.

SLUDGE BUFFER EQUIPMENT CRITERIA

Max. Sludge Flow Rate Required:	= 44 gpm	= (10 m^3/hr)
Max. Supernatant Flow Rate Required:	= 176 gpm	= (40 m^3/hr)
Average Power Consumption:	= 8 kWh/day (at 80% design load)	

POST-EQUALIZATION DESIGN PARAMETERS

Avg. Daily Flow (ADF):	= 0.25 MGD	= (958 m^3/day)
Max. Daily Flow (MDF):	= 0.50 MGD	= (1,893 m^3/day)
Decant Flow Rate from (Qd):	= 1,609 gpm	= (365 m^3/hr)
Decant Duration (Td):	= 45 min	

POST-EQUALIZATION VOLUME DETERMINATION

The volumes determined in this summary reflect the minimum volumes necessary to achieve the desired results based upon the input provided to Aqua-Aerobic. If other hydraulic conditions exist that are not mentioned in this design summary or associated design notes, additional volume may be warranted.

POST- EQUALIZATION BASIN DESIGN VALUES

No./Basin Geometry:	= 1 Rectangular Basin(s)				
Length of Basin:	= 15.3 ft	= (4.7 m)			
Width of Basin:	= 30.0 ft	= (9.1 m)			
Min. Water Depth:	= 0.0 ft	= (0.0 m)	**Min. Basin Vol. Basin:**	= 0 gal	= (0 m^3)
Max. Water Depth:	= 14.1 ft	= (4.3 m)	**Max. Basin Vol. Basin:**	= 48,260 gal	= (183 m^3)

POST- EQUALIZATION EQUIPMENT CRITERIA

Max. Flow Rate Required Basin:	= 402.3 gpm	= (91.4 m^3/hr)
Avg. Power Required:	= 25.5 kW-hr/day	

AquaNereda: Influent Buffer

Level Sensor Assemblies

1 Sensor installation(s) consisting of:

- Pressure transducer(s).
- Stainless steel sensor guide rail weldment(s).
- PVC sensor mounting pipe(s).
- Top support(s).

1 Level Sensor Assembly(ies) will be provided as follows:

- Float switch(es).
- Float switch mounting bracket(s).
- Stainless steel anchors.

AquaNereda

Influent Valves

2 Influent Valve(s) will be provided as follows:

- 12 inch diameter Milliken 601 electrically operated eccentric plug valve(s) with 125# flanged end connection, ASTM A-126 Class B cast iron body with welded in nickel seat, EPDM coated ductile iron plug, assembled and tested with an Auma, 115 VAC, 60 hertz, single phase open/close service electric actuator. Valve actuator includes compartment heater.

Influent Distribution System

2 Influent Distribution Assembly(ies) consisting of:

- Influent distribution system consisting of HDPE and PVC pipe with supports.

Effluent Weir Assembly

2 Effluent Weir Assembly(ies) consisting of:

- Concrete main effluent channel(s) provided by others.
- Stainless steel weir assembliy(ies) with supports.

Sludge Removal System

2 Solids Waste System(s) consisting of:

- HDPE solids waste system(s).
- Pressure transmitter(s).

2 Sludge Decant/WLC Valve Set(s) consisting of:

- Each reactor includes two (2) of the following automatic control valves and two (2) of the following manual throttling valves:
- 12 inch electrically operated butterfly valve(s) with actuator.
- Manual plug valve(s).

2 Air Valve Set(s) consisting of:

- Each reactor includes two (2) of the following automatic valves and one (1) of the following manual valves:
- 4 inch manually operated butterfly valve(s) with lever handle.
- 4 inch electrically operated butterfly valve(s) with actuator.

Fixed Fine Bubble Diffusers

2 Fixed Fine Bubble Diffuser Assembly(ies) consisting of:

- 304 SS, 12 Ga. drop pipe(s).
- PVC, Sch 40 Manifold(s) with connection to drop pipe.
- PVC, Air distributor(s) with connection to the manifold and required PVC pipe joint connections.
- 304 Stainless steel piping supports with vertical supports, clamps, adjusting mechanism and anchor bolts.
- Fine bubble diffuser assemblies.
- Air muffler(s).

Positive Displacement Blowers

3 Positive displacement Blower Package(s), with each package consisting of:

- Aerzen 50HP Rotary Positive Displacement Blower(s).
- 6 inch manually operated butterfly valve(s) with lever handle.

Air Valves

2 Air Control Valve(s) will be provided as follows:

- 6 inch electrically operated butterfly valve(s) with actuator.
- Auma actuator will be upgraded from open/close service to modulating service.
- Air flow meter(s).
- Flow conditioner(s).
- 6 inch manually operated butterfly valve(s) with lever handle.

Level Sensor Assemblies

2 Pressure Transducer Assembly(ies) each consisting of:

- Pressure transducer(s).
- Mounting bracket weldment(s).
- Transducer mounting pipe weldment(s).

2 Level Sensor Assembly(ies) will be provided as follows:

- Float switch(es).
- Float switch mounting bracket(s).
- Stainless steel anchors.

Instrumentation

1 Server Based Control and Monitoring System will be provided as follows:

- Process Controller Server.
- Small server monitor.

2 Dissolved Oxygen Assembly(ies) consisting of:

- DO probe(s).

2 TSS Sensor(s) will be provided as follows:

- TSS probe(s).

2 ORP Sensor installation(s) consisting of:

- ORP sensor(s).
- Stainless steel sensor guide rail weldment(s).
- PVC sensor mounting pipe(s).
- Top support(s).

2 pH Sensor(s) will be provided as follows:

- pH probe(s).

1 Phosphorus Analyzer(s) will be provided as follows:

- Phosphate analyzer(s).

1 Filtrax Sampling System(s) will be provided as follows:

- Sampling system.

1 Process Controller(s) consisting of:

- Controller and display module(s).

2 Process Controller(s) consisting of:

- Controller(s).

1 Process Control System will be provided as follows:

- Hach SC1000 display module.
- FRP enclosure(s) for SC1000 Display.

2 Ammonium Probe(s) will be provided as follows:

- Ammonium probe(s).
- Controller(s).

AquaNereda: Post-Equalization

Level Sensor Assemblies

1 Sensor installation(s) consisting of:

- Pressure transducer(s).
- Stainless steel sensor guide rail weldment(s).
- PVC sensor mounting pipe(s).
- Top support(s).

1 Level Sensor Assembly(ies) will be provided as follows:

- Float switch(es).
- Float switch mounting bracket(s).
- Stainless steel anchors.

AquaNereda: Sludge Buffer

Transfer Pumps/Valves

1 External pump assembly(ies) consisting of the following items:

- 5HP Pump assembly(ies).
- 2 inch manual plug valve(s).

1 Sludge Valve(s) consisting of the following items:

- 3 inch electrically operated plug valve(s).

1 Supernatant Valve(s) consisting of the following items:

- 4 inch electrically operated plug valve(s).

Sludge Removal System

1 Solids Removal Assembly(ies) consisting of:

- Solids removal assembly(ies) consisting of PVC and/or HDPE pipe with supports.

Level Sensor Assemblies

1 Sensor installation(s) consisting of:

- Pressure transducer(s).
- Stainless steel sensor guide rail weldment(s).
- PVC sensor mounting pipe(s).
- Top support(s).

1 Level Sensor Assembly(ies) will be provided as follows:

- Float switch(es).
- Float switch mounting bracket(s).
- Stainless steel anchors.

Sludge Buffer Instrumentation

1 Hach TSS WAS Sensor(s) will be provided as follows:

- Hach Solitax Inline sc stainless steel pipe isertion probe with stainless steel wiper and 33 ft electric cable. One (1) probe per basin.

1 Process Controller(s) consisting of:

- Controller and display module(s).

AquaNereda: PLC Controls

Controls wo/Starters

1 Controls Package(s) will be provided as follows:

- NEMA 12 panel enclosure suitable for indoor installation and constructed of painted steel.
- Fuse(s) and fuse block(s).
- Compactlogix Processor.
- Operator interface(s).
- Remote access Ethernet modem(s).

MEMPULSE® MEMBRANE BIOREACTOR SYSTEM

Town of Lyons WWTP

Colorado

Budgetary Proposal No. A-188872
June 7th, 2024

FilmTec™ Corporation
455 Forest Street, Marlborough, MA 01752
https://www.dupont.com/water

EXECUTIVE SUMMARY

Thank you for your interest in MEMCOR's MemPulse Membrane Bioreactor (MBR) System. MemPulse MBR technology uses the latest advances in filtration specifically designed to create highly efficient membrane aeration in conjunction with the assurances of an absolute barrier provided by membrane filtration. MemPulse MBR offers several key advantages over both conventional treatment processes and competitive MBR membrane systems.

Low Energy Air Scour System

MemPulse MBR was the first low-energy, high-efficiency aeration system to be introduced to the marketplace. MemPulse uses a simple device with no moving parts to intermittently release pulses of air to effectively scour the membranes and keep them free form solids accumulation.

MemPulse provides the most efficient scouring technology on the market, at the lowest operating cost – providing long-term, stable operation at low airflow rates.

Minimizing Maintenance Requirements

Reinforced MBR fibers require regular maintenance for slack adjustment or manual solids removal. MEMCOR's advanced fibers and aeration system require no regular in-tank maintenance or removal of the modules.

Additionally, MemPulse provides uniform distribution of mixed liquor and scour air across the entire membrane rack ensuring a homogeneous environment for each sub-module and preventing preferential fouling of membranes.

Small Process Footprint

MEMCOR's monolithic PVDF fibers provide a high membrane area per unit of tank footprint– up to 25% smaller than other competitive hollow fiber systems. This means substantial savings in system footprint and concrete construction costs.

Furthermore, the MemPulse process allows for elevated mixed liquor suspended solids up to 14,500 mg/L in the membrane tank, allowing the biological tank volume to be reduced compared to competitive systems.

We would like to thank you again for your interest in MEMCOR Products. We believe that every MEMCOR product comes with more than just equipment – it includes the expansive knowledge of MEMCOR's dedicated team of membrane scientists, engineers, and technicians who stand behind every installation. We are eager to share this expertise with those responsible for providing the world with clean, consistent, and high-quality water. Should you have any questions regarding this quotation or would like to request any additional information please contact us the Technical Sales Manager listed below.

DuPont Sales Manager:

William Wittich

Will Wittich
Technical Sales Manager, MEMCOR
Telephone: 719-330-5578
william.wittich@dupont.com

Project Overview

The following table summarizes the contents of this quotation:

MEMCOR SYSTEM - SUMMARY OF SCOPE:	2 x 50B50N
Biological System: Mixers, Diffusers, & Biological Blowers	
Membrane System: 2 x 50 B50N Modules, Racks, Headers, & Rack Supports	
Filtration Pump System	
Return Activated Sludge Pump System	
Membrane Blower System	
Compressed Air System	
Chemical Transfer System	
Custom Tools Package	
Controls System	
Manufacturing Services (Commissioning & Training)	
Budgetary Price:	**USD $1,395,000**

Please note that the pricing above does not include insurance, bonds, or any applicable taxes. The scope of supply and pricing are based on DuPont's standard equipment selection, standard terms of sale and warranty terms described herein. Any variations from these standards may affect this budgetary quotation.

Neither this document nor any part thereof shall be regarded or construed as a formal binding legal offer for the provision of goods and/or services. Any figures reflected herein are merely suggestive of the potential cost of the works described and are therefore only to be regarded approximate, indicative and/or speculative. No liability shall arise in relation to the reliance upon or use of the information herein contained. Additionally, please note that this budgetary quotation is for review and informational purposes only and does not constitute an offer for acceptance.

Manuals: *One (1) electronic operation and maintenance manual is included.*

Delivery: *Estimated 16 - 18 weeks after acceptance of an order and submittals are approved (if required). Delivery schedule to be coordinated with the purchaser and will be confirmed at the time of order.*

Freight: *Free on Board (FOB) shipping point, with freight prepaid to the jobsite.*

Terms: *DuPont Standard Terms & Conditions.*

Payment Terms:
10% on Order, net 30
15% on Submittals, staged submittals allowed, net 30
25% on Order of major rotating equipment, net 30
45% on Delivery, partial deliveries accepted, net 30
5% on Start-up, net 30
Full payment not to exceed 120 days after shipment

Company Profile

Company: DuPont (FilmTec Corporation)

DuPont (NYSE: DD) is a global innovation leader with technology-based materials, ingredients and solutions that help transform industries and everyday life. Our employees apply diverse science and expertise to help customers advance their best ideas and deliver essential innovations in key markets including electronics, transportation, construction, water, health and wellness, food and worker safety.

For over 200 years, DuPont has been synonymous with life-changing discoveries and scientific know-how, reinventing ourselves along the way.

The history of DuPont is a history of scientific and technology breakthroughs. But more than that, it's a story of transformation. From the beginning, our company has changed and evolved, so that we can keep finding essential innovations to solve the most challenging problems and help people live safer, healthier lives.

DuPont is a leader in water purification and separation technology including ultrafiltration, reverse osmosis and ion exchange resins. The FilmTec™ brand is recognized globally and known for consistent and reliable performance. Each of the recent acquisitions, including Desalitech, and MEMCOR supports our strategy to drive growth and innovation through access to new manufacturing capabilities, geographies and technologies.

MEMCOR®
a DuPont™ brand

Product Line: MEMCOR®

The first MEMCOR installation in the USA was at the Keystone Ski Resort in the late 1980's. MEMCOR pioneered the first dead end back-washable low-pressure membrane filtration process which is widely utilized today for drinking water, wastewater reuse, desalination pretreatment and MBR applications.

MEMCOR placed its first drinking-water system into operation in 1987, its first wastewater reuse system in 1990, and the first MBR system was installed in 1999. In 1997, MEMCOR supplied the world's first-drinking water system to be installed in a cold-weather climate at the Marquette, Michigan Water Treatment Plant; and our first cold-weather MBR was installed at the Grayeagle Casino in Alberta in 2007.

MEMCOR continues to manufacture its own membrane modules, providing a high level of quality control and accountability to their customers. This allows MEMCOR continually invest in R&D and innovate with holistic improvements in membrane technology and system design to provide the best solutions for its customers.

Over its history, MEMCOR has brought several new products and technology improvements to the market. The benefits of the R&D developments and innovations are passed on to new customers as well as to existing ones. By partnering directly with a membrane manufacturer, customers are assured of a comprehensive warranty and access to new and improved solutions.

MEMCOR now has 350,000+ N membrane modules installed at some 2,000 sites worldwide. The history of supporting these installations is one of first-class service and excellent product knowledge. This knowledge base, strong commitment to product development and history of supporting customers for almost 30 years in the water filtration market makes MEMCOR the most reliable choice for any membrane facility.

Technology Profile

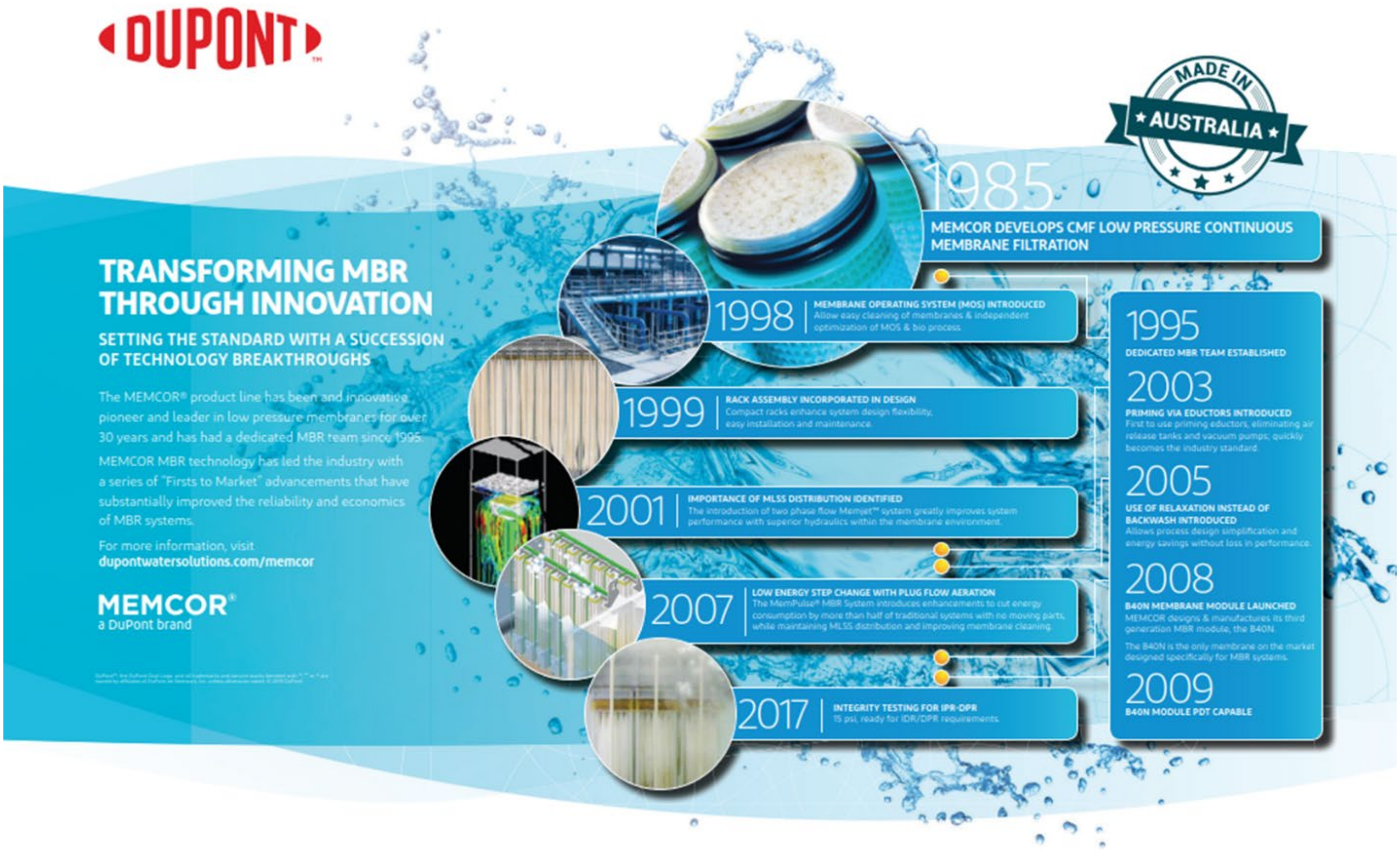
Technology: MemPulse Membrane Bioreactor System (MBR)

Proven to deliver greater effluent and productivity, while reducing the lifecycle cost, MemPulse MBR technology is the preferred in the industry by those who value a low total cost of ownership. MemPulse uses a fully automated process that provides liquid/solid separation by combining biological oxidation and membrane separation. MEMCOR pioneered many key innovations in the evolution of the MBR industry, such as pulsed aeration, efficient foulant removal and integrity testing for MBR. MEMCOR's membrane filtration process expertise, product development and manufacturing capabilities has propelled MEMCOR into the MBR arena as an innovator, continuously improving on past successes. Today, MemPulse MBR technology operates in hundreds of municipal and industrial plants across the globe.

Key Advantages

- ✓ Saves Footprint on Sites with Limited Space
- ✓ No Need to Use Clarifier or Sand
- ✓ Improves Effluent Quality, Allowing Water to Be Re-Used
- ✓ Allows for Plant Expansions in The Same Footprint
- ✓ Uses A Smaller Biological Process
- ✓ Fully Automated

The figure below presents a summary of the long history of MBR process innovations led by the MEMCOR team, many of which are industry standards today.



1 Design Information

1.1 Influent Flows

HYDRAULIC CONDITIONS	VALUE	UNITS
Average Daily Flow (ADF)	0.253	Millions of gallons per day (MGD)
Maximum Month Flow (MMF)	0.253	MGD
Peak Hourly Flow (PHF)	0.759	MGD

1.2 Influent Water Quality

INFLUENT WATER QUALITY	VALUE	UNITS
Chemical Oxygen Demand (COD)	*	milligrams/liter (mg/L)
Biochemical Oxygen Demand (BOD_5)	900	mg/L
Total Suspended Solids (TSS)	400	mg/L
Total Kjeldahl Nitrogen (TKN)	70	mg/L
Total Phosphorus	20	mg/L
Alkalinity	175	mg/L as $CaCO_3$
Fats, Oils & Grease (FOG), Freon extractable	< 50*	mg/L
Minimum Influent Temperature	10*	degrees Celsius (°C)
Maximum Influent Temperature	20	degrees Celsius (°C)

Notes:

*1 * Denotes a value that was not specified in the request. All values must be confirmed for any associated process guarantee and membrane warranty.*

1.3 Effluent Water Quality

The following effluent criteria are based on correspondence related to the opportunity.

EFFLUENT WATER QUALITY	VALUE	UNITS
BOD_5	<30	mg/L
Total Suspended Solids	<30	mg/L
Total Inorganic Nitrogen	<15	mg/L
Ammonia-N	<3	mg/L
Total Phosphorus (1)	<1	mg/L
Turbidity	<0.5	NTU
Fecal Coliforms / E. coli (2)	<200	Geometric mean per 100 mL

Notes:

1 Chemical addition of metal salts (i.e. alum) may be required to meet effluent total phosphorous requirement.

2 DuPont can guarantee Fecal Coliforms & E. Coli effluent of 25 cfu/100 mL monthly geometric mean and <200 maximum for the membrane system.

2 Design Basis

2.1 System Design Parameters

The Membrane Bioreactor System (MBR) has been designed assuming the following pretreatment parameters. If other design assumptions should be considered, please advise and we can discuss how the design of the membrane operating system can be modified to achieve optimal performance.

DESIGN PARAMETER	VALUE
Membrane Pre-Screening	< 2.0 mm perforated (1.0 mm preferred) System designed to prevent screen bypass under all conditions
Grit Removal	> 95 % of particles > 50 mesh in size > 85 % of particles > 70 mesh but < 50 mesh in size > 70 % of particles > 100 mesh but < 70 mesh in size Removal efficiency shall meet or exceed these values across a flow range of 25 - 100 % of PHF. System designed to prevent Grit removal bypass under all conditions.
Raw Sewage	>90% Municipal
ML Capillary Suction Time (CST)	< 100 seconds
Sludge Retention Time (SRT) - Aerobic	13.5 days
Raw Sewage: Fats, Oils and Greases (FOG)	< 80 mg/L
Raw Sewage: Hydrocarbons	< 5 mg/L
MLSS Temperature Range	10 – 20° C
Site Elevation	0ft above MSL
Effluent Soluble BOD_5	< 5 mg/L
Effluent Ammonia	< 3 mg/L
Coagulant Addition	Aluminum Sulfate ≤ 50 mg/L
Biological Mixed Liquor Suspended Solids (MLSS)	8000 mg/L
Filtrate Pump and Pipework Design	> 9.5 PSI TMP
Bioreactor Foam / Scum Removal	Required: Foam / scum removal to be carried out to control coverage to < 30 % of surface area

Notes:

1 Any additional requirement for neutralization to be decided during detailed design.

2 If the wastewater alkalinity is less than the table value, supplemental alkalinity may be required to ensure the pH does not inhibit bacterium growth.

3 Inhibitory Matter and Heavy Metals must be less than the threshold limits (or within any ranges specified), as defined on page 227 of WPCF Manual of Practice No. 8, 1977 Edition (See Appendix II) The wastewater shall also be free of any substance toxic or inhibitory to the biological treatment process as determined by treatability tests using Method 302B; OECD Guideline for Testing of Chemicals, Adopted 17 July 1992 or International Organization of Standardization, Evaluation of the Ultimate Aerobic Biodegradability of Organic Compounds, ISO/DIS 7827, IOS, Washington, D.C, 1983.

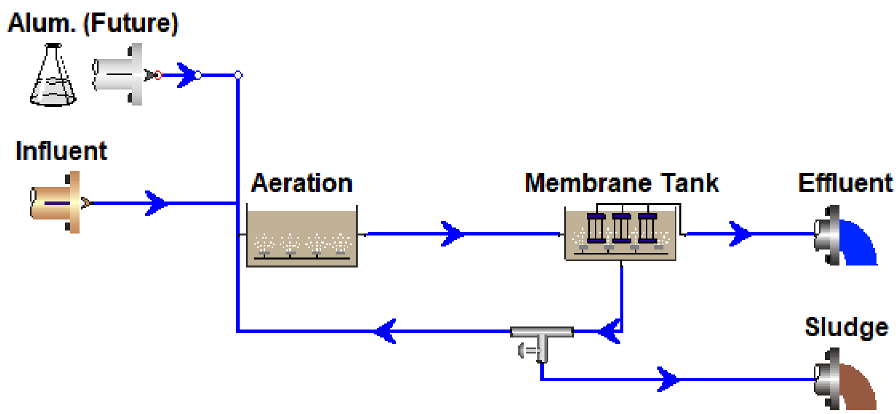
2.2 Biological Design Information

The following sections outline the design basis for the biological system. The parameters detailed below are based on max month flow conditions and the average wastewater concentrations outlined above in this proposal.

Configuration Information

The proposed biological system is designed with an aeration zone followed by the membrane operating system. DuPont has extensive experience with this arrangement, which we feel provides superior performance and flexibility when coupled with DuPont's biological treatment expertise and controls architecture.

SYSTEM CONFIGURATION	TRAINS
Number of Parallel Biological Trains	2



The adjacent tanks use common intermediate walls with the following tank configuration. The proposed configuration of each train is:

PROCESS TANK	QTY / TRAIN	LENGTH (FT)	WIDTH (FT)	SWD (FT)	VOLUME EA (GAL)	VOLUME TOTAL (GAL)
Aeration (Fine Bubble)	2	52	23	14	127,500	255,000
Membrane Operating System	2	9.34	7.87	9.65	5,304	10,608
Total						265,608

Biological Design Parameters

The following design parameters were used as the basis of design for sizing the proposed biological system.

DESIGN PARAMETERS	VALUE	UNITS
Hydraulic Retention Time (HRT)	24.2	Hours
Mixed Liquor Suspended Solids (MLSS)	8500	mg/L
Solids Retention Time (SRT) - Aerobic	13.5	d
Return Sludge Pumping Rate	400	% of ADF
Biosolids Produced	1,330	lb/d
Oxygen Requirement	94.52	Lb/hr
Aeration Blower Design Flow	965 @ 9.8 psi (18 ft SWD Max)	Scfm @ psi

2.3 Membrane Operating System Design

Membrane Operating System Design

DESIGN CRITERIA	VALUE	UNITS
Module Type	B50N + MEMPULSE	
Membrane Area Per Module	538.2	ft^2
Modules per Rack	10	
Total Number of Membrane Tanks	2	
Number of Racks per Tank (installed)	5	
Spare Racks Slots per Tank	1	
No. of Modules Installed per Tank	50	
Membrane Area per Tank	26,910	ft^2

Membrane Tank Dimensions

DESCRIPTION	VALUE	UNITS
Tank Length	9.34	ft
Tank Width	7.87	ft
Tank Depth (top of concrete)	11.7	ft
Tank Liquid Level	9.6	ft

Membrane System Operation

DESIGN FLUXES	ADF	MMF	PHF	Units
Flow Condition	0.253	0.253	0.759	MGD
No. of Membrane Tanks in Operation	1	1	2	—
No. of membrane Tanks in Standby	1	1	0	—
Net Flux	9.4	9.4	14.1	gfd
Net Flux (temperature-corrected)	12.3	12.3	18.4	gfd
Instantaneous Flux	10.3	10.3	15.5	gfd
Instantaneous Flux (temperature-corrected)	13.5	13.5	20.2	gfd

Membrane System Mixed Liquor Feed Requirements

The following table summarizes the mixed liquor feed flow / return activated sludge flow during average and peak flow events, based on an average mixed liquor concentration in the bioreactor of 8000 mg/L. The feed flow requirements are based on maintaining a MLSS concentration below the maximum allowable concentration in the membrane tank.

PARAMETER	ADF	MMF	PHF	UNITS
Operating MLSS in Membrane Tank	10,500	11,000	12,500	mg/L
Total Mixed Liquor Feed Flow Required	922	773	1,647	gpm
Total Return Activated Sludge Flow Required	747	597	1,120	gpm

Note: Maximum allowable mixed liquor concentration in the membrane tank is 14,500 mg/L.

Membrane System Air Scour Requirements

The following table summarizes the air scour requirements during average and peak flow events.

PARAMETER	AVERAGE	PEAK	UNITS
Flux Rate	≤ 14.7	> 14.7	gfd
Air Flow per Tank: Installed Modules	134	150	SCFM (68°F)
Air Flow per Tank: Max Modules	161	185	SCFM (68°F)
Discharge pressure	4.6	4.7	psi

Notes:

1 The actual air usage will be dependent upon the frequency and duration of any peak flow events. This is because the aeration flow per module is flux dependent.

2 Units in short term storage (< 1 day and remaining in Mixed Liquor) must be aerated for 10 minutes every hour.

3 Upon the provision of expected annual & daily flow pattern an annual air usage value can be calculated.

Maintaining Membrane Performance

The following table summarizes the maintenance procedures to ensure optimal performance of the MemPulse membrane system average daily flow (ADF).

PARAMETER	RELAXATION	MAINTENANCE CLEAN	SODIUM HYPOCHLORITE CIP	CITRIC ACID CIP
Interval Between Cycle	12 min	7 days	90 days	180 days
Cleaning Cycle Duration	60 sec	50 min	260 min	260 min

The expected chemical usage for Average Daily Flows (ADF), including design margin is:

PURPOSE	CHEMICAL	BULK CHEMICAL CONC.	CLEANING SOLUTION CONC.	CHEMICAL PER CIP[1] (GAL)	USE@ ADF (GAL/YR[1,2])
Chlorine Maintenance Clean	Sodium Hypochlorite	12.5% w/v Liquid	200 ppm	3	153
Chlorine Clean-In-Place	Sodium Hypochlorite	12.5% w/v Liquid	600 ppm	23	94
Citric Acid Clean-In-Place	Citric Acid	50.0% w/w Liquid	0.5% w/w Liquid	39	79

Notes:

1 Bulk chemical excludes chemicals for neutralization (if required).

2 Based on continuous operation at ADF, excluding any standby tanks.

Hydraulic Design Basis

The hydraulic design capacities for the designs presented in this proposal are listed below:

DESIGN CONDITIONS	FLOW	UNITS	CONTINUOUS DURATION	MAXIMUM DURATION
Average Daily Flow (ADF)	0.253	MGD	365 consecutive days	N/A
Peak Hour Flow (PHF)	0.759	MGD	2 hours	

Notes:

1 Average Day Flow (ADF): this is the average flow for the plant measured on monthly basis. If flow is greater Diurnal Peak Flow for > 3 hrs per day a chlorine MW is required.

2 After all Peak Flow events; Peak Week, Peak Day, Peak Hour the filtrate flow will be returned to Average Day Flow for an equivalent period to that of the peak flow period before entering another peak flow operation.

3 After any Peak Day Flow and Peak Hour Flow Events, a chlorine Maintenance Clean is required.

3 Scope of Supply

The following equipment is included with the proposed scope of supply.

3.1 Equipment Scope of Supply

Biological System Equipment

QTY	DESCRIPTION
1 Lot	Fine bubble diffusers designed to meet biological aeration requirements.
1 Lot	Instrumentation integral to monitor and control the biological system including ORP probe, DO probe, controllers, pressure gauges, blower discharge pressure transmitters.
1 Lot	Manual valves required for isolation and operation of rotating equipment.
2	Positive displacement membrane air scour blower designed to meet average and peak air flow requirements. Designed with 1 duty and 1 standby blower.

Membrane Operating System Equipment

QTY	DESCRIPTION
100	B50N membrane submodules fabricated of oxidant-resistant polyvinylidene fluoride (PVDF) membrane material including MEMPULSE devices.
10	Membrane rack assembly (10 module capacity) consisting of header assemblies, guide racks, mixing skirt, and air dropper tube.
1 Lot	Membrane supports for mounting membrane racks constructed of stainless steel.
1 Lot	Filtrate and air headers for each membrane tank constructed of stainless steel.
1 Lot	Piping and hoses to connect the membrane racks to the filtrate and air headers.
1 Lot	Filtrate air release system to prime filtrate pumps includes eductors and solenoid valves.
1 lot	Instrumentation integral to monitor and control the membrane operating system including level transmitters, level switches, pressure transmitters, and pressure gauges.

Filtration Pump System Equipment

QTY	DESCRIPTION
2	Rotary lobe filtrate suction pump constructed of cast iron, controlled by VFD (by others). Designed with 1 duty pumps and 1 standby during ADF/MMF - 2 duty for peak flow.
2	Turbidimeter to measure the turbidity of the filtrate from each membrane tank.
1 lot	Instrumentation integral to monitor and control the filtrate system including flow meters, pressure gauges, pressure switches, and temperature transmitter.
1 lot	Valves required for equipment isolation and control of the filtrate system including manual valves, automated valves with pneumatic actuators, automatic diaphragm valves, chemical injection quills, check valves, and solenoid valves.

Return Activated Sludge (RAS) Pump System Equipment

QTY	DESCRIPTION
2	Centrifugal mixed liquor return activated sludge pump constructed of cast iron to return the mixed liquor from the membrane tanks, controlled by VFD (by others). Designed with 1 duty pump and 1 stand-by pump.
1 lot	Instrumentation integral to monitor and control the return activated sludge system including flow meters, pressure gauges, and pressure switches.
1 lot	Valves required for equipment isolation and control of the return activated sludge system including manual valves and check valves.

Membrane Blower System Equipment

QTY	DESCRIPTION
2	Positive displacement membrane air scour blower designed to meet average and peak air flow requirements. Designed with 1 duty and 1 standby blower.
1 lot	Valves & instrumentation integral to monitor and control the membrane blowers.

Compressed Air System Equipment

QTY	DESCRIPTION
2	Rotary screw compressors designed to operate the supplied pneumatic valves, eductor system, and leak testing. Designed for one (1) duty and one (1) stand-by.
1	Compressed air receiver designed to meet compressed air requirements.
1 lot	Instrumentation integral to monitor the compressed air system including pressure switches, pressure regulators, and pressure gauges.
1 lot	Valves required for equipment isolation and control of the compressed air system including manual isolation valves, pressure relief valves, solenoid valves, and drain valve.

Chemical Transfer System Equipment

QTY	DESCRIPTION
1	Sodium hypochlorite dosing system skid. Includes two (2) air operated diaphragm dosing pumps, valves and instruments necessary for proper operation and calibration.
1	Citric acid dosing system skid. Includes one (1) air operated diaphragm dosing pump, valves and instruments necessary for proper operation and calibration.

Custom Tools Equipment

QTY	DESCRIPTION
1	Maintenance Stand for membrane rack assembly and maintenance.
1	Spreader bar for installation and removal of membrane racks.
1	Rack locking tool, air dropper assembly tool, and nylon pins.
1 Lot	Membrane rack spares kit including O-rings, air droppers, clips, and typical rack spares.

Control System Equipment

QTY	DESCRIPTION
1	Process Control Panel, to coordinate operation of all MEMCOR supplied equipment including, an Allen Bradley PLC, Allen Bradley touch screen Human Machine Interface (HMI), and Digital and Analog I/O (Input/Output) modules.
2	Remote I/O panel per membrane tank, used to relay information to/from Process Control Panel to the membrane systems via an Ethernet/IP communications link.

3.2 Manufacturer's Services

The entire execution process from design to start-up will be supported by DuPont's experienced engineering team and a Project Management Professional® (PMP) certified project manager. The following table details the personal support your MEMPULSE MBR project will receive:

QTY	DESCRIPTION

One (1) Electronic PDF	MEMCOR MBR system submittal including:
	- Process Overview
	- Valve, Equipment and Instrumentation List
	- Manufacturer's Cut Sheets
	- Mechanical Drawings
	    o Membrane System P&ID (showing DuPont supplied equipment)
	    o MBR Unit P&ID
	    o General Arrangements for Memcor supplied equipment
	- I/O List
	- Electrical Bill of Materials
	- Electrical Drawings
	    o Process Control Panel diagrams
	    o Control Single Line
	    o Field Interface Connections
	    o Three Phase Power Single Line

One (1) Electronic PDF	Operation and maintenance manuals are included. Manuals will conform to DuPont's commercial standards. This shall include detailed, project-specific manufacturer drawings and cut sheets for major equipment, valves, and instruments. No drawings, except those used internally by consultant/customer, are to be reproduced without the expressed, written permission of DuPont.
1 Lot Service Days	Eight-hour service-days for manufacturer's services at regular intervals during the project to ensure proper installation and assembly procedures are followed as well as commissioning and training of the MEMCOR MBR system. Additional services may be retained at MEMCOR scheduled rates of US$1650 per day, per person plus travel expenses at cost plus 5% mark up. The services included are: - On-site supervision that includes MEMCOR installation support and plant pre-commissioning, - On-site services for plant commissioning which includes startup, and completion of functional test, - Training of operators and technical staff in conjunction of startup. Training will include; equipment description, field instrumentation, control panels, detailed component description, preventive maintenance and troubleshooting.

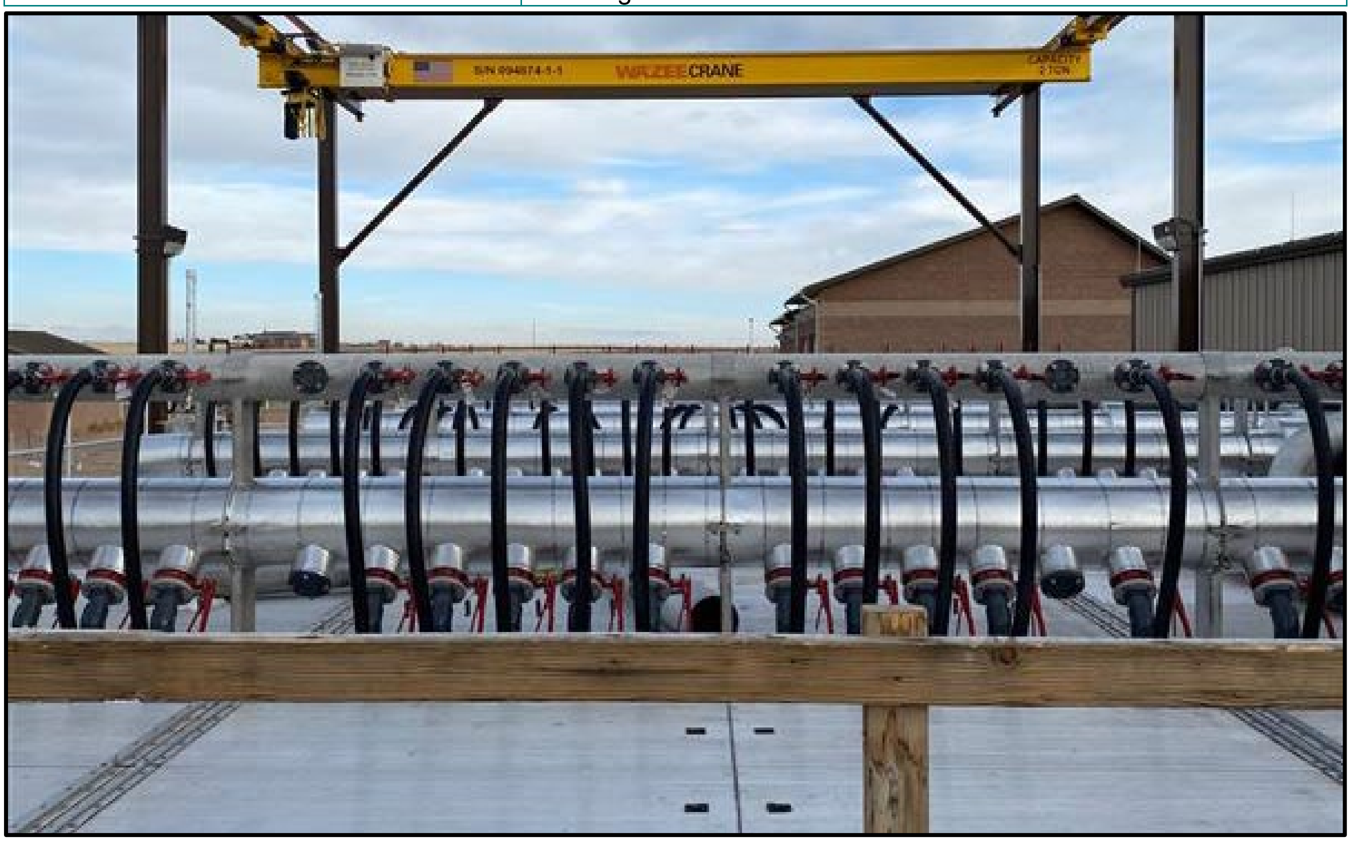
3.3 Equipment and Services Provided by Others

All other works and equipment necessary to complete the project and not shown as being supplied by DuPont shall be supplied by others, including but not limited to:

- Civil works and any and all building modifications or construction to house the MEMCOR membrane filtration system equipment including all concrete work related with construction, grouting of equipment and else as applicable.
- Unloading, unpacking, storage (according to DuPont's recommendation), installation, assembly and field erection of the MEMCOR system.
- Interconnecting pipework between the MEMCOR membrane operating system and the ancillary systems (including air scour, compressed air, and chemical cleaning systems), between the MEMCOR supplied equipment and between equipment supplied by others.
- Pipe support including pipe hangers for all piping supplied outside the membrane operating system.
- Pneumatic lines supplying air to the pneumatic actuators.
- Headworks equipment (grit removal and fine screen).
- Mixed liquor re-screening.
- Effluent disinfection.
- Disposal of clean in place waste including neutralization system (if required).
- Waste activated sludge (WAS) equipment or solids handling system.
- Chemical transfer systems for services other than related to the chemical cleaning of the membrane modules, specifically coagulant transfer systems.
- Supply and storage of all chemicals required for MEMCOR membrane filtration system cleaning, maintenance, and/or operation.
- Supply and programing of supervisory control and data acquisition (SCADA) system.
- Supply and installation of all VFDs, motor control centers, and disconnects, unless otherwise specified.
- Supply and installation of all control wiring, power cabling including cabling tray, conduits, fittings and supports as necessary. Including building power, lighting, main disconnect, power distribution.
- Installation of all MEMCOR supplied control panels and turbidimeter panels.
- Pump alignment, vibration analysis, and lubricants.
- Additional engineering services including structural, foundation design, or anchor bolt calculations.
- Any equipment, valves, instrumentation or spare parts not specifically listed in the MEMCOR scope herein.
- Upgrades to support ICEAS™ most current process control system / OIT

4 Reference Plants

CHEROKEE WATER RECLAMATION FACILITY, COLORADO	
Plant Location	Colorado Springs, CO
Owner Contact	Joshua Watkins +1 (719) 322 5511 jwatkins@cherokeemetro.org
Engineer of Record	Karla Kinser, Burns and McDonnell, 9785 Maroon Circle, Suite 400, Centennial, CO 80112
Brief description	Four (4) tanks, each with 304 N Series modules. Site footprint is small. MEMCOR was selected because of our industry-leading form factor and our commitment to site support.
Module Type	MEMCOR N Series with MemPulse
Type of System (municipal/Industrial)	Municipal
Application	Surface Discharge
Startup Year	January 2023
Design hydraulic capacity	4.0 MGD ADF, 4.8 MGD MMF 9.4 MGD PHF
Flux	ADF: 7.7gfd, MMF: 9.2 gfd, PDF: 12.2 gfd, PDF N+1: 16.3 gfd
Temperature (°C)	8
Effluent Goals/Limits	Turbidity < 1 NTU; SDI < 3.5; BOD < 30 mg/L; TSS < 30 mg/L ; TIN < 10 mg/L



STAR CITY WASTEWATER TREATMENT PLANT	
Facility Name	Star City Wastewater Treatment Plant
Facility Location	Frontier St., Morgantown, WV 26505
Facility Contact	Greg Shellito, Manager of Treatment and Production Tel.: 304.599.2111
Plant Narrative	Five (5) tanks, each with 568 N Series modules. MEMCOR was selected due to the limited footprint available when expanding the existing treatment facility. MBR effluent quality resulted in approval to bypass the downstream UV system enabling energy savings.
Application	Municipal Wastewater
Equipment / Number of Units Installed	5 x 568 MEMCOR N Series with MemPulse™
Average Design Flow (ADF)	9.0 MGD
Peak Hydraulic Rated Capacity	12.8 MGD
Years of Installation	June 2020
Design and operating net flux rate	9.1 gfd ADF / 13.0 PDF 13.89 gfd average / 15.51 gfd maximum
Temperature	6°C
Effluent Goals/Limits	BOD < 5, TSS < 5, Ammonia < 3; Turbidity <1.0
Video Link:	Maximizing Efficiency with Minimum Footprint Memcor MemPulse® MBR systems

PENNSYLVANIA STATE UNIVERSITY PARK WWTP	
Project Name	Pennsylvania State University Park WWTP University Park WRF Upgrade Project
Country	USA
City	State College
State	PA
Application	Surface Discharge
Influent	Residential
Design ADF (gpd)	3,000,000
Design Capacity (gpd)	6,000,000
System Type	MOS
Number of Membrane Tanks	4
Module Type	B40N + MemPulse
Installed per Tank	224
Maximum per Tank	336
Net Flux	ADF: 10.4 PHF: 20.7
Temperature (°C)	10
Effluent Goals/Limits	Turbidity < 0.2 NTU 95% of time, TSS < 2 mg/L
Biological System	Conventional - Fine Bubble
Start Up Date	August 2022
Plant Status	Operational
Owner Contact	E: dms328@psu.edu T:(814) 867-6123
Engineer of Record	Hazen and Sawyer 4011 Westchase Boulevard, Suite 500 Raleigh, North Carolina 27607 Anthony D. Greiner, PE, CCM, Assoc. DBIA 704 357-3150 (main) | 704 940-8904 (direct) tgreiner@hazenandsawyer.com

MODESTO JENNINGS ROAD WASTEWATER TREATMENT PLANT	
Owner's name, address, telephone number	Ben Kohler, Operations Supervisor 7007 Jennings ROctober 2015oad, Modesto, CA 95358 Tel.: 209.814.5834
Commissioning & start-up completion	October 2015
Identify system by model or type	MEMCOR B40N with MemPulse™
Plant performance in terms of meeting design objectives	Since plant startup, it has consistently met all effluent requirements including capacity. The City has applied for the highest classification of recycled wastewater and consistently delivered 12.6 MGD to its irrigation consumers.
Location of project.	Modesto, CA, United States
Configuration	6 x 448B40N
Max. # of Modules per Tank	544
Module Type	B40N
Membrane Area per Cell (ft^2)	181,440
Design Temperature (deg C)	15
Design Flow, ADF (MGD)	12.6 (14.7 MGD and Operating 12.6MGD)
Design Net Flux, ADF (gfd)	11.6 (Temperature-corrected: 13.1 GFD N-1: 13.9 GFD; N-1 Temperature- corrected: 15.7 GFD)
Maintenance Clean Interval/Concentration	7 days/300 ppm of NaOCl
Hypo CIP Interval/Concentration	90 days/1,500 ppm NaOCl
Acid CIP Interval/Concentration	180 days/0.5 wt% Citric Acid + 0.05 wt% Sulfuric Acid (for pH adjustment)
Startup	2015
Type of System (Municipal/Industrial)	Municipal
Application	Irrigation
Effluent Goals/Limits	TN < 10; Ammonia < 1

CASE STUDY
MEMCOR® MBR, Jennings Secondary/Tertiary Treatment Facility Modesto, California USA

The six MOS cells at the Modesto plant each have provision for 34 x 16B40N MemRACK Assemblies with 28 racks fitted.

THE BACKGROUND

The City of Modesto has partnered with the Del Puerto Water District to reclaim the future of thriving California farming communities

Memcor MemPulse® membrane technology is helping San Joaquin Valley farming communities tap a sustainable source of irrigation water to ensure their future viability.

The Del Puerto Water District located in Stanislaus County, California, has been hit hard by numerous years of drought and a decrease in the reliability of water supply available under the terms of its federal water service contract, in some years by as much as 70 %. The community of approximately 500,000 residents, includes about 4200 farms, with 45,000 acres under irrigation, generating more than four billion dollars in annual revenue for the Californian economy. Ensuring the viability of this farming community came down to two issues:– First, the Del Puerto Water District needed to identify a sustainable source of irrigation water and secondly, the City of Modesto Utility Department had to plan for imminent and more stringent wastewater discharge requirements for the San Joaquin River.

Jennings STTF
Membrane Operating System Details

Location	Modesto, California, USA
Technology	MEMCOR® B40N MBR PVDF Ultrafiltration Modules with MemPulse®
Feed Source	Primary Treated Municipal wastewater
Application	Surface Discharge and Irrigation
Plant	Six (6) MOS cells/tanks each with thirty-four 16 x B40N MemRACK® Assembly locations. (28 Racks filled Total 2688 Modules)
MBR Plant Capacity	12.6 MGD (47.7 ML/d) ADF 15.1 MGD (57.2 ML/d) Design
Future Expansion	Each tank can fit another 96 x B40N Modules, Total 576 Modules, for available capacity increase of ~20 %
Startup	In stages 2015 to 2016

THE STAKEHOLDERS

In May of 2010, a collaborative called North Valley Regional Recycled Water Program (NVRRWP) was formed. It included Del Puerto Water District, Stanislaus County and the cities of Modesto, Turlock and Ceres. The charter of the partnership was to provide a more reliable source of irrigation water to the farming community and to comply with more stringent National Pollutant Discharge Elimination System (NPDES) regulations by recycling water. A plan was developed for the three cities to build tertiary reuse facilities that would meet both quality and quantity needs for the Del Puerto Water District.

The Jennings STTF treats primary treated effluent for reuse using Biological Nutrient Removal (BNR) and MemPulse® Membrane Bioreactor (MBR) technology, followed by UV disinfection.

The MBR aeration blower building (ABB) includes acoustic panelling for blower noise abatement, making hearing protection unnecessary in the area.

THE PLANT

The City of Modesto spent a decade and over $130 million to design and construct the state-of-the-art Jennings Secondary/Tertiary Wastewater Treatment Plant utilising Tertiary Biological Nutrient Removal (BNR) and Memcor MemPulse® Membrane Bioreactor (MBR) technology.

Effluent from the Sutter Primary Treatment Facility, which handles an average of 20 MGD of raw wastewater, is pumped six miles to the Jennings plant for further treatment. The Jennings plant, designed by Carollo Engineers Inc., of Walnut Creek CA, includes anoxic and aerobic secondary treatment followed by membrane filtration then ultraviolet (UV) disinfection. The treated water meets the requirements of Title 22 of California's Code of Regulations for unrestricted non-potable reuse making it suitable for irrigation in local farming communities.

FEATURES & BENEFITS OF MEMPULSE® MBR

- Reduction in air scour energy by 30 to 60 % compared to previous generation MBR Systems.
- Reduction of operation and maintenance costs with no moving parts in the MemPulse® aeration process.
- Efficient pulsed, plug flow aeration maximises shear and prevents channelling and solids build-up.
- Modular rack design that provides the flexibility to fit most tank arrangements.

THE RESULT

A sustainable and cost-effective alternative water supply prepares local farming communities for the future.

The superior performance and cost advantages of MemPulse® MBR technology have been key to enabling The City of Modesto to address impending regulatory requirements and cost effectively produce a reliable source of irrigation water for the Del Puerto Water District and the San Joaquin Valley.

Modesto's Utilities Department is now able to meet the new state discharge standards that took effect in 2018, and has a new revenue source by providing the Del Puerto Water District with an alternative, cost-effective water supply.

MEMBRANE SOLUTIONS

MEMCOR® membranes from DuPont Water Solutions have helped municipalities and industrial customers around the world to protect and improve the world's most fundamental natural resource – water.

CITY OF MODESTO
CALIFORNIA

Utilities Department
P.O. Box 642
Modesto, California 95354
209.577.5200
Modestogov.com

November 5, 2019

RE: MEMCOR MBR

To Whom It May Concern:

In the Fall of 2015 the City of Modesto began startup of the Phase 2 Membrane Bioreactor for the Jennings Road Wastewater Treatment Plant, a 12.6 MGD recycled water plant. The membrane bioreactor technology selected for this plant was a MEMCOR MemPulse MBR.

The MEMCOR Service Team worked tirelessly and collaboratively with our Operations and Maintenance Staff for the duration of the facility start-up. They provided fine tuning adjustments, field expertise and invaluable, induvial and group training to our staff. MEMCOR's attention to detail and willingness to provide adjustments to the system programming demonstrated commitment to their customer and belief in their product. This has far exceeded our expectation in what has become a flag ship design and process for The City of Modesto and MEMCOR.

After the start-up was complete, the MBR system suffered severe coating failures. This required one cell to be emptied and membranes removed for repairs that took approximately four weeks to complete, per cell. The MEMCOR Service Team assisted the City of Modesto by writing a custom program that allowed the facility to remain in production with one full cell out of service for roughly six months. Even though MEMCOR held no responsibility for the coating failures, they were an integral part of the solution.

Since that time, I have worked closely with the MEMCOR Service Team, and have found them to be among the best in the business when it comes to service and support. This is true for both regular service visits, and emergency situations.

If you have any questions about our experience with the MEMCOR MBR system, feel free to reach out and give me a call at (209) 577-6200.

Best Regards,

Ben Koehler
Acting Plant Manager- Wastewater
City of Modesto, CA

CRITERIA	DESCRIPTION
Facility Name	Healdsburg WWTP
Facility Location	Healdsburg, California, USA
Facility Contact	Mr. Rob Scates Email: rscates@ci.healdsburg.ca.us Phone: 707-236-0970
Plant Narrative	DuPont scope included bioreactor, dual 2mm perforated plate drum screens, membrane system, instrumentation, controls, and startup. The membrane operating system contains five membrane cells, each with 128 N Series modules and MemPulse aeration devices, expandable to 160 N Series modules. The Healdsburg plant has consistently met effluent limits since startup. In 2018 the plant celebrated 10 years of continuous operation with the same N Series membranes while producing 3-day peak flows at 95% of design flows. The modules at Healdsburg have never been removed for maintenance of any kind, including manual cleaning.
Application	Municipal Wastewater
Equipment / Number of Units Installed	5 x 128 MEMCOR N Series with MemPulse™
Average Design Flow (ADF)	1.6 MGD
Peak Hydraulic Rated Capacity	4.0 MGD
Years of Installation.	April 2008
Design and operating net flux rate	ADF: 11.8 GFD @ 20°C PHF: 21.1 GFD @ 20°C
Temperature	15°C
Effluent Goals/Limits	TSS < 5; Turbidity <0.2
Video Link	Achieving Long Term Success with MBR Technology

MEMCOR® MemPulse® Membrane Bioreactor – Benefitting Healdsburg for the Long Haul

The challenge

The City of Healdsburg, California is nestled amongst the vineyards of Sonoma County where Chardonnay, Cabernet Sauvignon, and Pinot Noir varietals are grown for world famous Sonoma wines. In 2004, the US EPA required strict effluent limits that made their lagoon treatment system obsolete. A desire to procure a system that is both reliable and produces a high-quality effluent suitable for irrigation at local wineries led to a technology selection process and competitive procurement bid for a membrane bioreactor (MBR) system.

The solution

In a competitive bid process, DuPont was selected as the supplier for the membrane process. The City decided to participate in beta testing for the new MemPulse® MBR process and the first tank was started up in 2008. By 2009, all five tanks were operating at the plant with MemPulse®.

The benefits

The Healdsburg Wastewater Treatment Plant has produced effluent that consistently meets Title 22 standards for non-potable reuse for over 12 years. Even during the bi-annual "crush" season where organic waste spikes up to 2,000 ppm of COD, the plant produces high-quality effluent.

Since the upgrade to MemPulse®, the membrane system has not required any in-tank maintenance, compared to competitive systems that require annual or semi-annual removal for slack adjustment and cleaning. The MemPulse® system, along with our monolithic PVDF hollow fiber membrane, provides consistent solids removal and eliminates the need for operator interventions.

Along with these benefits, the membranes have lasted over 10 years in operation with some membrane tanks currently at 12 years of membrane life.

Fast Facts

Country: United States

Technology: Membrane Bioreactor

Product: MEMCOR® MemPulse®

End-user: City of Healdsburg, CA

Application: Wastewater

Total # of Modules: 640

Plant capacity: 15.1 MLD and 4 MGD

Commissioning: 2008

Feed water type: municipal wastewater with light industrial

Product water quality: <0.2 NTU turbidity (CA Title 22 standard)

Temperature range: 14-24 °C

Pretreatment: coarse/fine screening; conventional MLE with fine-bubble aeration

10+ years Operating membranes without replacement, demonstrating consistent performance and durability.

DUPONT

Water Solutions
Have a question? Contact us at:
dupont.com/water/contact-us

Form No. 45-D03740-en CDP, Rev. 1
August 2022

CITY OF HEALDSBURG
Municipal Utilities Department

401 Grove Street
Healdsburg, CA 95448-4723

Phone (707) 431-3346
Fax: (707) 431-3140

Visit us at ***www.ci.healdsburg.ca.us***

February, 26, 2018

To Whom It May Concern:

Our Evoqua membrane bioreactor (MBR) plant was started up in April 2008 and has run without significant maintenance issues since that time.

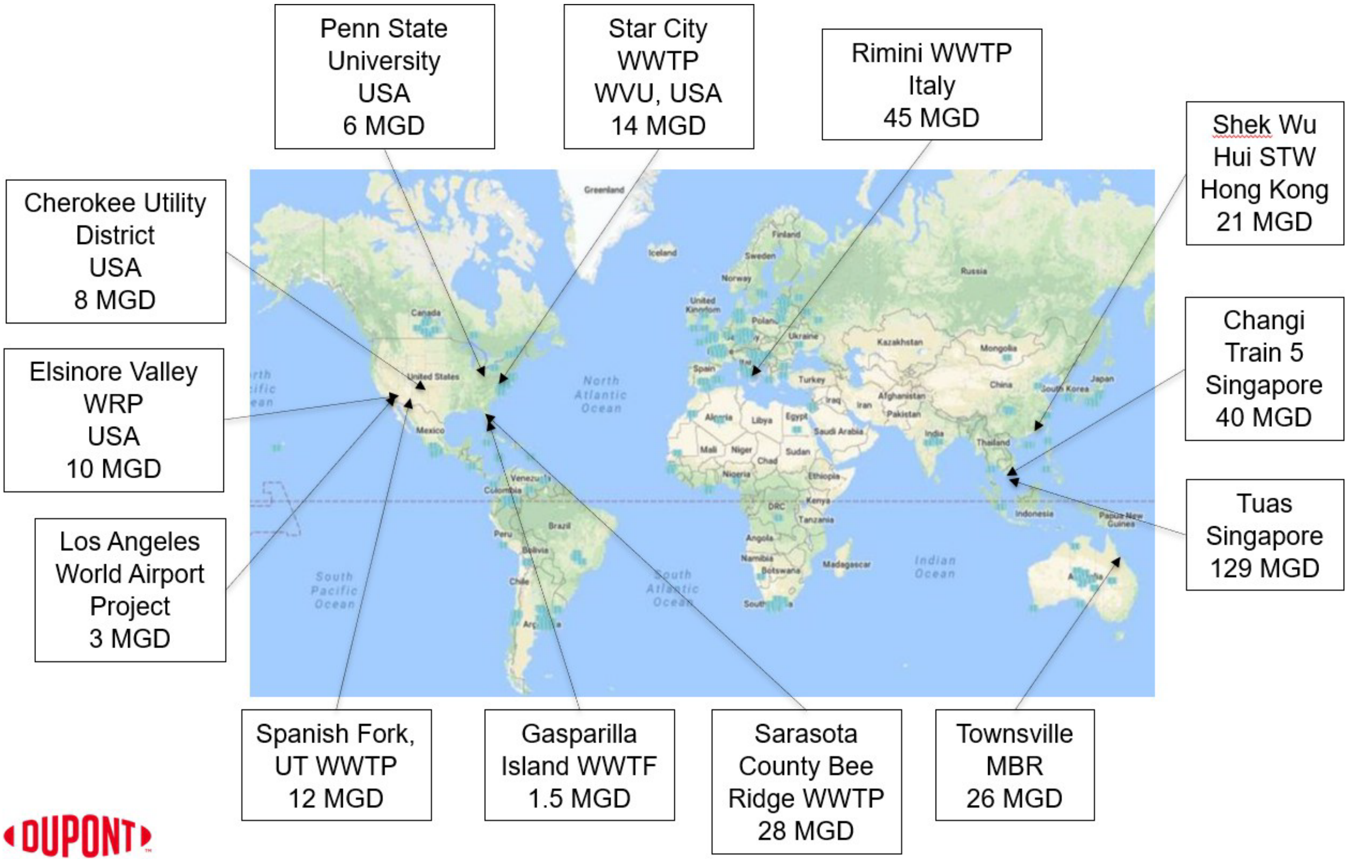
The B40N membranes in Cell 5 have been running for 10 years and are still producing great effluent every day. In addition, our plant runs three-day peak flows within 95% of peak design flows. We have followed the manufacturers recommended backwash, maintenance wash and CIP intervals and our membrane permeability and effluent performance have been consistently good over this time. The Evoqua MBR system has not required any in-tank maintenance on the membranes since we upgraded to the B40N membranes in 2009.

We have had a 10-year ongoing relationship with Evoqua and continue to work with them regularly on any issues that come up at the plant. We are on a first-name basis with Evoqua staff and consider them a partner in the success of our daily plant operation.

Best regards,

Rob Scates
Water/Wastewater Operations Superintendent
Municipal Utilities Department
City of Healdsburg

In addition, DuPont recent projects underway or recently started include the following:



DuPont Water Solutions Multi-Tech Offering Selected for Use in the World's Largest MBR-RO Water Reuse Plant

PUB, Singapore's National Water Agency, and its water infrastructure contractor, UES Holdings Pte. Ltd., has selected DuPont to implement its MemPulse™ MBR and FilmTec™ RO technologies for the sustainable production of NEWater at the landmark Tuas Water Reclamation Plant

An aerial shot of the Tuas Water Reclamation Plant. PHOTO: PUB[1]

WILMINGTON, Del., March 2, 2023 – DuPont MemPulse™ Membrane Bioreactor System (MBR) and FilmTec™ Reverse Osmosis (RO) technologies have been selected as part of a multi-technology solution for implementation in Singapore's Tuas Water Reclamation Plant (WRP), which is currently under construction as part of PUB's Deep Tunnel Sewerage System Phase 2 project. This new facility is planned to commence initial operations in 2026 and is poised to become one of the world's largest membrane bioreactor (MBR) facilities when fully completed.

"Over the last twenty years, Singapore has been an international trendsetter in water reclamation. NEWater, its third National Tap, has helped to educate people about the benefits of recycled water and how reuse is proving critical to helping the country strengthen its water resilience in the face of climate change," said Alan Chan, Global Vice President and General Manager, DuPont Water Solutions. "Our MBR and RO products are now set to be at the heart of the pioneering Tuas plant, supporting the sustainable production of NEWater to enhance the sustainability of Singapore's water supply."

Once fully operational, the Tuas WRP will have the capacity to treat an average dry weather flow of 650,000m^3/day of domestic wastewater using an advanced multi-technology process; MBR and low-fouling RO elements will make it more energy-efficient to further purify the treated wastewater and produce NEWater.

"DuPont has a long-term commitment to Singapore, and we are very proud to see our technology deployed as part of such an internationally significant project," said Kee Hoe Ng, Project Sales Leader, DuPont Water Solutions. "Our MemPulse™ MBR technology is being used across the globe to create stable membrane environments with automated membrane cleaning systems that reduce maintenance requirements and total lifecycle costs."

DuPont MemPulse™ MBR and FilmTec™ RO can be integrated together as a multi-technology wastewater recycling solution in many different environments from municipal wastewater plants to complex industrial settings, offering robust and high levels of performance and energy efficiency while maintaining operational flexibility. To learn more about the extensive portfolio of technologies offered by DuPont Water Solutions, please visit: https://www.dupont.com/water.html.

1 Source: Shabana Begum, Tuas Water Reclamation Plant On Track To Open In 2026 Amid Rising Costs, Boosting Recycled Water Supply | The Straits Times, https://www.straitstimes.com/singapore/tuas-water-reclamation-plant-on-track-for-2026-opening-despite-rising-costs

5 DuPont – Standard Terms of Sale

1. Applicable Terms. These terms govern the purchase and sale of equipment, products, related services, leased products, and media goods if any (collectively herein "Work"), referred to in Seller's proposal ("Seller's Documentation"). Whether these terms are included in an offer or an acceptance by Seller, such offer or acceptance is expressly conditioned on Buyer's assent to these terms. Seller rejects all additional or different terms in any of Buyer's forms or documents.

2. Payment. Buyer shall pay Seller the full purchase price as set forth in Seller's Documentation. Unless Seller's Documentation specifically provides otherwise, freight, storage, insurance and all taxes, levies, duties, tariffs, permits or license fees or other governmental charges relating to the Work or any incremental increases thereto shall be paid by Buyer. If Seller is required to pay any such charges, Buyer shall immediately reimburse Seller. If Buyer claims a tax or other exemption or direct payment permit, it shall provide Seller with a valid exemption certificate or permit and indemnify, defend and hold Seller harmless from any taxes, costs and penalties arising out of same. All payments are due within 30 days after receipt of invoice. Buyer shall be charged the lower of 1 ½% interest per month or the maximum legal rate on all amounts not received by the due date and shall pay all of Seller's reasonable costs (including attorneys' fees) of collecting amounts due but unpaid. All orders are subject to credit approval by Seller. Back charges without Seller's prior written approval shall not be accepted.

3. Delivery. Delivery of the Work shall be in material compliance with the schedule in Seller's Documentation. Unless Seller's Documentation provides otherwise, delivery terms are Ex Works Seller's factory (Incoterms 2010). Title to all Work shall pass upon receipt of payment for the Work under the respective invoice. Unless otherwise agreed to in writing by Seller, shipping dates are approximate only and Seller shall not be liable for any loss or expense (consequential or otherwise) incurred by Buyer or Buyer's customer if Seller fails to meet the specified delivery schedule.

4. Ownership of Materials and Licenses. All devices, designs (including drawings, plans and specifications), estimates, prices, notes, electronic data, software and other documents or information prepared or disclosed by Seller, and all related intellectual property rights, shall remain Seller's property. Seller grants Buyer a non-exclusive, non-transferable license to use any such material solely for Buyer's use of the Work. Buyer shall not disclose any such material to third parties without Seller's prior written consent. Buyer grants Seller a non-exclusive, non-transferable license to use Buyer's name and logo for marketing purposes, including but not limited to, press releases, marketing and promotional materials, and web site content.

5. Changes. Neither party shall implement any changes in the scope of Work described in Seller's Documentation without a mutually agreed upon change order. Any change to the scope of the Work, delivery schedule for the Work, any Force Majeure Event, any law, rule, regulation, order, code, standard or requirement which requires any change hereunder shall entitle Seller to an equitable adjustment in the price and time of performance.

6. Force Majeure Event. Neither Buyer nor Seller shall have any liability for any breach or delay (except for breach of payment obligations) caused by a Force Majeure Event. If a Force Majeure Event exceeds six (6) months in duration, the Seller shall have the right to terminate the Agreement without liability, upon fifteen (15) days written notice to Buyer, and shall be entitled to payment for work performed prior to the date of termination. "Force Majeure Event" shall mean events or circumstances that are beyond the affected party's control and could not reasonably have been easily avoided or overcome by the affected party and are not substantially attributable to the other party. Force Majeure Event may include, but is not limited to, the following circumstances or events: war, act of foreign enemies, terrorism, riot, strike, or lockout by persons other than by Seller or its sub-suppliers, natural catastrophes or (with respect to on-site work), unusual weather conditions.

7. Warranty. Subject to the following sentence, Seller warrants to Buyer that the (i) Work shall materially conform to the description in Seller's Documentation and shall be free from defects in material and workmanship and (ii) the Services shall be performed in a timely and workmanlike manner. Determination of suitability of treated water for any use by Buyer shall be the sole and exclusive responsibility of Buyer. The foregoing warranty shall not apply to any Work that is specified or otherwise demanded by Buyer and is not manufactured or selected by Seller, as to which (i) Seller hereby assigns to Buyer, to the extent assignable, any warranties made to Seller and (ii) Seller shall have no other liability to Buyer under warranty, tort or any other legal theory. The Seller warrants the Work, or any components thereof, through the earlier of (i) eighteen (18) months from delivery of the Work or (ii) twelve (12) months from initial operation of the Work or ninety (90) days from the performance of services (the "Warranty Period"). If Buyer gives Seller prompt written notice of breach of this warranty within the Warranty Period, Seller shall, at its sole option and as Buyer's sole and exclusive remedy, repair or replace the subject parts, re-perform the Service or refund the purchase price. Unless otherwise agreed to in writing by Seller, (i) Buyer shall be responsible for any labor required to gain access to the Work so that Seller can assess the available remedies and (ii) Buyer shall be responsible for all costs of installation of repaired or replaced Work. If Seller determines that any claimed breach is not, in fact, covered by this warranty, Buyer shall pay Seller its then customary charges for any repair or replacement made by Seller. Seller's warranty is conditioned on Buyer's (a) operating and maintaining the Work in accordance with Seller's instructions, (b) not making any unauthorized repairs or alterations, and (c) not being in default of any payment obligation to Seller. Seller's warranty does not cover (i) damage caused by chemical action or abrasive material, misuse or improper installation (unless installed by Seller) and (ii) media goods (such as, but not limited to, resin, membranes, or granular activated carbon media) once media goods are installed. THE WARRANTIES SET FORTH IN THIS SECTION OF DUPONT'S PROPOSAL ARE THE SELLER'S SOLE AND EXCLUSIVE WARRANTIES AND ARE SUBJECT TO THE LIMITATION OF LIABILITY PROVISION BELOW. SELLER MAKES NO OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE. DUPONT CAN OFFER AN "EXTENDED LOW PRESSURE MEMBRANE MODULE WARRANTY" UPON FURTHER REVIEW OF THE APPLICATION.

8. **Indemnity.** Seller shall indemnify, defend and hold Buyer harmless from any claim, cause of action or liability incurred by Buyer as a result of third-party claims for personal injury, death or damage to tangible property, to the extent caused by Seller's negligence. Seller shall have the sole authority to direct the defense of and settle any indemnified claim. Seller's indemnification is conditioned on Buyer (a) promptly, within the Warranty Period, notifying Seller of any claim, and (b) providing reasonable cooperation in the defense of any claim.

9. **Assignment.** Neither party may assign this Agreement, in whole or in part, nor any rights or obligations hereunder without the prior written consent of the other party; provided, however, the Seller may assign its rights and obligations under these terms to its affiliates or in connection with the sale or transfer of the Seller's business and Seller may grant a security interest in the Agreement and/or assign proceeds of the agreement without Buyer's consent.

10. **Termination.** Either party may terminate this agreement, upon issuance of a written notice of breach and a thirty (30) day cure period, for a material breach (including but not limited to, filing of bankruptcy, or failure to fulfill the material obligations of this agreement). If Buyer suspends an order without a change order for ninety (90) or more days, Seller may thereafter terminate this Agreement without liability, upon fifteen (15) days written notice to Buyer, and shall be entitled to payment for work performed, whether delivered or undelivered, prior to the date of termination.

11. **Dispute Resolution.** Seller and Buyer shall negotiate in good faith to resolve any dispute relating hereto. If, despite good faith efforts, the parties are unable to resolve a dispute or claim arising out of or relating to this Agreement or its breach, termination, enforcement, interpretation or validity, the parties will first seek to agree on a forum for mediation to be held in a mutually agreeable site. If the parties are unable to resolve the dispute through mediation, then any dispute, claim or controversy arising out of or relating to this Agreement or the breach, termination, enforcement, interpretation or validity thereof, including the determination of the scope or applicability of this agreement to arbitrate, shall be determined by arbitration in Pittsburgh, Pennsylvania before three arbitrators who are lawyers experienced in the discipline that is the subject of the dispute and shall be jointly selected by Seller and Buyer. The arbitration shall be administered by JAMS pursuant to its Comprehensive Arbitration Rules and Procedures. The Arbitrators shall issue a reasoned decision of a majority of the arbitrators, which shall be the decision of the panel. Judgment may be entered upon the arbitrators' decision in any court of competent jurisdiction. The substantially prevailing party as determined by the arbitrators shall be reimbursed by the other party for all costs, expenses and charges, including without limitation reasonable attorneys' fees, incurred by the prevailing party in connection with the arbitration. For any order shipped outside of the United States, any dispute shall be referred to and finally determined by the International Center for Dispute Resolution in accordance with the provisions of its International Arbitration Rules, enforceable under the New York Convention (Convention on the Recognition and Enforcement of Foreign Arbitral Awards) and the governing language shall be English.

12. **Export Compliance.** Buyer acknowledges that Seller is required to comply with applicable export laws and regulations relating to the sale, exportation, transfer, assignment, disposal and usage of the Work provided under this Agreement, including any export license requirements. Buyer agrees that such Work shall not at any time directly or indirectly be used, exported, sold, transferred, assigned or otherwise disposed of in a manner which will result in non-compliance with such applicable export laws and regulations. It shall be a condition of the continuing performance by Seller of its obligations hereunder that compliance with such export laws and regulations be maintained at all times. BUYER AGREES TO INDEMNIFY AND HOLD SELLER HARMLESS FROM ANY AND ALL COSTS, LIABILITIES, PENALTIES, SANCTIONS AND FINES RELATED TO NON-COMPLIANCE WITH APPLICABLE EXPORT LAWS AND REGULATIONS.

13. **LIMITATION OF LIABILITY.** NOTWITHSTANDING ANYTHING ELSE TO THE CONTRARY, SELLER SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER INDIRECT DAMAGES, AND SELLER'S TOTAL LIABILITY ARISING AT ANY TIME FROM THE SALE OR USE OF THE WORK, INCLUDING WITHOUT LIMITATION ANY LIABILITY FOR ALL WARRANTY CLAIMS OR FOR ANY BREACH OR FAILURE TO PERFORM ANY OBLIGATION UNDER THE CONTRACT, SHALL NOT EXCEED THE PURCHASE PRICE PAID FOR THE WORK. THESE LIMITATIONS APPLY WHETHER THE LIABILITY IS BASED ON CONTRACT, TORT, STRICT LIABILITY OR ANY OTHER THEORY.

14. **Rental Equipment / Services.** Any leased or rented equipment (#Leased Equipment") provided by Seller shall at all times be the property of Seller with the exception of certain miscellaneous installation materials purchased by the Buyer, and no right or property interest is transferred to the Buyer, except the right to use any such Leased Equipment as provided herein. Buyer agrees that it shall not pledge, lend, or create a security interest in, part with possession of, or relocate the Leased Equipment. Buyer shall be responsible to maintain the Leased Equipment in good and efficient working order. At the end of the initial term specified in the order, the terms shall automatically renew for the identical period unless canceled in writing by Buyer or Seller not sooner than three (3) months nor later than one (1) month from termination of the initial order or any renewal terms.

Upon any renewal, Seller shall have the right to issue notice of increased pricing which shall be effective for any renewed terms unless Buyer objects in writing within fifteen (15) days of issuance of said notice. If Buyer timely cancels service in writing prior to the end of the initial or any renewal term this shall not relieve Buyer of its obligations under the order for the monthly rental service charge which shall continue to be due and owing. Upon the expiration or termination of this Agreement, Buyer shall promptly make any Leased Equipment available to Seller for removal. Buyer hereby agrees that it shall grant Seller access to the Leased Equipment location and shall permit Seller to take possession of and remove the Leased Equipment without resort to legal process and hereby releases Seller from any claim or right of action for trespass or damages caused by reason of such entry and removal.

15. **Hardship.** The parties acknowledge that events beyond their control may arise during the Term of this Agreement affecting (without limitation) their performance, their future ability to perform or their cost. Should such an event (including but not limited to events of an economic, monetary, fiscal or political nature) occurs and renders the continued performance of the affected party's contractual obligations excessively onerous, and provided the affected party could not reasonably have avoided or overcome the event or its consequences, the parties shall, within 30 (thirty) days of the invocation of the provisions of this Section, meet and negotiate in good faith such changes in contractual terms or price which shall reasonably allow the affected party to overcome the consequences of the event. If the parties are unable to reach an agreement within the aforementioned 30 (thirty)-day period, the affected party shall be entitled to terminate this Agreement upon giving 30 (thirty) days' notice to the other party. Such termination shall not constitute grounds for breach of contract claims and if the affected party is the Seller, the same shall be entitled to payment for work performed whether delivered or undelivered up to the effective date of the termination.

16. **Miscellaneous.** These terms, together with any Contract Documents issued or signed by the Seller, comprise the complete and exclusive statement of the agreement between the parties (the #Agreement") and supersede any terms contained in Buyer's documents, unless separately signed by Seller. No part of the Agreement may be changed or cancelled except by a written document signed by Seller and Buyer. No course of dealing or performance, usage of trade or failure to enforce any term shall be used to modify the Agreement. To the extent the Agreement is considered a subcontract under Buyer's prime contract with an agency of the United States government, in case of Federal Acquisition Regulations (FARs) flow down terms, Seller will be in compliance with Section 44.403 of the FAR relating to commercial items and those additional clauses as specifically listed in 52.244-6, Subcontracts for Commercial Items (OCT 2014). If any of these terms is unenforceable, such term shall be limited only to the extent necessary to make it enforceable, and all other terms shall remain in full force and effect. The Agreement shall be governed by the laws of the Commonwealth of Pennsylvania without regard to its conflict of laws provisions. Both Buyer and Seller reject the applicability of the United Nations Convention on Contracts for the international sales of goods to the relationship between the parties and to all transactions arising from said relationship.

6 Additional Technical Documents

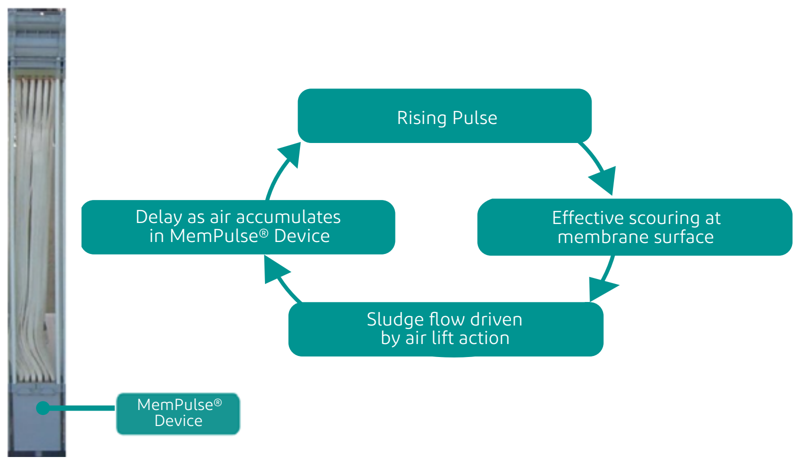
The following technical documents are attached to this proposal. If there is any additional information that we can provide to assist you, please contact the Technical Sales Manager listed above.

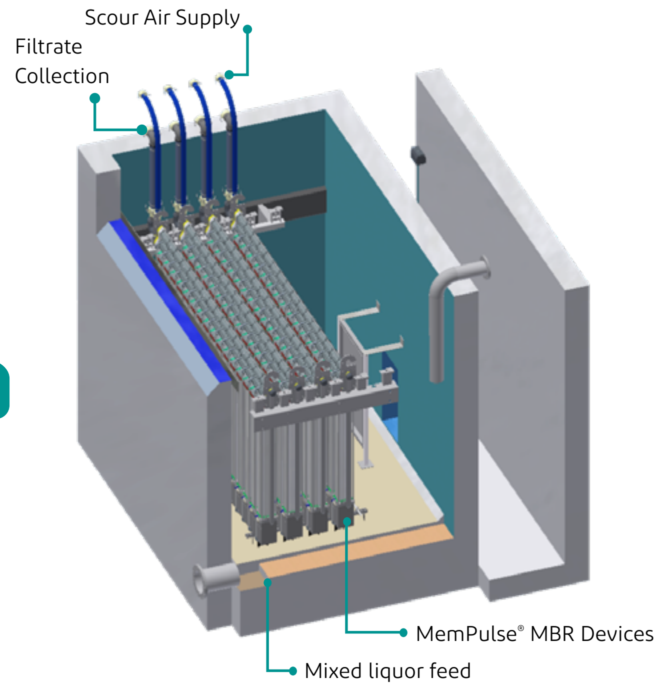
- MEMPULSE Membrane Bioreactor System
- MEMCOR B50N Membrane Filtration Module Specification Sheet
- MEMCOR MBR System MemRACK™ Specification Sheet
- MEMCOR MBR System MemRACK™ Assemblies
- MEMCOR MBR Process Description
- Membrane General Arrangement Drawings
- Membrane Design Outline

MemPulse®

MemPulse® MBR System in operation

The graphic below depicts air scouring efficiencies achieved by introducing a plug flow of air at the base of each module.





Delivering reliability & operational simplicity

The MemPulse MBR system is designed to increase reliability, decrease operating and maintenance costs and dramatically reduce energy usage. A continuous air flow is evenly distributed to each MemPulse device located directly at the base of each MBR module. The system introduces air at the base of the membrane module in the form of large bubbles or slugs that increase in size as they move up the membrane modules. The size and the focused nature of the large slugs of air prevent trash and solids build up by pushing debris away from the membrane fibre surfaces.

At the same time the large aeration pulse creates an airlift flow that draws mixed liquor into the bottom of each membrane module through an airlift tube. The air bubbles then blend with the mixed liquor and rise between the individual membrane fibers. This creates a unique crossflow pattern, providing an even distribution of mixed liquor and a reduction of solids concentration on the membrane surface.

The cross flow combined with focused, slug aeration prevents channeling and solids accumulation on the membrane surface resulting in greater system efficiency and reduced air scour requirement.

In addition; the up-flow pattern in the tank creates a flotation effect that moves grease, scum and other floatable constituents to the surface for removal.

Proven and reliable

The MEMCOR Product line has been leading the membrane industry for over 30 years and has had a dedicated MBR team since 1995. The membranes used in the MemPulse system have been proven in the field since 2007.

The efficiencies achieved with the MemPulse MBR system coupled with a proven installation base of over 200 plants and the experience of the MEMCOR MBR team make this DuPont Water Solutions technology ideally suited for a wide range of municipal and industrial applications.

A legacy of technical leadership

The MemPulse® modular rack design allows flexibility in plant design, as well as compatibility with nearly any existing tank or plant footprint.

MEMCOR® branded technology (or products) has led the industry with a series of "first to market" advancements that have increased the productivity of MBR systems.

- **Separate Membrane Tank:** Allows easy cleaning of membranes and independent optimization of MOS and bio process.
- **Improved MLSS distribution:** The introduction of the MemJet™ system greatly improved system performance with superior hydraulics within the membrane environment.
- **Removal of Release Tanks:** First to use priming educators, now the industry standard.
- **Replaced cyclic with Plug Flow Aeration:** The technology used in the MemPulse system was introduced with further enhancements that cut energy consumption to up to half of traditional systems with no moving parts.

Compared to alternative MBR membrane solutions MemPulse® MBR provides optimum filtrate quality, with lower energy consumption and flexible rack and tank configurations that enable our customers to implement superior MBR solutions.

MemPulse® MBR – Designed for What Matters

Aeration Like No Other

- The unique efficiency of two phase plug flow MemPulse membrane cleaning.
- No need for daily cyclic peak operation.
- Doesn't waste energy – Focused bubbles
- Low chemical use

In Tank – Membranes where they Belong

- Keep your team productive
  – No need to adjust slack
- Fully automated membrane cleaning
  – No need for manual cleaning
- Minimise operator exposure to bacteria and pathogens

Filtration Strong Durability

- Strength where you need it: 100% UF membrane
- Can withstand forces in all directions
- Self-healing smaller ID membranes
- Reliable effluent quality with proven pathogen rejection for >10 years
- Enabling re-use – Tier 3 capable

Adaptable and Flexible

- State-of-the-art modular and configurable rack design
- Can fit into any tank geometry
- Fits into other membrane system cassette and rack layouts
- Compact MBR footprint up to 30% smaller

DUPONT™

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DuPont Water Solutions

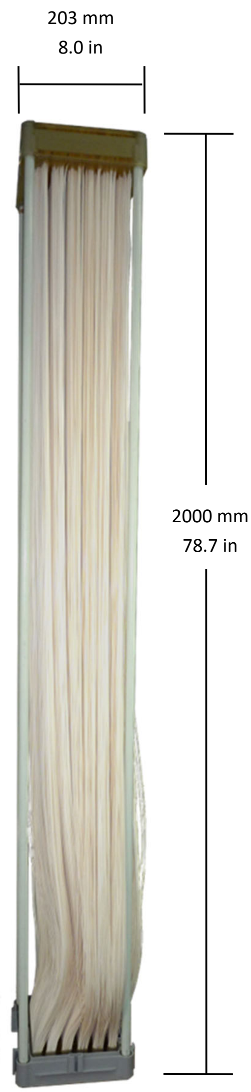
45-D03567-en 0821 CDP

SPECIFICATION SHEET

MEMCOR® B50N MemPulse MBR Membrane Filtration Module

MEMEMPULSE MBR MODULE SPECIFICATIONS

Parameter	Details
Module Operating Process	Submerged Ultrafiltration
Application	Membrane Bioreactor (MBR) Systems
Membrane Type	Hollow Fiber
Filtration Flow Direction	Outside to Inside
Backwash Type	Relaxation
Membrane Material	PVDF (Polyvinylidene Fluoride)
Other Wetted Module Components	Polyurethane, Fibreglass, Polyamide, Silicone Rubber, EPDM, SS316
Nominal Membrane Pore Size	0.04 µm
Nominal Membrane Area	50.0 m^2 / 538 ft^2
Nominal Module Length (Overall)	2000 mm / 78.7 in
Nominal Module Pot Dimensions (Overall)	203 mm x 203 mm / 8.0 in x 8.0 in Square
Approximate Module Mass	22 kg / 49 lb



B40N-L MODULE OPERATING SPECIFICATIONS

Parameter	Details
Operating Temperature Range	> 0 to 40 °C / > 32 to 104 °F (Must not be exposed to freezing conditions)
Temperature Range for Transportation and Storage	Preferred range 5 to 25 °C / 41 to 77 °F Allowable range > 0 to 40 °C / > 32 to 104 °F (shipment/storage in a temperature controlled container (or reefer) at 20 °C / 68 °F recommended). Modules must not be exposed to freezing conditions and must remain moist at all times.
Typical Feed pH Range	6.0 – 9.0 pH [Note i]
Allowable pH Range for Cleaning	2.0 – 10.5 pH typical
Typical Maximum Available Trans-Membrane Pressure (TMP) in Filtration	50 kPa / 7.3 psi [Note ii]
Maximum Allowable TMP at any time	+75 kPa / +11 psi to –110 kPa / -16 psi
Typical target chlorine concentration during cleaning:	
- Maintenance Wash	200 – 600 mg/L @ 20 °C / 200 – 600 ppm @ 68 °F
- CIP	500 - 1000 mg/L @ 20 °C / 500 – 1000 ppm @ 68 °F
Maximum chlorine concentration during cleaning	1500 mg/L @ 20 °C / 1500 ppm @ 68 °F [Note iii]
Maximum total chlorine exposure	1,000,000 mg.h/L @ 25 °C / 1,000,000 ppm.h @ 77 °F [Note iv]

Notes:

i. Exposure to chloramines is not recommended in feeds below 6.5 pH.

ii. Maximum available filtration TMP is based on a number of variables including atmospheric pressure, module submergence depth and filtrate pump NPSH requirement. The actual value may vary slightly from that shown.

iii. The recommendation for maximum chlorine cleaning solution concentration is to account for an initial rapid consumption of chlorine at the start of a MW or CIP cleaning cycle. The targeted chlorine cleaning solution concentration is then typically 200 to 1000 ppm for the remainder of the cycle.

iv. Please consult DuPont Water Solutions for additional guidance on exposure limits and for operation at different temperatures.

v. Parameters are subject to change without notice.

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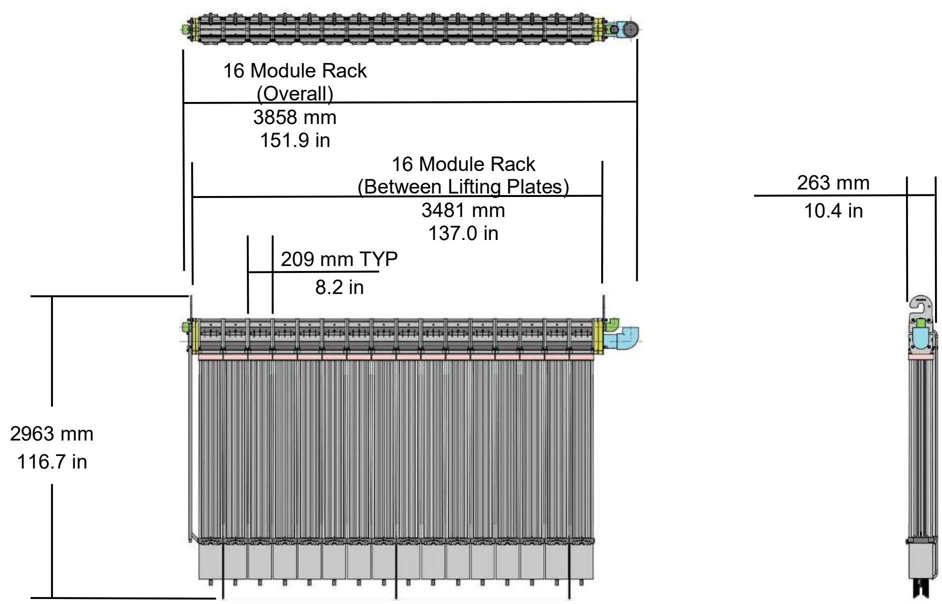
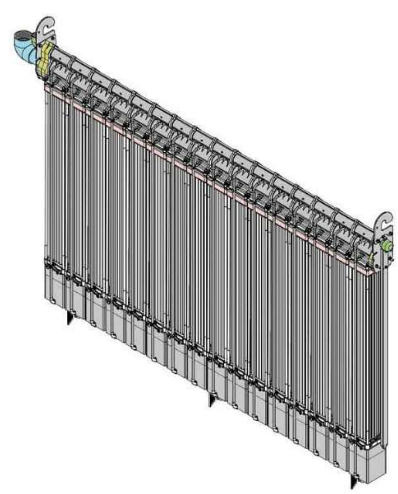
SPECIFICATION SHEET
MBR MemRACK® Assemblies – SR
MemPulse® 5B50N to 16B50N
Single Racks



SPECIFICATIONS

Parameter	Details
Module Operating Process	Submerged Ultrafiltration with MemPulse®
Application	Membrane Bioreactor (MBR) Systems
Membrane Module Type	Memcor® B50N Hollow Fibre Membrane Filtration Modules Note i
Filtration Flow Direction	Outside to Inside
Backwash Type	Relaxation
Number of Membrane Module Mounting Positions (Module Blanking Kits available)	Typically from 5 to 16 x B50 Module positions (Typical 16 Module MemRACK® Assembly illustrated)
Membrane Material	PVDF (Polyvinylidene Fluoride)
Nominal Membrane Pore Size	0.04 µm
Nominal Total Membrane Area	800 m^2 / 8611 ft^2 for 16B50N Modules



ASSEMBLY DETAILS

<table>
<tr><th>Parameter</th><th>Details</th></tr>
<tr><td>Process Connection Options

(Refer to End Connection Detail drawing for option details)

(Both process connections are vertical upwards. Standard arrangement has both at one end. Option for Air and Filtrate connections at opposite ends)</td><td>Filtrate Outlet (all Grey PVC):
Standard 4” (DN 100) Plain Inch Socket
Pipe Stub 4” (DN 100) Plain Pipe Stub
BSP Male Thread 4” (DN 100) BSP Threaded Nipple
Metric Pipe Socket 110 mm Plain Metric Socket

Aeration Air Inlet (all Grey PVC)
Standard 2” (DN 50) Plain Inch Socket
Pipe Stub 2” (DN 50) Plain Pipe Stub
BSP Male Thread 2” (DN 50) BSP Threaded Nipple
NPT Male Thread 2” (DN 50) NPT Threaded Nipple
Metric Pipe Socket 63 mm Plain Metric Socket</td></tr>
<tr><td>Aeration and Filtrate Termination Point Connection hardware</td><td>Air Inlet hoses and quick couplings are not included but can be supplied as options to suit site requirements (length and connection types to be specified)</td></tr>
<tr><td>Nominal Rack Assembly Width and Height</td><td>263 mm / 10.4 in W
2963 mm / 116.7 in H</td></tr>
<tr><td>Nominal Standard Rack Assembly Lengths
[For Racks with both connections at one end. Add 48 mm to overall lengths for connections at opposite ends of rack.]

Refer to General Arrangement Drawings for additional details.

(Heavily soiled membranes can add up to ~15 kg per Module)</td><td>
<table>
<tr><th>Rack Size</th><th>Overall Length (mm/in)</th><th>Approximate Mass (kg/lb) [Note ii]</th></tr>
<tr><td>6 Modules</td><td>1768 / 69.6</td><td>230 kg / 510 lb</td></tr>
<tr><td>8 Modules</td><td>2186 / 86.1</td><td>290 kg / 640 lb</td></tr>
<tr><td>10 Modules</td><td>2604 / 102.5</td><td>360 kg / 795 lb</td></tr>
<tr><td>12 Modules</td><td>3022 / 119.0</td><td>430 kg / 950 lb</td></tr>
<tr><td>14 Modules</td><td>3440 / 135.4</td><td>490 kg / 1080 lb</td></tr>
<tr><td>16 Modules</td><td>3858 / 151.9</td><td>560 kg / 1235 lb</td></tr>
</table>
</td></tr>
<tr><td>Recommended Minimum Hoist Capacity</td><td>1500 kg / 3300 lb</td></tr>
<tr><td>Typical Wetted Rack Assembly Components</td><td>SS316L end/lifting plates, SS316 tie rods, nuts and washers, Nylon mouldings and ABS End Plates, EPDM seals, ABS/PVC Air Droppers, POM Locator Plates, PP MemPulse® Devices, ABS and UPVC pipe/tube and fittings. [Note iii]</td></tr>
<tr><td>Temperature Range for Transportation and Storage (without Modules)</td><td>> 0 to 50 °C / > 32 to 122 °F [Note i]
(Must not be exposed to freezing conditions)</td></tr>
<tr><td>Protection from ultraviolet (UV) radiation</td><td>The assembly should not be exposed to ultraviolet radiation (direct sunlight) during storage or operation.</td></tr>
</table>

Notes:

i. When Membrane Filtration Modules are fitted to the MemRACK® Assemblies, the transport, storage and operating limits of the membranes determine allowable limits of exposure. Please refer to the relevant Module specification sheet for further details.

ii. Mass estimates are for MemRACK® Assemblies loaded with Modules and filtrate side substantially filled with water. The mass will be greater if the Modules are heavily soiled.

iii. Some alternative materials of construction may be recommended for seawater or other high TDS applications.

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MEMCOR® MBR

DuPont Water Solutions

PROCESS DESCRIPTION

Document	MAS00trp03_09_MBR_Mempulse.docx
Issue	9
Issue Date	21 April 2020

MEMCOR® MEMBRANE BIOREACTOR (MBR) FILTRATION SYSTEMS

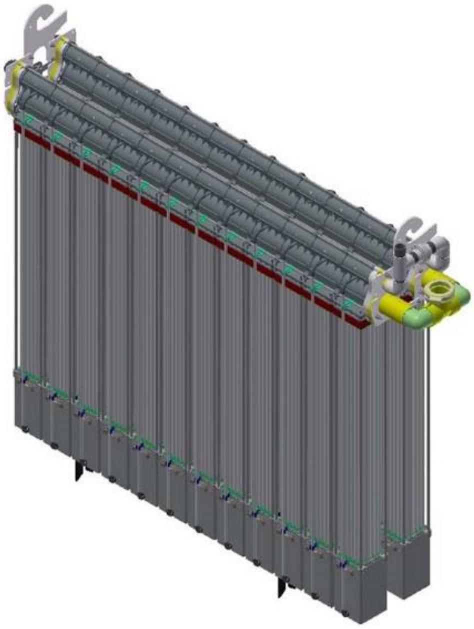
Introduction

DuPont Water Solutions has unrivalled experience in the research and development of membrane filtration products and membrane manufacturing processes. It continues to produce leading edge technology membrane filtration systems that are used around the world for a wide range of industrial and municipal filtration applications.

The MEMCOR® MBR Membrane Operating System (MOS) is an advanced wastewater treatment technology using low pressure membranes to extract liquid from a suspended growth activated sludge system.

The Memcor Membrane Bioreactor (MBR) process replaces the secondary clarifiers typically used in conventional waste treatment methods for solid/liquid separation. Unlike secondary clarifiers, however, the treated water quality is not dependent on the mixed liquor suspended solids concentration or the settling characteristics of those solids. In fact, Memcor MBR systems can operate at much higher mixed liquor suspended solids (MLSS) concentrations than conventional activated sludge systems.

MBR systems combine a biological process and a low pressure membrane filtration process, so expert knowledge in both areas is essential. The development of Memcor MBR technology has combined the skills of both membrane and biological treatment specialists, part of the global expertise available from DuPont Water Solutions. The result – the unique MemPulse® MBR system.



The membranes and process developed for Memcor MBR systems are founded on our unrivalled experience in membranes for water and wastewater treatment.

Memcor Submerged Membrane Filtration processes leverage more than 30 years of proven low pressure membrane filtration product know-how. Over this time, Memcor membrane systems have achieved increased product scale and improved operating economies and have proven ideal for use in Membrane Bioreactor systems.

The Memcor MBR system provides high quality, highly efficient and reliable waste water processing with a small plant footprint and economic operation.

A Membrane Operating System (MOS) typically incorporates one or more Membrane Filtration Cells located adjacent to the biological treatment system. The use of a separate tank for the Membrane Filtration Modules, adjacent to the biological reactor provides a number of benefits, including:

- A controlled membrane environment;
- Positive fluid transfer of Mixed Liquor through the Membrane Filtration Modules and uniform distribution of flow and of solids (Mixed Liquor Suspended Solids or MLSS);
- Flexibility in biological process selection;
- Independent optimisation of biological and membrane processes;
- A small footprint;
- A Clean-In-Place system that allows chemical cleaning without membrane removal, providing safer operation and reduced downtime;
- Separation of biological processes from chemical cleaning systems.

Typical MOS Components

The biological section of an MBR plant typically includes:

- Primary waste water treatment, including fine screening and grit removal;
- A biological treatment system, often including anaerobic, anoxic and aerobic zones;
- Flow balancing.

Following the biological process, the Membrane Operating System (MOS) typically includes:

- A Mixed Liquor recirculation system which recirculates Mixed Liquor from the biological treatment system through the MOS. The recirculation system can be configured to be pump feed/gravity return or gravity feed/pump return;
- One or more Memcor Membrane Filtration Cells. Each Cell is a rectangular tank in which several Racks are fitted. Each Rack holds a number of MEMCOR® MBR Hollow Fibre Membrane Filtration Modules and has manifolds to collect filtrate and distribute low pressure air. Cells may be covered for odour control;
- An aeration system which continuously supplies low pressure air to the Filtration Modules in each Cell;
- A Filtrate Pump, which draws filtered liquid from the Membrane Filtration Modules in the Cell;
- Valves, instrumentation and controls, including a programmable automation controller (PLC/PAC) and human machine interface (HMI);
- Ancillary equipment, such as a compressed air system and chemical storage/delivery system, to provide operating and cleaning resources;
- Downstream storage and processing systems (such as disinfection or Reverse Osmosis);
- Maintenance components, such as a Rack Removal System and special tools.

MEMCOR® MBR Membrane Filtration Modules

The critical components of the Membrane Operating System are the Membrane Filtration Modules. MEMCOR® MBR Modules have the following membrane characteristics:

- Chlorine tolerant PVDF;
- Hollow fibre configuration;
- Pore size in the ultrafiltration (UF) range;
- Homogeneous asymmetric structure.

Each Memcor MBR Membrane Filtration Module contains thousands of fibres which are partitioned or “layered”, into thin fibre bundles. Fibres are sealed with polyurethane “pots” at each end of the Module and supported in a frame. The upper pot allows filtered water to pass from the hollow inner core, or lumen, of all the membrane fibres into the filtrate manifold. The lower pot seals the ends of all the fibres but allows the two-phase Mixed Liquor and low pressure process air to pass from the Air Sub-Manifold through a series of openings to the outside surfaces of the membranes within the fibre bundle.

The Membrane Filtration Modules are assembled on a Rack that manifolds the process connections and supports the Modules. O-Rings create watertight seals between the different wetted components. Tie rods hold the Rack components together.

Each Membrane Filtration Module is a serviceable filter element that may be removed from the Rack for repair or replacement.

Figure 1

Left: *A MEMCOR® B40N MBR Membrane Filtration Module.*

Right Upper: *Close-up of an MBR Rack Assembly showing Air Droppers connected to the Aeration Air Manifold on each Head Piece.*

Right Lower: *Close-up of Air Droppers connected to the MemPulse® aeration devices fitted to the bottom of each Module on the MBR Rack Assembly.*

Figure 2 *A typical MBR Rack Assembly fitted with sixteen MEMCOR® B40N Membrane Filtration Modules. It is mounted on a Rack Maintenance Stand and has a Rack Spreader Bar (Lifting Beam) attached to the Lifting Plates at each end.*

The MemPulse® System

During operation, Mixed Liquor is fed from the biological treatment process to the cell. The Mixed Liquor, or Sludge, is distributed throughout the cell, flowing upwards through the membrane modules before overflowing out of the cell and back to the biological treatment system.

At the base of each Memcor module is a patented MemPulse® device. MemPulse® technology uses a simple arrangement with no moving parts to achieve a significant reduction in energy consumption and lower maintenance costs. It does this by converting continuous airflow into irregular pulses of air at the base of each membrane module. Coarse bubble air scouring of the membrane fibres is thus achieved intermittently through the accumulation of air which is then released in a random plug flow, producing highly efficient “Two-Phase Flow”. This upward plug flow generates an “airlift effect” causing two-phase (air-liquid) fluid to flow upwards through the Membrane Filtration Modules. The cross-flow dynamics created in the fibre bundles scour the membrane surfaces to prevent accumulation and dehydration of solids.

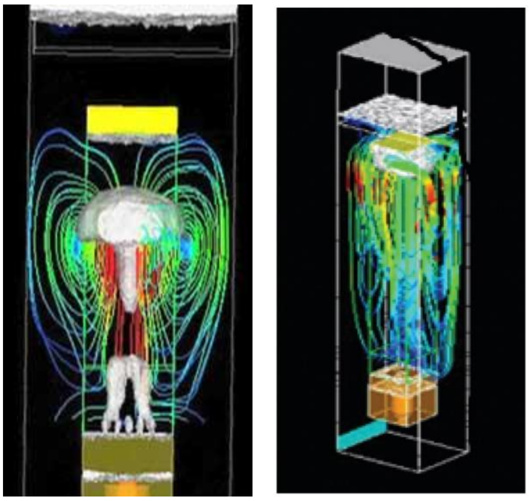


Figure 3 *This computer model shows the dynamic “Airlift Effect” of the “Plug Flow” of air generated by the MemPulse® Aeration Device.*

This dynamic plug flow maximises efficiency because:

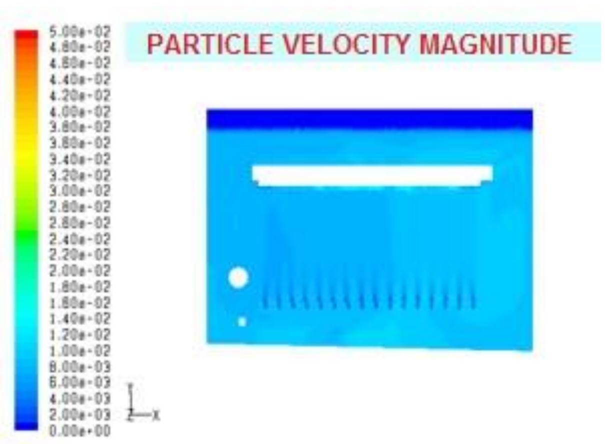
- The moving bubbles generate secondary flows behind the initial bubble that assist in breaking up the filter cake layer and promoting local mixing near membrane surfaces;
- The film around the outside of the bubble acts as a high shear region which promotes the movement of solids away from membrane surfaces;
- The moving slugs of air result in pressure pulses in the liquid around them producing agitation which scours the membrane surfaces.

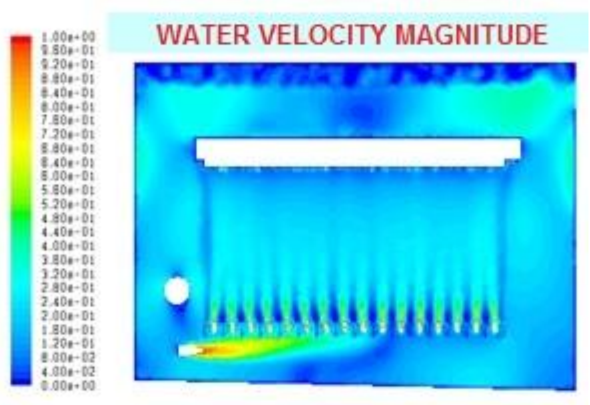
At the same time, the Filtrate Pump draws filtrate from inside each membrane fibre and discharges this liquid to the next treatment process step. Virtually all solids are rejected at the membrane surface and retained in the Mixed Liquor which returns to the biological process system. Mixed Liquor is recirculated typically at between three to five times the filtrate flowrate.

The MemPulse® system is designed to minimise polarisation (concentration) of suspended solids around the membrane fibre bundles. With this system mixed liquor is pumped directly into each Membrane Module distributing mixed liquor evenly so that every Module sees the same process conditions.

Typical solids concentration, air and water velocity profiles for Memcor systems are shown in the figures below. Without the MemPulse® system, Membrane Modules at the far end of the Cell would see increased solids concentrations, causing uneven fouling of these membranes.

Additionally, Memcor systems provide an integrated cleaning solution combining efficient scouring of the membranes with chemical cleaning. The integrated cleaning system allows the Membrane Modules to be automatically cleaned in place at appropriate intervals. The Clean-In-Place procedure eliminates the need for membrane removal from the Cell, improving plant operator safety and reducing the risk of damage to membranes and other system components.





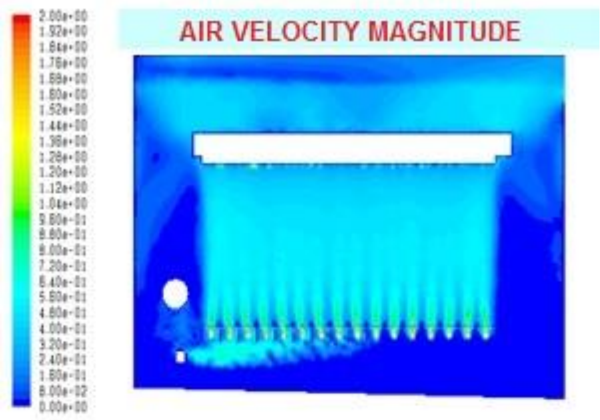


Figure 4

Computational Fluid Dynamics (CFD) models of a MemPulse® Rack Assembly show excellent particle, air and water distribution.

Maintaining Membrane Performance

During membrane filtration, filtered solids tend to form a compressible filter-cake on the membrane surface. The filter cake forms its own filter layer and so adds to the filtration performance of the system. But at the same time it increases the head loss or pressure drop across the membrane, commonly referred to as the Trans-membrane Pressure (TMP). This filter cake must be controlled to maintain a reasonable pressure drop or TMP across the membranes during filtration.

The minimisation of this fouling layer or filter cake is regulated by three processes, namely:

- Relaxation;
- Maintenance Wash (MW), and;
- Clean-In-Place (CIP).

Filtration rates are principally maintained by Relaxation. However, a small residual of foulants remains on the membrane surfaces and accumulates over time. This is reflected by a slow increase in membrane resistance to flow. To remove these foulants, occasional chemical cleaning is carried out, either with a Maintenance Wash (MW) cycle or with a Clean-in-Place (CIP) cycle.

These three processes are described in more detail in the following sections.

1. Relaxation

Relaxation takes place when filtration through the membrane is stopped. This reduces the TMP to zero, allowing the filter cake to relax and expand. This improves the efficiency of the MemPulse® two-phase scrubbing action, which scours the filter cake back into the bulk solids solution. This process prevents the filter cake thickening to such an extent that filtration performance is significantly affected.

Backwash vs Relaxation

The standard operating regime for Memcor MBR Systems is to use Relaxation only. Considerable operating experience has shown that there is no significant increase in membrane performance when operating with a more complex backwash sequence as compared to a simple Relaxation step.

Therefore, Memcor MBR Systems do not require a backwash as part of the standard operating regime. However, for operational flexibility, provision can be made in the Membrane Operating System design for a backwash cycle to be used if required.

The Relaxation Cycle

Typically, the Relaxation cycle operates as follows:

- Frequency: Every 10 to 12 minutes of filtration;
- Duration: Filtration is stopped for 60 seconds.

2. Maintenance Wash (MW)

Typical MBR operation includes a Maintenance Wash (sometimes referred to as a Chemical Backwash (CBW) or as a Maintenance Clean) every 1 to 2 weeks of operation. A Maintenance Wash is usually performed automatically after a pre-set total time in filtration.

During a Maintenance Wash, chlorinated filtrate is passed in the reverse direction through the Membrane Filtration Modules to inhibit biological growth and reduce fouling on the membranes and in filtrate pipework. During this process, membrane aeration continues, the Cell remains full of Mixed Liquor, and Mixed Liquor recirculation usually continues, but may be turned off if appropriate. The whole cycle typically lasts for about 30 minutes after which the Cell can be returned to service.

A Maintenance Wash typically uses the following sequence and takes around 60 minutes:

- Stop filtration;
- Reverse flow backwash of clean water dosed with chlorine (typically sodium hypochlorite) normally at a concentration of about 200 mg/L (ppm) – typically around 5 minutes;
- Relaxation for around 15 minutes;
- Repeat previous reverse flow backwash with chlorine solution and Relaxation steps;
- Prime filtrate manifolds and Filtrate Pump with filtrate if necessary;
- If filtrate recirculation is available, resume Mixed Liquor recirculation with aeration and recirculate filtrate for about 10 to 15 minutes. Returning filtrate to the Cell, that is, to the Mixed Liquor recirculation system neutralises any remaining cleaning solution. Rinse effectiveness can be determined by measuring the pH of the filtrate;
- Return Cell to normal operation.

During a Maintenance Wash the membranes remain fully submerged in Mixed Liquor. No neutralisation is required as the small amount of chlorine used in the MW is consumed by the Mixed Liquor.

3. Clean-in-Place (CIP)

The Memcor MBR process is designed so that a CIP cycle is usually only required once every 3 to 6 months of operation. During the CIP cycle the Membrane Modules are fully submerged in the cleaning solution. This process is performed in the Cell, providing operational simplicity by eliminating the need to remove membranes to a separate location for cleaning.

In a CIP cycle, the Mixed Liquor is drained from the Cell and the Cell is flushed with filtrate before being filled again with dilute cleaning solution made up with membrane filtrate.

For biological systems using coagulant for phosphorus removal, both acid and chlorine cleaning solutions are typically used. In these systems, the Acid CIP cycle typically uses a blend of Citric Acid (0.5 %). The Chlorine CIP cleaning solution is usually made up to achieve a recirculation concentration of around 1,000 mg/L of free chlorine.

For MEMCOR® MBR systems, the Chlorine CIP cycle Soak step time has a recommended minimum of 3 hours. For colder climates with water temperatures below 20 °C (68 °F), the soaking time should be extended where possible to improve cleaning efficiency, based on the following equation:

$$\text{Soak Time (hours)} = -0.2 \times \text{Water Temperature (°C)} + 7$$

For example: *If the cleaning solution temperature on the day of the Chlorine CIP cleaning cycle is 5 °C (41 °F) then the soak time should be extended to (–0.2 x 5) + 7 = 4.5 hours*

A CIP cycle will usually be initiated when:

- the filtration TMP reaches a pre-set maximum value;
- the total filtration time reaches a pre-set value, or;
- an operator starts the CIP cycle manually, for example, if Cell maintenance is required.

Usually only one Cell in a system is cleaned at a time with the others remaining in service.

Although some variations may be necessary due to different process designs, a typical CIP cycle generally uses the following sequence and takes around 3 hours. :

1. Stop filtration but continue aeration;
2. Drain Mixed Liquor from the Cell. Stop aeration when the Cell reaches a low level;
3. Use filtrate from the Filtrate Storage Tank to Flush the Cell floor to help remove solids;
4. Fill the Cell with filtrate from the Filtrate Storage Tank to CIP level. This typically takes about 20 minutes. Commence aeration when the Cell level permits;
5. Continue aeration for another 30 minutes. If filtrate recirculation is possible, recirculate filtrate with the Filtrate Pump during this time;
6. Drain the Cell and Modules again;
7. Prime the filtrate lines and Modules with service water (as used for cleaning solution makeup);
8. Reverse flow backwash of service water dosed with CIP concentrate [either acid or chlorine] at the specified concentration to displace filtrate with cleaning solution. This typically takes around one minute each time;
9. Continue with reverse flow chemical backwash for a further 15 to 30 seconds;
10. Soak for 4 to 5 minutes;
11. Repeat previous reverse flow backwash with cleaning solution and soak steps until the Cell level reaches around one eighth full (~10 to 15 %). This typically takes about 8 to 10 repeats.

12. Fill the Cell with service water (or filtrate) to the CIP level. Recirculate filtrate if possible and add more concentrate if necessary. Recirculate for a total time of about 20 minutes (including dosing time) to ensure even mixing;
13. Soak for 3 - 5 hours (depending on water temperature or other requirements). For Acid CIP, use intermittent aeration – typically for the first 30 seconds of every 30 minutes. As odour can be strong, Chlorine CIP usually does not use aeration;
14. Drain used cleaning solution from Cell, Modules and Filtrate pipework to the CIP Waste Disposal or Neutralisation system;
15. For a single CIP cleaning cycle or the final clean of a Dual CIP cycle, proceed to the next step. If this step is at completion of the first CIP cleaning cycle of a Dual CIP (typically Acid followed by Chlorine), then return to Step 7 to prime the filtrate lines and Modules with service water (as used for cleaning solution makeup) prior to the second CIP cycle;
16. On completion of the single CIP or final Dual CIP solution drain, reverse flush filtrate pipework and Modules with filtered water for about 5 minutes;
17. Fill the Cell with Mixed Liquor then continue ML recirculation. Commence aeration when the Cell level permits;
18. When Cell is filled with Mixed Liquor, prime the filtrate manifolds and Filtrate Pump with filtrate if necessary;
19. If filtrate recirculation is available, continue Mixed Liquor recirculation with aeration and recirculate filtrate for about 10 to 15 minutes. Returning filtrate to the Cell, that is, to the Mixed Liquor recirculation system neutralises any remaining cleaning solution. Rinse effectiveness can be determined by measuring the pH of the filtrate;
20. Return Cell to normal operation.

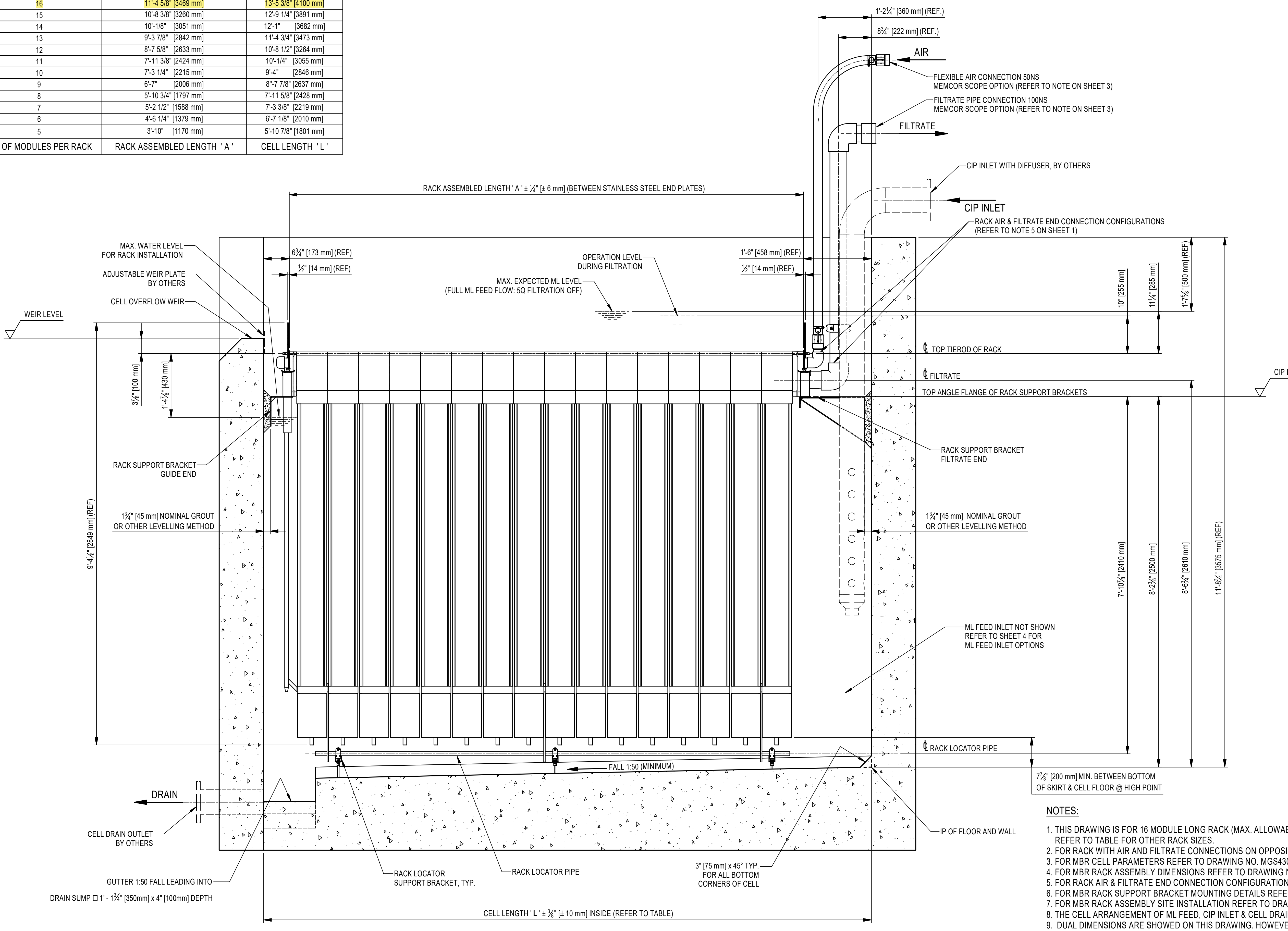
Some Advantages of Memcor MBR Systems

The MEMCOR® MBR Membrane Operating System offers important advantages over competitive systems:

Efficient Membrane Scouring	Two Phase flow created by the MemPulse® device under each Module. Plug flow of membrane scour air provides more vigorous and efficient cleaning. Elastic fibres that move freely with minimal aeration.
Simplicity	Unique MemPulse® cleaning action has no moving parts or valves.
Reduced Process Complexity	Larger bubble size created by MemPulse® aeration system does not significantly increase Dissolved Oxygen (typically only 1 – 2 mg/L).
Highly Efficient Mixed Liquor distribution	Memcor systems are designed to ensure even distribution of Mixed Liquor to each Membrane Module. The MemPulse® device under each Module in the Cell directs Mixed Liquor evenly into each Module, ensuring that all Modules see the same process conditions. Memcor systems ensure even solids concentration profiles across the filter Cell. Other systems have uneven distribution with some membranes seeing very high sludge concentrations resulting in uneven performance and fouling of membranes.

Ease of Maintenance	MEMCOR® Membrane Filtration Modules are easily handled. Modules are self-supporting and light weight (a B40N Module weighs less than 20 kg). Competitive membrane systems don't have these characteristics and are often difficult to handle, increasing the risk of injury to personnel and of damage to membranes during maintenance.
Ease of Repair	MEMCOR® Membrane Filtration Modules are easily repaired with a reliable pin repair process. Fibre damage is easily located and can be mechanically repaired in just a few minutes – with the positive effect of the repair immediately evident. Competitive membrane systems can be difficult to repair for two reasons: • Locating the damaged area of the membrane can be very difficult (especially in flat sheet systems); • Repairs typically involve the use of adhesives which are both time consuming and sometimes unsuccessful.
Homogeneous Membrane Structure	MEMCOR® MBR membranes are manufactured from a homogeneous material. The membrane material is the same from the inside to the outside surfaces of the fibre. Many competitor membranes rely on a composite structure that uses a very thin layer of membrane glued or cast onto a coarse support structure for strength. The weakness of this approach is in the bond between the membrane and the support. Delamination (the process of the thin membrane surface peeling from the support structure) is a significant problem for some suppliers.
Durability	MEMCOR® MBR hollow fibre membrane tensile elongation is typically greater than 200 %.
Continuous Quality	High quality filtrate is provided by the Memcor membrane system, an advantage particularly for reuse applications. There is a much lower bypass risk because fibre inside diameter is smaller than many competitor membranes.
In-situ Membrane cleaning	MEMCOR® Membrane Operating Systems are designed for automatic membrane cleaning in the filter Cell. There is no need for membranes to be removed from the Cell for cleaning. Some competitive systems, particularly those with membranes located in the activated sludge bioreactor, have limited *in situ* cleaning efficiency and require removal for efficient cleaning.

NO. OF MODULES PER RACK	RACK ASSEMBLED LENGTH 'A'	CELL LENGTH 'L'
16	11'-4 5/8" [3469 mm]	13'-5 3/8" [4100 mm]
15	10'-8 3/8" [3260 mm]	12'-9 1/4" [3891 mm]
14	10'-1/8" [3051 mm]	12'-1" [3682 mm]
13	9'-3 7/8" [2842 mm]	11'-4 3/4" [3473 mm]
12	8'-7 5/8" [2633 mm]	10'-8 1/2" [3264 mm]
11	7'-11 3/8" [2424 mm]	10'-1/4" [3055 mm]
10	7'-3 1/4" [2215 mm]	9'-4" [2846 mm]
9	6'-7" [2006 mm]	8"-7 7/8" [2637 mm]
8	5'-10 3/4" [1797 mm]	7'-11 5/8" [2428 mm]
7	5'-2 1/2" [1588 mm]	7'-3 3/8" [2219 mm]
6	4'-6 1/4" [1379 mm]	6'-7 1/8" [2010 mm]
5	3'-10" [1170 mm]	5'-10 7/8" [1801 mm]



CELL CROSS SECTION

(RACK WITH AIR & FILTRATE CONNECTIONS AT SAME ENDS)

NOTES:

1. THIS DRAWING IS FOR 16 MODULE LONG RACK (MAX. ALLOWABLE). REFER TO TABLE FOR OTHER RACK SIZES.
2. FOR RACK WITH AIR AND FILTRATE CONNECTIONS ON OPPOSITE ENDS REFER TO SHEET 2.
3. FOR MBR CELL PARAMETERS REFER TO DRAWING NO. MGS430-310.
4. FOR MBR RACK ASSEMBLY DIMENSIONS REFER TO DRAWING NO. MGS460-301.
5. FOR RACK AIR & FILTRATE END CONNECTION CONFIGURATIONS REFER TO DRAWING NO. MGS460-302.
6. FOR MBR RACK SUPPORT BRACKET MOUNTING DETAILS REFER TO DRAWING NO. MGS460-304, 305 & 306.
7. FOR MBR RACK ASSEMBLY SITE INSTALLATION REFER TO DRAWING NO. MGS460-307.
8. THE CELL ARRANGEMENT OF ML FEED, CIP INLET & CELL DRAIN BY OTHERS ARE FOR REFERENCE ONLY.
9. DUAL DIMENSIONS ARE SHOWED ON THIS DRAWING. HOWEVER, THE PRIMARY DIMENSIONS ARE IN METRIC [mm].

ISSUE NO	DATE	DRN	ZONE REF.	DESCRIPTION OF CHANGE	CHKD	APVD
2	06/11/2023	JL		UPDATE DRG. TITLE TO MEMPULSE MBR B50 SR (SINGLE RACK). PARALLEL FEED CHANNEL OPTION ADDED.	GJ	YT
1	29/11/2022	JL		PRELIMINARY ISSUE	GJ	YT
0	29/11/2022	JL		ORIGINAL		

DIMENSIONS IN MILLIMETRES
DRAWN TO AS1100
DO NOT SCALE
IF IN DOUBT ASK

DRAWN	DATE
JL	29/11/2022
CHECKED GJ	31/01/2023
APPROVED YT	31/01/2023

TOLERANCES
Linear :

≤ 2m	= ± 1.0mm	≤ 6'	= ± 1/32"
> 2m ≤ 4m	= ± 2.0mm	> 6' ≤ 12'	= ± 1/16"
> 4m	= ± 5.0mm	>12'	= ± 3/16"

Angular : ± 0.5˚ OR AS NOTED

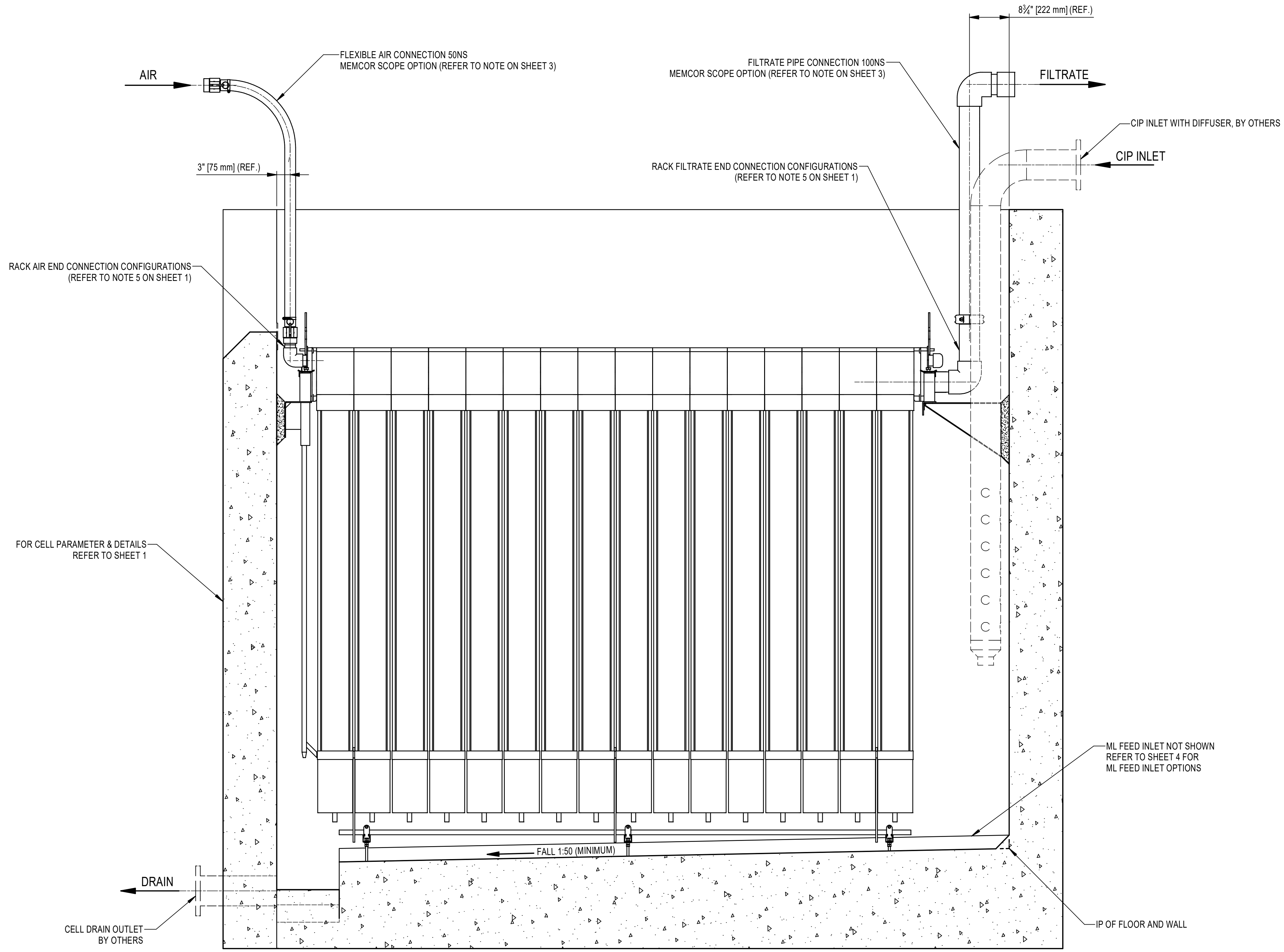
TITLE: MEMPULSE® MBR B50 SR (SINGLE RACK) CELL PARAMETERS & GENERAL ARRANGEMENT

CLIENT: MEMCOR GLOBAL STANDARD

MEMCOR® a DuPont brand

DuPont Memcor (Australia) Pty Ltd
ABN 36 166 784 694
15 Blackman Crescent, South Windsor
NSW 2756, Australia
Tel: +61 2 45776800

SCALE: N.T.S. OR AS NOTED
DRAWING NUMBER: MGS460-300
SHEET 1 OF 5
P/N
ISSUE: 2
A1



CELL CROSS SECTION

(RACK WITH AIR & FILTRATE CONNECTIONS AT OPPOSITE ENDS)
(REFER TO SHEET 1 FOR CELL PARAMETER & DETAILS)

ISSUE NO	DATE	DRN	ZONE REF.	DESCRIPTION OF CHANGE	CHKD	APVD
2	06/11/2023	JL		UPDATE DRG. TITLE TO MEMPULSE MBR B50 SR (SINGLE RACK). PARALLEL FEED CHANNEL OPTION ADDED.	GJ	YT
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0	29/11/2022	JL		ORIGINAL		

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CHECKED	GJ	DATE 31/01/2023
APPROVED	YT	DATE 31/01/2023

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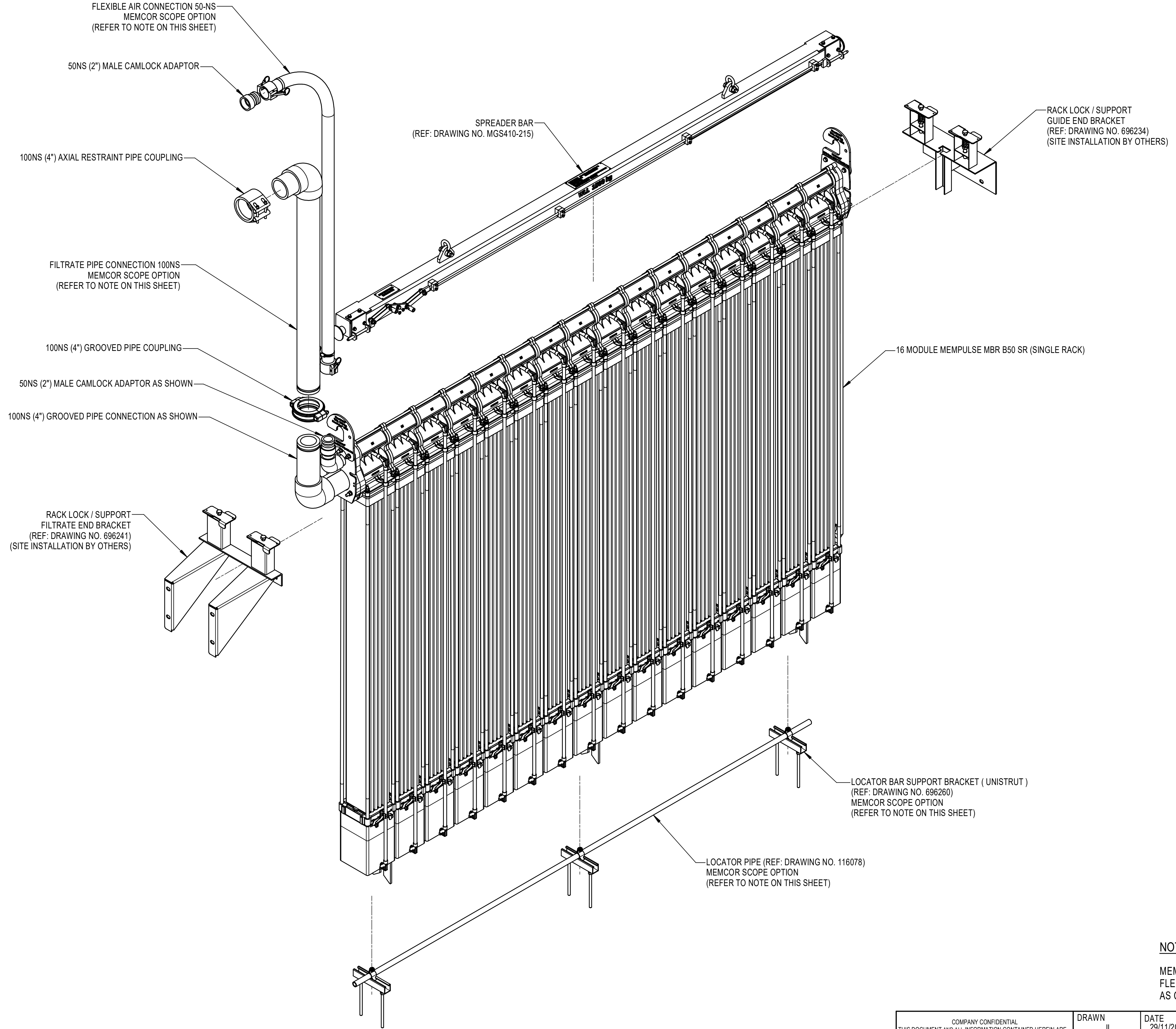
SCALE N.T.S. OR AS NOTED
DRAWING NUMBER MGS460-300
SHEET 2 OF 5 P/N
ISSUE 2
A1

Cad Model Name: C:\Vault\Designs\inv_stdmc\MGS460 B40-L SINGLE RACK\MBR MEMPULSE B40-L CELL PARAMETERS.iam
INVENTOR



TYPICAL COMPONENT VIEW OF 16 MODULES MEMPULSE MBR B50 SR (SINGLE RACK)

NOTE:

MEMCOR CAN SUPPLY FILTRATE PIPE CONNECTION ASSEMBLY, FLEXIBLE AIR CONNECTION HOSE ASSEMBLY, LOCATOR PIPE & SUPPORT BRACKET AS OPTIONS FOR SITE INSTALLATION BY OTHERS.

ISSUE NO	DATE	DRN	ZONE REF.	DESCRIPTION OF CHANGE	CHKD	APVD
2	06/11/2023	JL		UPDATE DRG. TITLE TO MEMPULSE MBR B50 SR (SINGLE RACK). PARALLEL FEED CHANNEL OPTION ADDED.	GJ	YT
1	29/11/2022	JL		PRELIMINARY ISSUE	GJ	YT
0	29/11/2022	JL		ORIGINAL		

DIMENSIONS IN MILLIMETRES
DRAWN TO AS1100
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DRAWN	JL	DATE	29/11/2022
CHECKED	GJ	DATE	31/01/2023
APPROVED	YT	DATE	31/01/2023

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> 4m	= ± 5.0mm	>12'	= ± 3/16"

Angular : ± 0.5˚
OR AS NOTED

TITLE MEMPULSE® MBR B50 SR (SINGLE RACK)
CELL PARAMETERS & GENERAL ARRANGEMENT

CLIENT MEMCOR GLOBAL STANDARD

MEMCOR®
a DuPont brand

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Tel: +61 2 45776800

SCALE N.T.S. OR AS NOTED
DRAWING NUMBER MGS460-300
SHEET 3 OF 5
P/N
ISSUE 2

A1

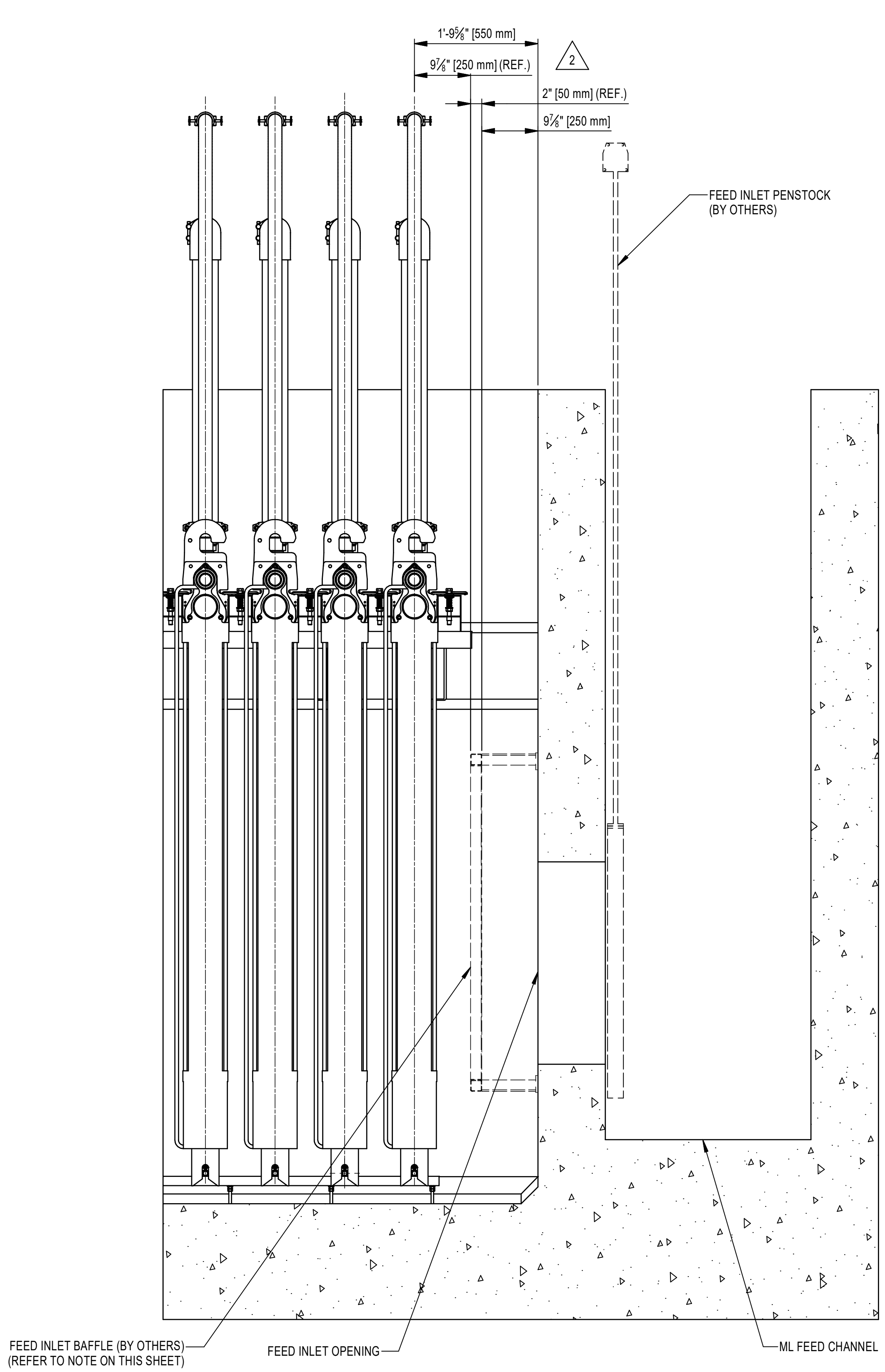
Cad Model Name: C:\Vault\Designs\inv_stdmc\MGS460 B40-L SINGLE RACK\MBR MEMPULSE B40-L for drawing.iam

INVENTOR

DRAWING NUMBER MGS460-300
SHEET 3 OF 5
P/N

PERPENDICULAR ML FEED CHANNEL OPTION (2)

(FEED INLET IS PERPENDICULAR TO THE MBR RACK LENGTH)

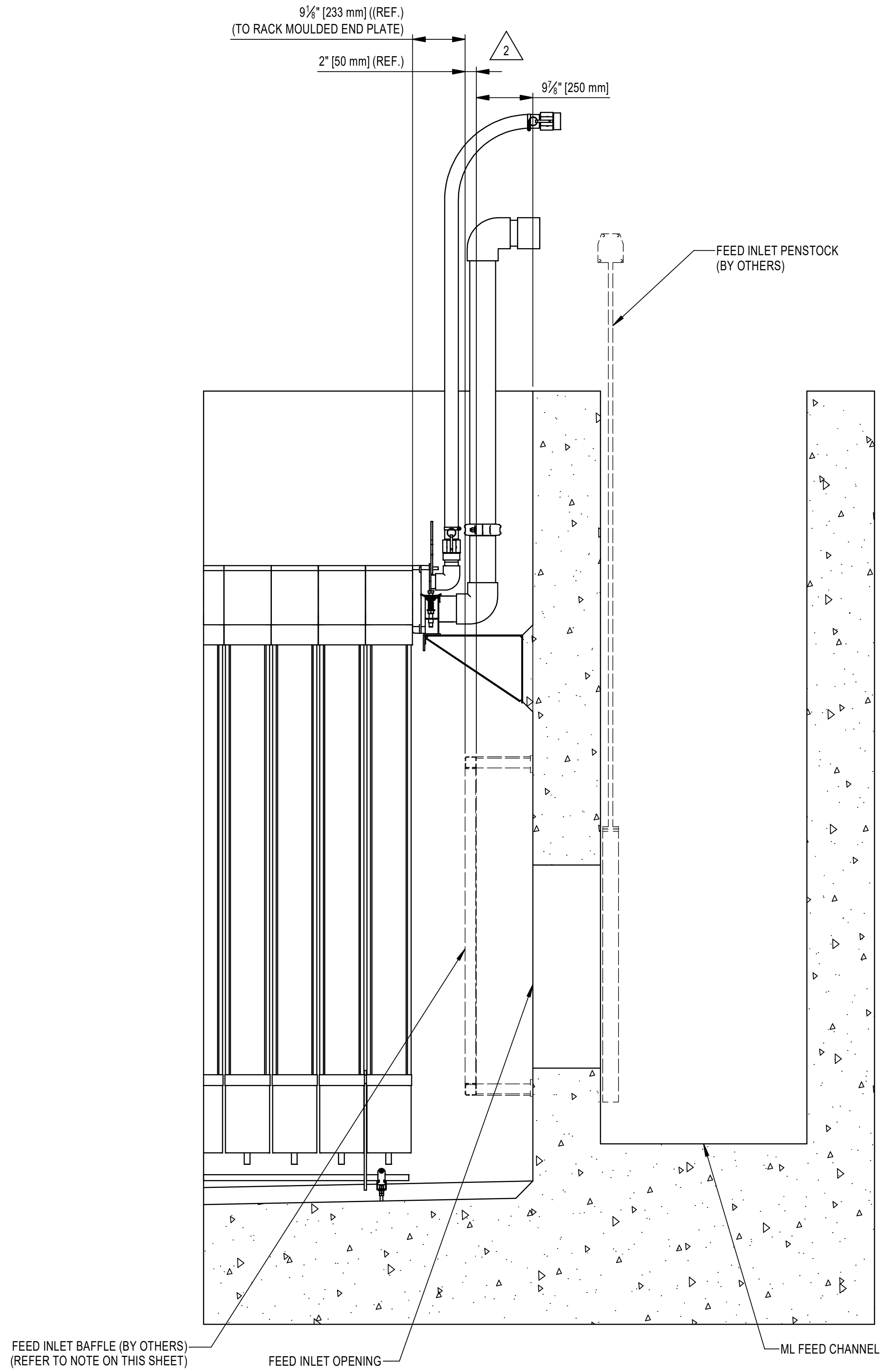


PARTIAL CROSS SECTION

(PERPENDICULAR ML FEED CHANNEL OPTION SHOWN)

PARALLEL ML FEED CHANNEL OPTION (2)

(FEED INLET IS PARALLEL TO THE MBR RACK LENGTH)



PARTIAL CROSS SECTION

(PARALLEL ML FEED CHANNEL OPTION SHOWN)

NOTE:

REFERENCE ONLY, DESIGN TO BE UPDATED FOR PROJECT REQUIREMENTS.
FEED INLET BAFFLE TO BE SIZED TO PREVENT DIRECT FLOW ONTO MEMBRANE RACKS.

ISSUE NO	DATE	DRN	ZONE REF.	DESCRIPTION OF CHANGE	CHKD	APVD
2	06/11/2023	JL		UPDATE DRG. TITLE TO MEMPULSE MBR B50 SR (SINGLE RACK). PARALLEL FEED CHANNEL OPTION ADDED.	GJ	YT
1	29/11/2022	JL		PRELIMINARY ISSUE	GJ	YT
0	29/11/2022	JL		ORIGINAL		

DIMENSIONS IN MILLIMETRES
DRAWN TO AS1100
DO NOT SCALE
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DRAWN	JL	DATE	29/11/2022
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APPROVED	YT	DATE	31/01/2023

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Angular : ± 0.5° OR AS NOTED

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CLIENT: MEMCOR GLOBAL STANDARD

MEMCOR® a DuPont brand

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Tel: +61 2 45776800

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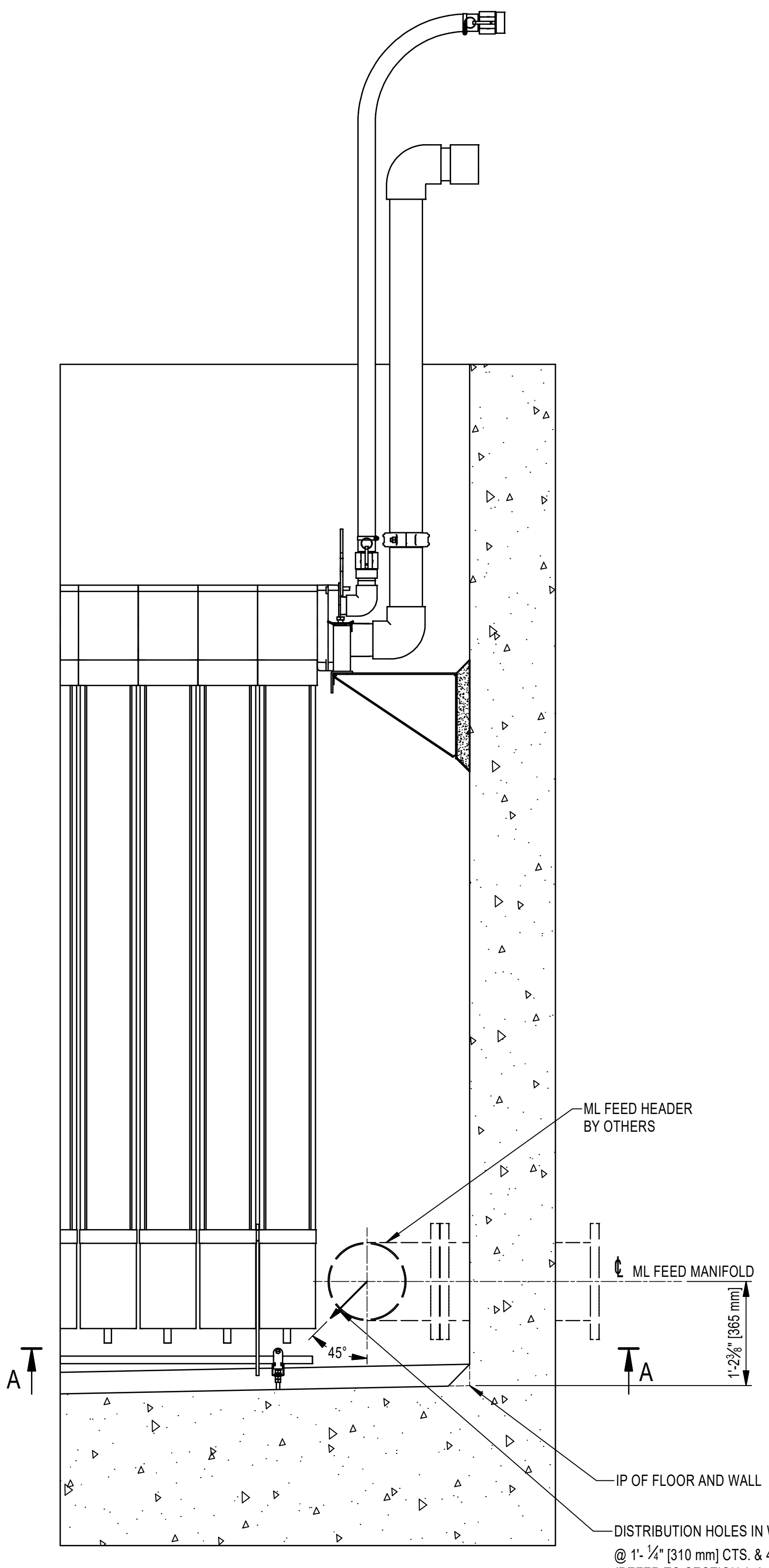
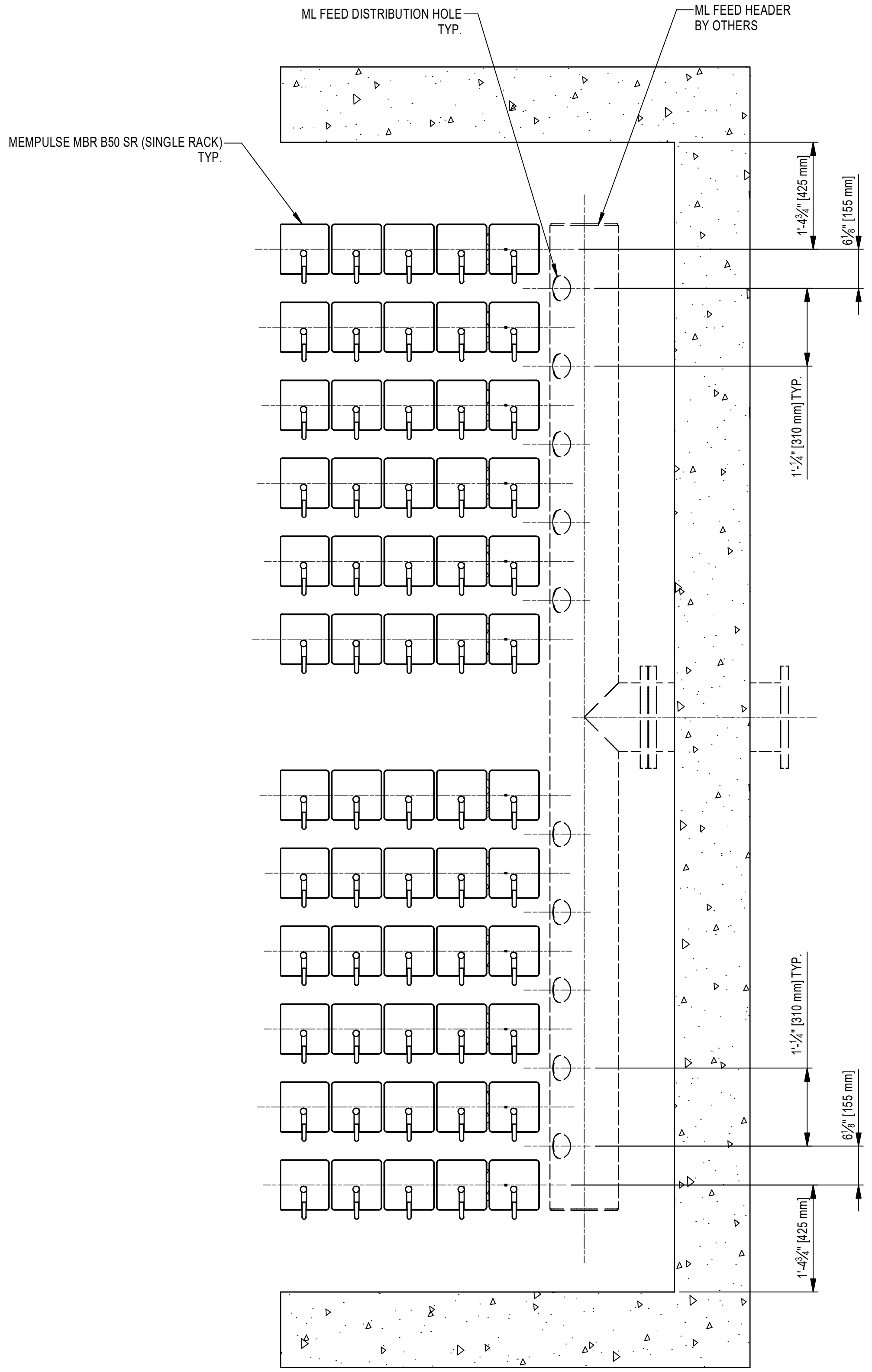
ISSUE: 2
A1

ML FEED HEADER OPTION



PARTIAL CROSS SECTION
(ML FEED HEADER OPTION SHOWN)



SECTION A-A
(TYPICAL ML FEED DISTRIBUTION HOLES ARRANGEMENT)

ISSUE NO	DATE	DRN	ZONE REF.	DESCRIPTION OF CHANGE	CHKD	APVD
2	06/11/2023	JL		UPDATE DRG. TITLE TO MEMPULSE MBR B50 SR (SINGLE RACK). PARALLEL FEED CHANNEL OPTION ADDED.	GJ	YT
1	29/11/2022	JL		PRELIMINARY ISSUE	GJ	YT
0	29/11/2022	JL		ORIGINAL		

DIMENSIONS IN MILLIMETRES
DRAWN TO AS1100
DO NOT SCALE
IF IN DOUBT ASK

DRAWN: JL	DATE: 29/11/2022
CHECKED: GJ	DATE: 31/01/2023
APPROVED: YT	DATE: 31/01/2023

TOLERANCES
Linear :

≤ 2m	= ± 1.0mm	≤ 6'	= ± 1/32"
> 2m ≤ 4m	= ± 2.0mm	> 6' ≤ 12'	= ± 1/16"
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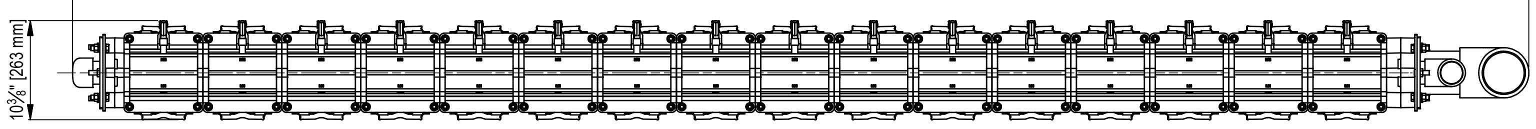
SCALE: N.T.S. OR AS NOTED
DRAWING NUMBER: MGS460-300
SHEET 5 OF 5
P/N
ISSUE: 2
A1

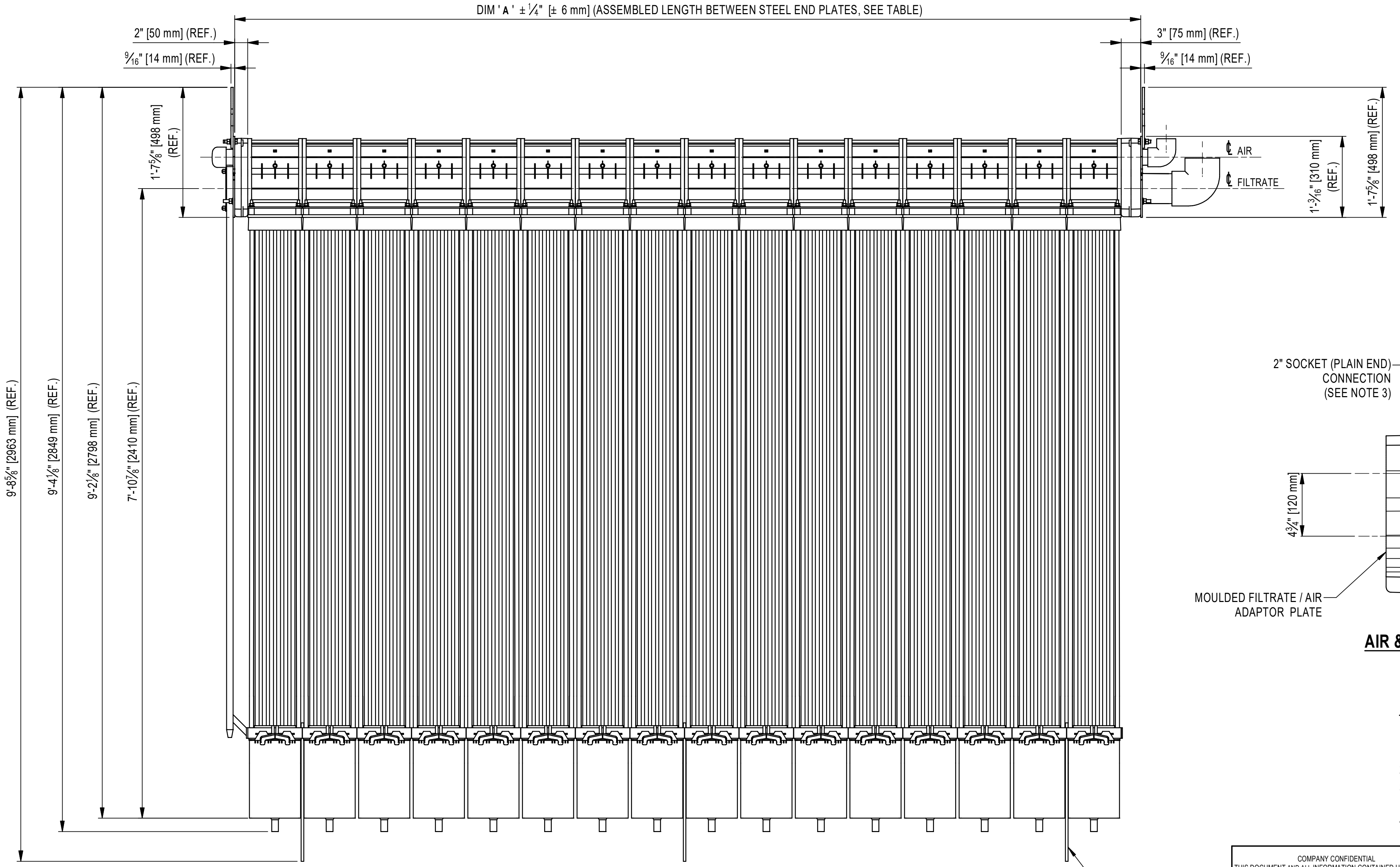
Cad Model Name: C:\Vault\Designs\inv_stdmc\MGS460 B40-L SINGLE RACK\MBR MEMPULSE B40-L CELL PARAMETERS.iam
INVENTOR

DRAWING NUMBER MGS460-300
SHEET 5 OF 5
P/N

NO. OF MODULES PER RACK	DIM 'A'	DIM 'B'	NO. OF LOCATOR PLATES 'N'
16	11'-4 5/8" [3469 mm]	12'-7 7/8" [3858 mm]	3
15	10'-8 3/8" [3260 mm]	11'-11 5/8" [3649 mm]	3
14	10'-1/8" [3051 mm]	11'-3 3/8" [3440 mm]	3
13	9'-3 7/8" [2842 mm]	10'-7 1/4" [3231 mm]	3
12	8'-7 5/8" [2633 mm]	9'-11" [3022 mm]	3
11	7'-11 3/8" [2424 mm]	9'-2 3/4" [2813 mm]	3
10	7'-3 1/4" [2215 mm]	8'-6 1/2" [2604 mm]	3
9	6'-7" [2006 mm]	7'-10 1/4" [2395 mm]	2
8	5'-10 3/4" [1797 mm]	7'-2 1/8" [2186 mm]	2
7	5'-2 1/2" [1588 mm]	6'-5 7/8" [1977 mm]	2
6	4'-6 1/4" [1379 mm]	5'-9 5/8" [1768 mm]	2
5	3'-10" [1170 mm]	5'-1 3/8" [1559 mm]	2



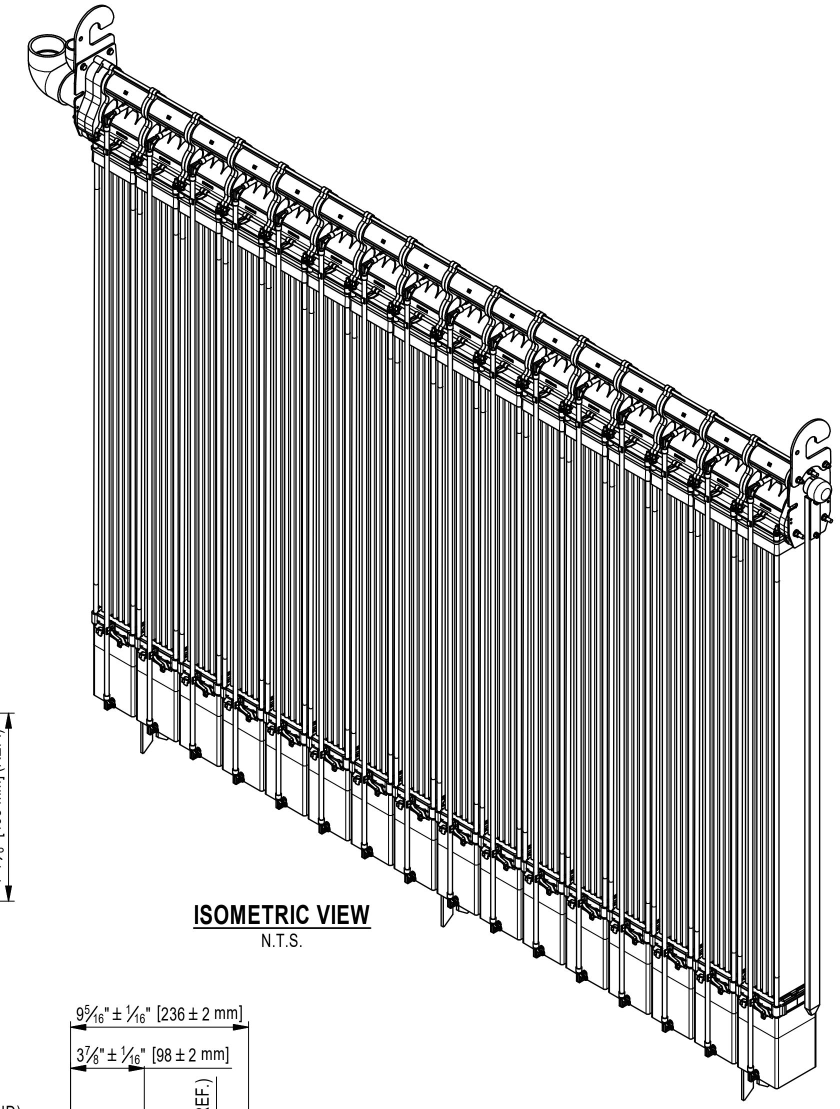
PLAN VIEW



SIDE ELEVATION

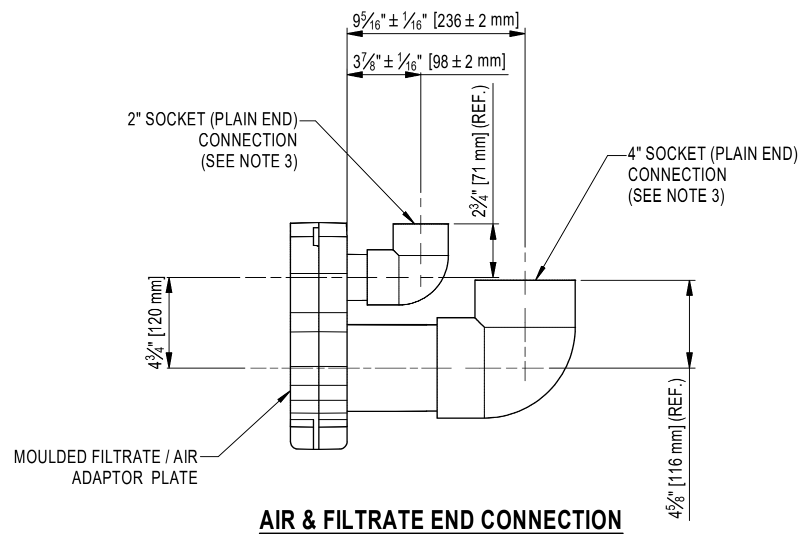
(RACK WITH AIR & FILTRATE END CONNECTIONS AT SAME END)

RACK LOCATOR PLATE TYP. 'N' PLACES



ISOMETRIC VIEW

N.T.S.



AIR & FILTRATE END CONNECTION

SCALE (1:5)

NOTES:

1. THIS DRAWING SHOWS A 16 MODULE MEMPULSE MBR B50 SR (SINGLE RACK) (MAX. ALLOWABLE) REFER TO TABLE FOR OTHER RACK SIZES.
2. FOR AIR AND FILTRATE END CONNECTIONS ON OPPOSITE ENDS SEE SHEET 2.
3. THE INCH SOCKET PLAIN CONNECTION IS THE STANDARD MBR RACK CONNECTION. REFER TO DRAWING MGS410-302 FOR OPTIONAL END CONNECTION CONFIGURATIONS.
4. DUAL DIMENSIONS ARE SHOWN ON THIS DRAWING. HOWEVER, THE PRIMARY DIMENSIONS ARE IN METRIC [mm].

ISSUE NO	DATE	DRN	ZONE REF.	DESCRIPTION OF CHANGE	CHKD	APVD
2	06/11/2023	JL		UPDATE DRG. TITLE TO MEMPULSE MBR B50 SR (SINGLE RACK)	GJ	YT
1	28/11/2022	JL		PRELIMINARY ISSUE	GJ	YT
0	28/11/2022	JL		ORIGINAL		

DIMENSIONS IN MILLIMETRES
DRAWN TO AS1100
DO NOT SCALE
IF IN DOUBT ASK

DRAWN	DATE
JL	28/11/2022
CHECKED GJ	13/01/2023
APPROVED YT	13/01/2023

TOLERANCES
Linear :
≤ 2m = ± 1.0mm ≤ 6' = ± 1/32"
> 2m ≤ 4m = ± 2.0mm > 6' ≤ 12' = ± 1/16"
> 4m = ± 5.0mm >12' = ± 3/16"
Angular : ± 0.5˚ OR AS NOTED

TITLE MEMPULSE® MBR B50 SR (SINGLE RACK) GENERAL ARRANGEMENT

CLIENT MEMCOR GLOBAL STANDARD

MEMCOR® a DuPont brand

DuPont Memcor (Australia) Pty Ltd
ABN 36 166 784 694
15 Blackman Crescent, South Windsor
NSW 2756, Australia
Tel: +61 2 45776800

SCALE 1:10 OR AS NOTED

DRAWING NUMBER MGS460-301 SHEET 1 OF 2 P/N

ISSUE 2

A1

DRAWING NUMBER MGS460-301 SHEET 1 OF 2 P/N

Cad Model Name: C:\Vault\Designs\inv_stdmc\MGS460 B40-L SINGLE RACK\MBR MEMPULSE RACK 16xB40-L.iam

INVENTOR

MEMCOR®
a DuPont brand

PRELIMINARY -
NOT FOR CONSTRUCTION

Membrane System Design Outline

Design Conditions

Average Daily Flow (ADF)	0.253 MGD	Wastewater Type	Municipal
Max Monthly Flow (MMF)	0.253 MGD	Min. Wastewater Temp. (°F)	50
Peak Hourly Flow (PHF)	0.759 MGD	Bioreactor MLSS (mg/L)	8,500
		Site Elevation (ft)	500

Membrane Tank Design

No. of Duty Tanks	1	Module Type	B50N + Mempulse
No. of Standby Tanks	1	Module Area (ft²)	538.2
Total No. of Tanks	2	Rack(set) Type	Single Rack

Per Tank	***Installed***	***Maximum***	***Dimensions of each tank:***	
Rack(set) Size (Modules per Rack(set))	10	10	Tank Length* (ft)	9.34
Rack(set)s per Tank	5	6	Tank Width* (ft)	7.87
Rack(set) Slots per Tank	1	0	Tank Depth (Top of Concrete) (ft)	11.7
Blinded Modules per Tank	0	0	Tank Weir Depth (ft)	9.6
Modules per Tank	50	60	Tank Operating Volume (gal)	5,305
Available Spare Modules per Tank	10	0	Tank CIP Volume (gal)	4,511
Percentage of Spare	16.7%	0%	Weight of Wet Rack(set) Assembly** (lb)	794
Membrane Area per Tank (ft²)	26,910	32,292	Weight of Fouled Rack(set) Assembly** (lb)	1,301

Total		
Total No. of Rack(set)s	10	12
Total No. of Modules	100	120
Total Membrane Area (ft²)	53,820	64,583

** If feeding along the racks, no baffle gap is required to be added to tank length.*
If feeding across the racks, 4.156166m baffle gap needs to be added to the tank v
*** Per rack. Includes weight of spreader bar.*

Design Fluxes

	ADF	MMF	PHF				Unit
Flow Condition	0.253	0.253	0.759				MGD
No. of Membrane Tanks in Operation	1	1	2				—
No. of Membrane Tanks in Standby	1	1	0				—
Design Water Temperature	10	10	10				ºC
Net Flux at Design Water Temperature	9.4	9.4	14.1				gfd
Net Flux (temperature-corrected to 20 deg C)	12.3	12.3	18.4				gfd
Instantaneous Flux at Design Water Temperature	10.3	10.3	15.4				gfd
Instantaneous Flux (temperature-corrected to 20 deg C)	13.5	13.5	20.2				gfd

Mixed Liquor Feed Flow Requirements

	ADF	MMF	PHF				Unit
Max operating MLSS Conc. in Membrane Tank	10,500	11,000	12,500				mg/L
Total Mixed Liquor Feed Flow Required	922	773	1,647				gpm
Total Return Activated Sludge Flow Required	747	597	1,120				gpm

Avg. Discharge Pressure	12.7	ft
Peak Discharge Pressure	11.5	ft

Air Scour Requirements for Installed Membranes

Average Air Flow per Tank	134	SCFM (68°F) (assuming ww T= 15 oC)	Avg Discharge Pressure	5.2	psig
Peak Air Flow per Tank	150	SCFM (68°F) (assuming ww T= 10 oC)	Peak Discharge Pressure	5.3	psig

Requirements for Air Scour Blower Design (including spare rack slots)

Minimum Flow per Tank	134	SCFM (68°F) (assuming ww T= 10 oC)	Avg Discharge Pressure	5.2	psig
Maximum Flow per Tank	185	SCFM (68°F) (assuming ww T= 10 oC)	Peak Discharge Pressure	5.3	psig

Power Requirements based on operation Average Daily Flow

Component	Quantity Installed	Quantity Operating	Flow per Component	Discharge Pressure	Assumed Efficiency	Power per Component	Total Power Consumption
RAS Pump	2	1	784 gpm	13 ft	75%	3.8 HP	67 kWh/d
Filtrate Pump	2	1	212 gpm	22 ft	65%	2 HP	33 kWh/d
MOS Air Scour Blower	2	1	141 scfm	5.2 psig	72%	4.2 HP	74 kWh/d
Air Compressors	2	1	21.8 cfm	141.4 psig		6.9 HP	23 kWh/d
Total							**198 kWh/d**

Chemical Cleaning Requirements

Cleaning Procedure	Cleaning Procedure Frequency	Bulk Chemical Concentration	Bulk Chemical per Clean (gal)	Annual Bulk Chemical Consumption (gal)
Chlorine MC	7.0 days	12.5% w/w Liquid	3	153
Chlorine CIP	90.0 days	12.5% w/w Liquid	23	94
Citric Acid CIP	180.0 days	50% w/w Liquid	39	79

Total CIP Waste Volume per CIP: 4,405 gal

MEMCOR®
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Ancillary Equipment Design Outline (Preliminary - Not for Construction)

Equipment Required	Type	Quantity Installed	Quantity in Service	Configu-ration	Max Capacity	Max Discharge Pressure	Average Capacity	Avg Discharge Pressure
Filtrate Pumps	End-suction centrifugal	2	1	One per cell	327 gpm	38 ft	212 gpm	22 ft
RAS Pumps	End-suction centrifugal	2	1	Manifolded	1176 gpm	11.5 ft	784 gpm	12.7 ft
MOS Aeration Blowers	Positive displacement	2	1	Manifolded	389 scfm	5.3 psig	141 scfm	5.2 psig
MC Hypo Dosing Pumps	Metering Pump	1	1	-	16 gph	15 psig		
CIP Hypo Dosing Pumps	Metering Pump	1	1	-	159 gph	15 psig		
CIP Citric Dosing Pumps	Metering Pump	1	1	-	400 gph	15 psig		
Compressed Air System	Rotary-screw	2	1	-	21.8 CFM	141.4 psig		

Note:
1. Schedule to be used for estimating and not for construction.
2. Pump head based on preliminary plant levels and headloss calcs - to be confirmed during detailed piping design.
3. The MOS aeration blowers are sized to include the spare slots and modules.
4. Min. capacities of the pumps and blowers are to be checked to meet the turndown requirements.

Water Solutions
dupont.com/water

COMMERCIAL PROPOSAL
20240728
06/17/2024

Multi-disc Screw Press for Dewatering Sludge MDQ-352 CLS

PREPARED FOR:
Cogent
14452 W. 44th Ave.
Golden, CO. 80403
Tel.: (303) 584-9000
https://www.cogentcompanies.com
fhenderson@cogentcompanies.com
Frank Henderson
RE: Town of Lyons WWTP

PREPARED BY:
ESMIL Corp.
3939 Mogadore Industrial Parkway
Mogadore, OH 44260
Tel.: (330) 685-0889
https://www.esmil.us
burns@esmil.us
Randy Burns

ITEM	COST EA.
Multi-disc screw press MDQ-352 CLS	**$266,375.00**

Dear Frank,

Enclosed is our proposal for a multi-disc screw press MDQ-352 CLS. Selection is based on the dewatering of aerobically digested sludge. The system is capable of unattended continuous duty and is sized to meet the performance requirements that were stated. This MDQ-352 CLS system includes a two drum multi-disc screw press with controls. Performance guarantee can be made after an on-site pilot test is completed.

The MDQ-352 CLS has a less-than 3.0 Hp duty and operates at less than 3 rpm which leads to a long maintenance life for dewatering drum rings and screw shaft bearings. Standard maintenance expectations could require replacement of the movable rings between 3-5 years, fixed rings and a simple screw shaft bearing replacement between 5-7 years. Our precision equipment is efficient and capable of automatic unattended continuous duty producing quality results in low odor emission. It requires very little maintenance. The screw press has a programmed periodic drum washing and cleaning function to reduce attendant needs with low water requirements. Simple removal of drum solids should also be considered at end of operation if unit will not be operated for long periods.

This proposal will serve as our intention to provide equipment and start-up services. Terms and conditions will be furnished along with a contract for mutual signing or our acceptance of a project Purchase Order.

Best regards,
Randy Burns

1. GENERAL INFORMATION

1.1. Features

- Pre-wired system ready to use;
- Compact design;
- Designed for small to medium municipal wastewater treatment plants and industrial applications;
- Minimum civil works on site;
- Easy to relocate.

1.2. Advantages

- Multi-disc screw press is an excellent solution for dewatering sludge with suspended solids concentration of up to 150,000 mg/l;
- Solids content of the dewatered cake is 16–35 %, depending on the properties and composition of the sludge;
- The drums have a built-in thickening zone, which eliminates need for additional equipment for mechanical thickening of the sludge. This allows dewatering of sludge with low dry solids concentration;
- The design of the screw press prevents clogging of the dewatering drum, therefore large volumes of rinsing water are not required;
- The press operates automatically, is easy to maintain and does not require the constant presence of staff;
- It is economical. Use of electricity, polymer and rinsing water consumption during operation of the system is lower than any other dewatering equipment;
- High wear resistance ensures reliable operation of the dewatering drum for up to 50,000 hours;
- Units with two or more dewatering drums may continue to operate while one drum is being repaired.

1.3. Main components

All metals in contact with polymer or sludge, and all other components specified to be stainless steel are AISI 304 stainless steel. Option in AISI 316 is also available.

The screw press consists of two main parts – the mixing tank (Fig. 1, pos. 1) and dewatering drum(-s) (Fig. 1, pos. 2). Each part has separate frame-bases (Fig. 1, pos. 3, 4). Side walls of the filtrate collection tray (Fig. 1, pos. 5) are the integral part of the frame-base of the dewatering drum(-s).

The screw press arrives on site with its mixing tank and dewatering drum(-s) preassembled with the frame-base.

The mixing tank and dewatering drum(-s) are connected with feed tube(-s) (Fig. 1, pos. 6).

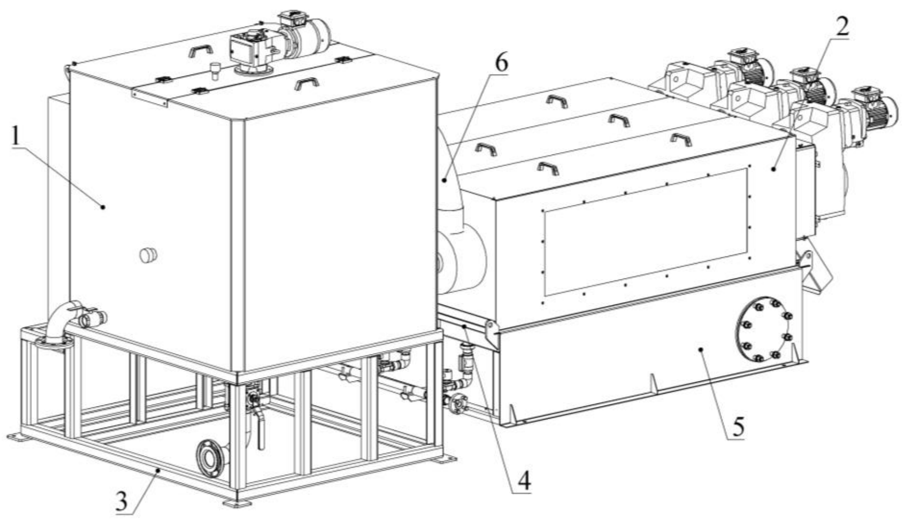


Fig. 1. Main components of the multi-disc screw press:
1 – Mixing tank; 2 – Dewatering drum(-s); 3 – Frame-base of the flocculation chamber;
4 – Frame-base of the dewatering drums; 5 – Filtrate collection tray; 6 – Dewatering drum feed tube.

The mixing tank is equipped with sludge inlet (Fig. 2, pos. 1), flocculant (polymer; Fig. 2, pos. 2) and coagulant (Fig. 2, pos. 3) inlets and drainage outlet (Fig. 2, pos. 4). Influent sludge and chemicals are mixed together with an electric agitator (Fig. 2, pos. 5). Furthermore, the flocculation tank is equipped with pressure sensor (Fig. 2, pos. 6) and conductometric level sensor (Fig. 2, pos. 7).

Chemically conditioned sludge enters the dewatering drum(-s) through the feed tube(-s) (Fig. 1, pos. 6).

The dewatering drum consists of a variable flight pitch screw (Fig. 3, pos. 3) located within a support frame (Fig. 3, pos. 4) of alternating fixed and moving discs. Fixed discs (Fig. 3, pos. 1) are equipped with spacers that hold the fixed discs apart and provide a gap for moving discs (Fig. 3, pos. 2) between them.

The screw flight pitch as well as the thickness of the spacers and, consequently, the gap between the fixed and moving discs decrease as the sludge is transported further down the drum. Therefore, the drum may be divided into two zones – the thickening zone and the dewatering zone with the different screw flight pitch and the gap between the moving and fixed discs.

At the end of the drum is an adjustable dam plate (Fig. 3, pos. 5) through which the cake exits the unit.

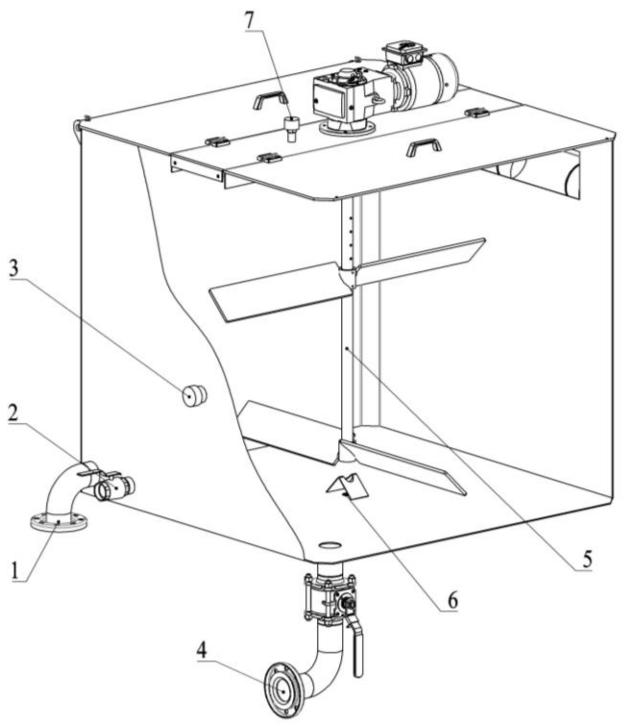


Fig. 2. Mixing tank:
1 – Sludge inlet; 2 – Flocculant (polymer) inlet; 3 – Coagulant inlet; 4 – Drainage outlet;
5 – Electric agitator; 6 – Pressure sensor; 7 – Level sensor.

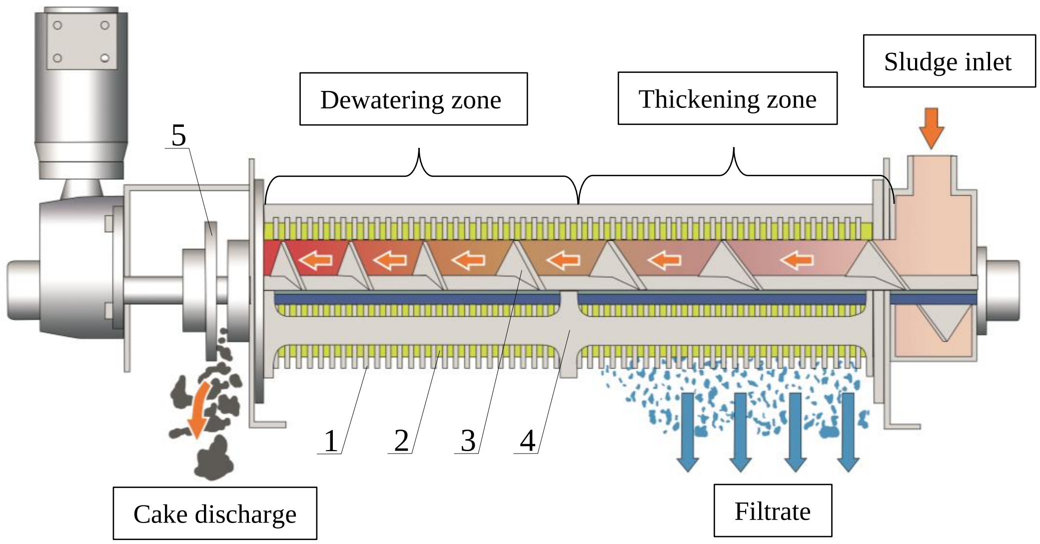


Fig. 3. Dewatering drum:
1 – Fixed disc; 2 – Moving disc; 3 – Screw; 4 – Support frame; 5 – Dam plate.

Each dewatering drum is equipped with individual rinsing water system. The system consists of water supply pipe (Fig. 4, pos. 1) with spray nozzles (Fig. 4, pos. 2), located above the dewatering drum. Each rinsing water system must be equipped with solenoid valve.

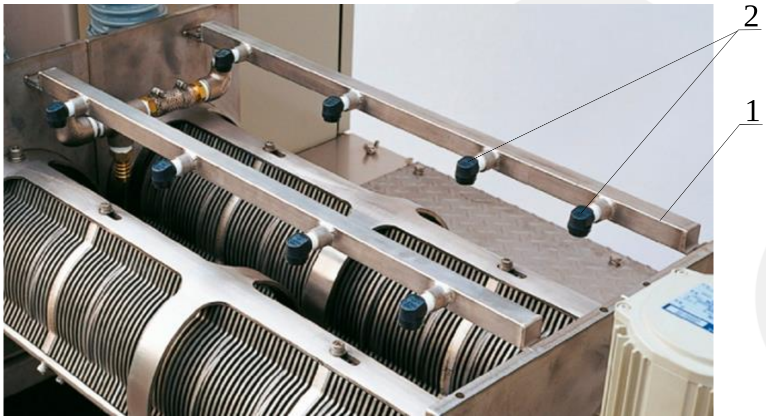


Fig. 3. Rinsing water supply system:
1 – Water supply pipe; 2 – Spray nozzles.

1.4. General operation description

Influent sludge from an external sludge storage tank is fed to the mixing tank by an influent sludge pump where it is mixed with flocculant (polymer) and optionally coagulant solutions and the flocs are formed.

Chemically conditioned sludge flows into the dewatering drum(-s) by gravity. The screw inside the drum rotates moving the sludge down the drum while released free water is drained through the gaps between the moving and fixed discs to the filtrate collection tray. The drum has a built-in thickening zone. Here, thickening of the sludge occurs and the majority of free water is released, mainly due to gravity. Filtrate from thickening zone may be reused. In the dewatering zone, the sludge is further dewatered due to the reduction of the screw flight pitch and the gap between the fixed and moving discs.

The dewatering drum is self-cleaning. Internal diameter of the moving discs is smaller than the screw diameter, therefore the internal radial surface of the moving discs is in constant contact with the flight lands of the screw. When the screw rotates, it pushes the moving discs resulting in their constant movement parallel to the fixed discs. This movement facilitates constant cleaning of the gaps between the discs and prevents their clogging.

The final dewatering occurs at the end of the drum where an adjustable, spring-loaded dam plate creates the pressure on the cake from the exit of the drum. The dewatered cake is discharged into either a container or a conveyor, while the filtrate is discharged in accordance with the process flow diagram of the wastewater treatment plant.

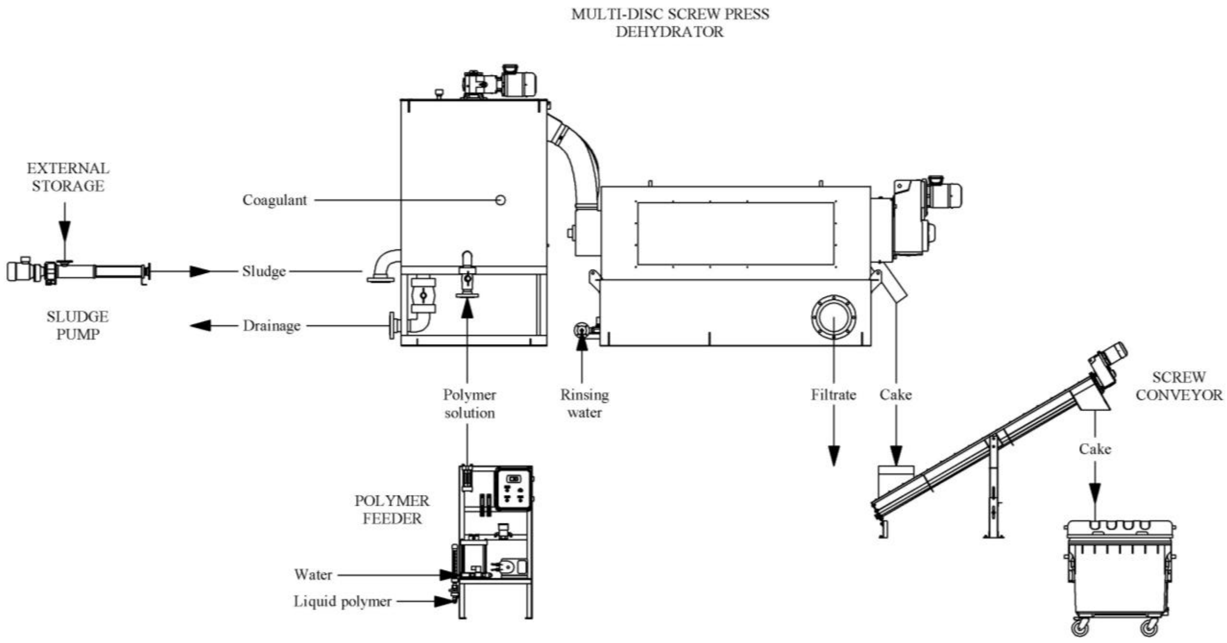


Fig. 4. Typical flow diagram of the dewatering system

1.5. Ancillary equipment

Polymer feeding system
Polymer feeding system is used for activation and dosing of polymer solution from a liquid concentrate.

Velodyne feeder

Feeder is specifically designed for systems that have low polymer feed rates. The feeder includes a small volume aging tank for improved polymer effectiveness (activation) and a progressive cavity pump.

The polymer metering pump can be controlled manually, paced externally, or controlled by an external 4-20 mA signal. A water flow switch turns off the polymer metering pump whenever the water flow drops below minimum. The system automatically restarts when adequate water flow resumes.

Motor-less mixing apparatus activates the polymer by injecting it into the water stream and immediately making the solution flow through a low-pressure high-energy polymer activation nozzle. The patented nozzle self-compensates for solution flow fluctuations. This assures that the polymer activation energy level remains adequate as solution flow changes.
An externally mounted polymer injection valve is accessible without disturbing the polymer activating apparatus. This is not included but can be supplied as part of the system.

Fig. 5. Polymer Feeder

Sludge feed pump

The sludge from an external sludge storage tank is fed to the dosing chamber of the screw press by an influent sludge pump. This is not included but can be supplied as part of the system.

Flow Meter

Feedback from a flow meter is used by the system's PLC to control the feed rate of polymer solution and sludge to the press's mixing tank and to display flow rate on the HMI. This is not included but can be supplied as part of the system.

Cake discharge

Dewatered cake is discharged through the discharge chutes of the screw press and then transported, on an incline, by a stationary shaftless screw conveyor. The conveyor will transport dry cake to a customer supplied dumpster. This is not included but can be supplied as part of the system.

INITIAL DATA

Type of influent sludge	Aerobically digested
Influent sludge DS concentration	0.5-2.0% (Average 1.45%)
Required hydraulic productivity per unit, max	65 gpm
Required DS productivity per unit, max	456 lb DS/h

2. COMMERCIAL PART

DESCRIPTION	PRICE PER UNIT
MULTI-DISC SCREW PRESS SYSTEM **Model: MDQ-352 CLS** **Quantity: 1 pc.** Hydraulic capacity: up to 65 gpm DS capacity: up to 456 lbDS/h Dimensions LxWxH: 13’ 10 13/16” x 4’ 10 1/4’’ x 6' 9 15/16" Dry weight: 5,440 lb Weight in operation: 9,030 lb Material of main construction: AISI 304 **Total installed power** (without additional equipment)**: 3.0 HP** **Agitator** Quantity: 1 pc. Material: AISI 304 **Agitator gearmotor** Manufacturer: NORD Quantity: 1 pc. Nominal power: 1 HP Ingress protection: IP 55 Material: painted cast iron **Dewatering drum(-s)** Quantity: 2 pcs. Inclination angle: 0° Nominal screw diameter: 14 in Drum discs thickness: 0.12 in Screw flights wear protection: welded FREA-METAL; Material: AISI 304 **Dewatering drum gearmotor** Manufacturer: NORD Quantity: 2 pcs.	**$266,375.00**

DESCRIPTION	PRICE PER UNIT
Nominal power: 1 HP Ingress protection: IP 55 Material: painted cast iron **Rinsing water system** Type of rinsing valve(-s): solenoid Manufacturer of rinsing valve(-s): GC valves or equal Quantity of rinsing water valves: 2pcs. Nominal rinsing water consumption: 11.6 gpm Nominal rinsing water pressure: 30-50 psi Typical sum consumption: 23.2 gph Manifold material: AISI 304 Rinsing nozzles material: PA **Level sensor** Manufacturer: Kobold or equal Model: NES-REAP1 Quantity: 1 pc. **Pressure sensor** Manufacturer: WIKA or equal Model: S-11 Quantity: 1 pc.	
CONTROL PANEL Number: 1 pc. Voltage: 480 VAC / 3 phases Frequency: 60 Hz Ingress protection: NEMA 4X Control system allows the system to operate in fully automatic mode and includes: • Allen Bradley PLC with I/O Modules • Ethernet IP SCADA connection using the second port of PLC • 15” Weintek HMI • Dewatering drum(s) VFD • Mixer VFD • External sludge feed pump control signals • Polymer unit control signals • Mixing tank automatic level control system Location: mixing tank mounted Quantity: 1 pc.	

DESCRIPTION	PRICE PER UNIT
SPARE PARTS	available upon request
SHIPPING Destination: F.O.B. Jobsite, CO	included
START-UP 1 trip 5 days	included
TRAINING During startup	included

2.1. Not included in price

- All civil engineering, erection of foundation and foundation works;
- Unloading of material and device at place of erection;
- Field wiring and conduits;
- Piping and ventilation;
- Macerator;
- Sludge pump;
- Magnetic flow meter;
- Polymer feeder;
- Cake conveyance;
- Laboratory fees;
- Material testing at the site;
- Provision of water and electrical power at the site;
- Additional lifting devices;
- Finishing coating at site;
- Painting of stainless-steel components;
- Interconnecting piping;
- Dumpster;
- Platform;

2.2. Commercial conditions

2.2.1. Proposal validity

This proposal is valid for a period of 60 days.

The stated price is based on shipment no later than one year from the date of this proposal. If the customer requests an extension of the delivery date or the warranty period beyond the terms specified in this offer, extended terms may be offered for an additional fee, which will be provided upon request.

2.2.2. Price policy

All taxes, duties, and/or other public expenses which could be levied are not included in the quoted prices and must be borne by the Customer.

2.2.3. Proposed terms of payment

Prices are based on the following payment terms:
30 % on receipt of purchase order
25 % upon submission of equipment approvals
25 % after completion of factory acceptance test (prior to shipment)
15 % upon completion of shipment
5 % upon completion of start-up not to exceed 45 days
Payment basis - net 30

2.2.4. Delivery

Shipping of the equipment is included with the offer stated above, all unloading or handling will be borne by the customer or designated contractor. Unloading on site must be carried out in a timely manner. The customer or designated contractor is responsible for providing necessary equipment to complete the unloading, which must be prepared prior to shipment.

Delivery time is approximately 16-20 weeks after technically and commercially clarified P.O.

The actual delivery date depends on the production workload and will be confirmed when placing the order.

2.2.5. Equipment warranty terms

ESMIL Corp. warrants the goods it supplied against defects in materials and workmanship for a period of twenty-four (24) months from the date of final acceptance of the equipment. ESMIL Corp. will either repair or replace, at its option, such component provided that written notice of any such defect or deficiency is given to ESMIL Corp. within 14 days after its initial discovery, including a description of the part, a description of the defect and date defect was discovered. ESMIL Corp. reserves the right to inspect said defect at the purchaser’s installation site or to have said defective part or parts returned to ESMIL Corp. via commercial freight carrier for inspection.

ESMIL Corp.’s warranty and obligations do not cover defects or deficiencies due to or arising out of normal wear and tear; improper or negligent handling, operation, maintenance, overloading or use; defective or improper premises or equipment installation; chemical, electro-chemical or electrical influences; weather or influences of nature; or alteration or repair performed by the Purchaser or third parties without ESMIL Corp.’s prior written consent.

2.2.6. Documentation

The first submittal is approximately 4-6 weeks after technically and commercially clarified P.O.
Submittals: electronic copy – 1 pc.
O&M: electronic copy – 1 pc.

2.2.7. Manufacturer rights

The manufacturer reserves the right to change technical characteristics of the equipment that may not influence technological parameters. Exact technical characteristics are determined in the contract of the equipment supply.

This offer is a confidential document and cannot be passed off to a third party or representative.

EKOTON guarantees the quality of services and works at all stages of the project, for the optimum combination of technical and technological solutions. We hope that our proposal meets your interests and needs!

Terms and conditions to be mutually agreed upon at the time of order.

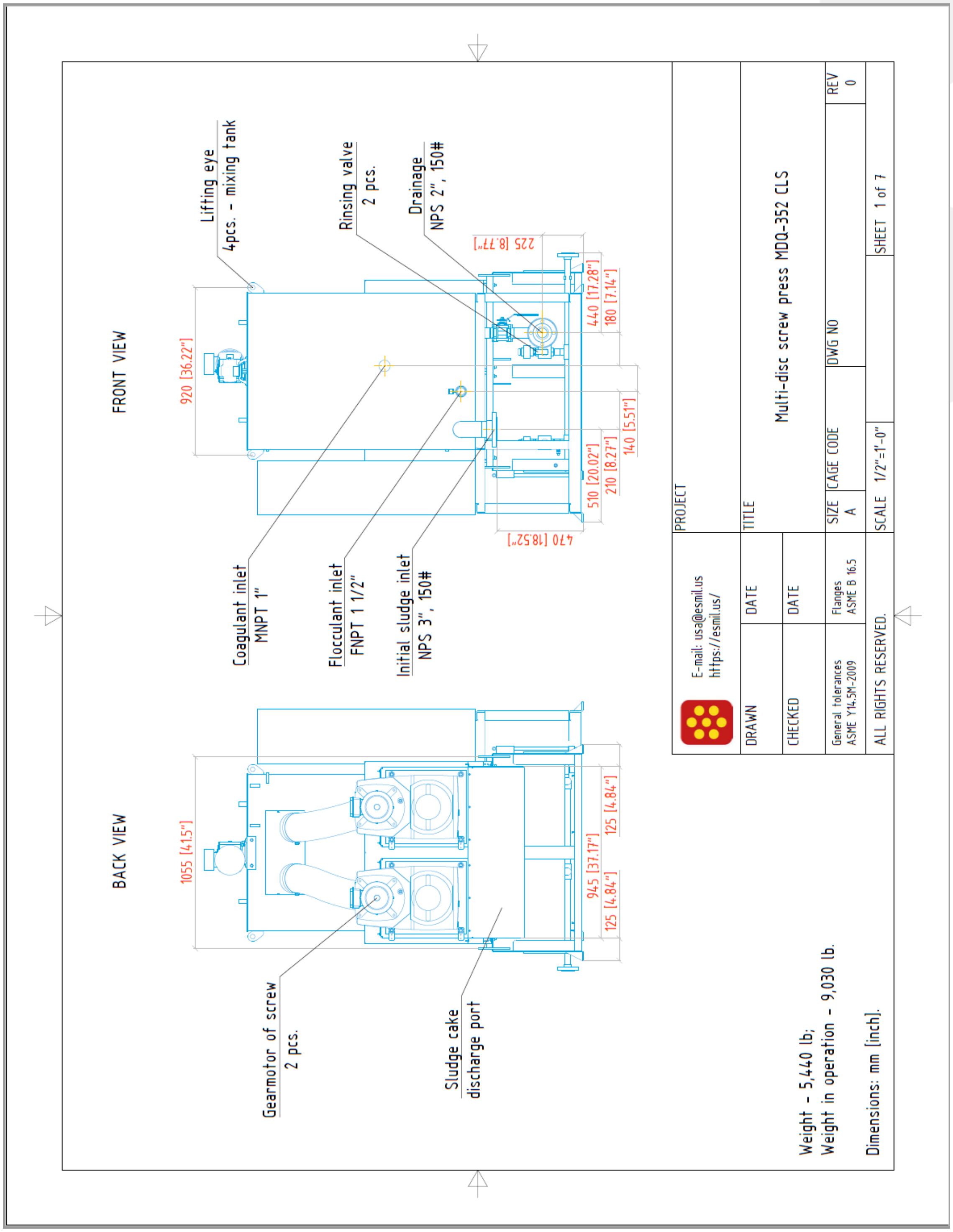
ATTACHMENTS

Attachment 1 – Drawings of the multi-disc screw press MDQ-352 CLS
Attachment 2 – Technical description of the multi-disc screw press MDQ-352 CLS
Attachment 3 – Pictures of the complex based on multi-disc screw press MDQ-354 CL

Best regards,

Randy Burns

Attachment 1 – Drawings of the multi-disc screw press MDQ-352 CLS



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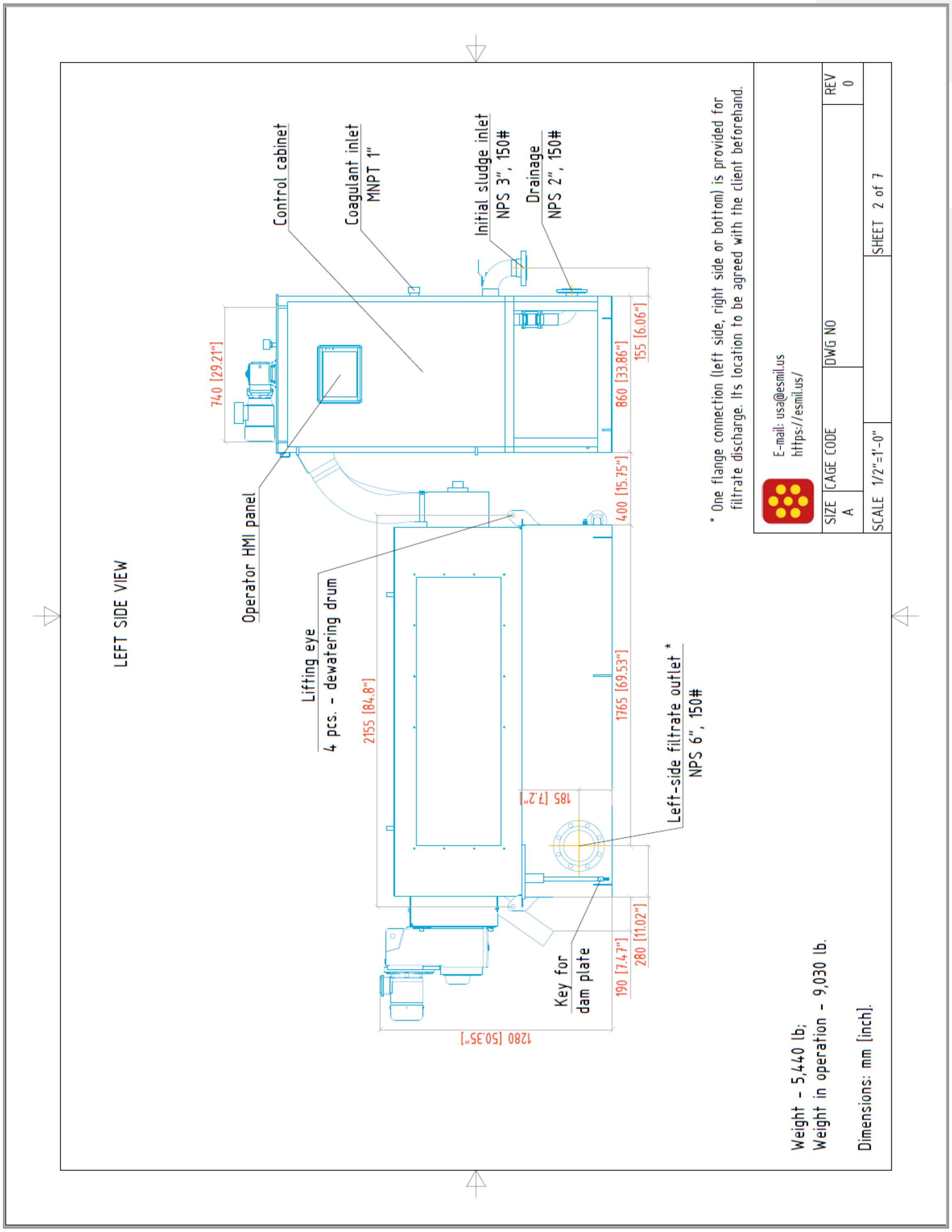

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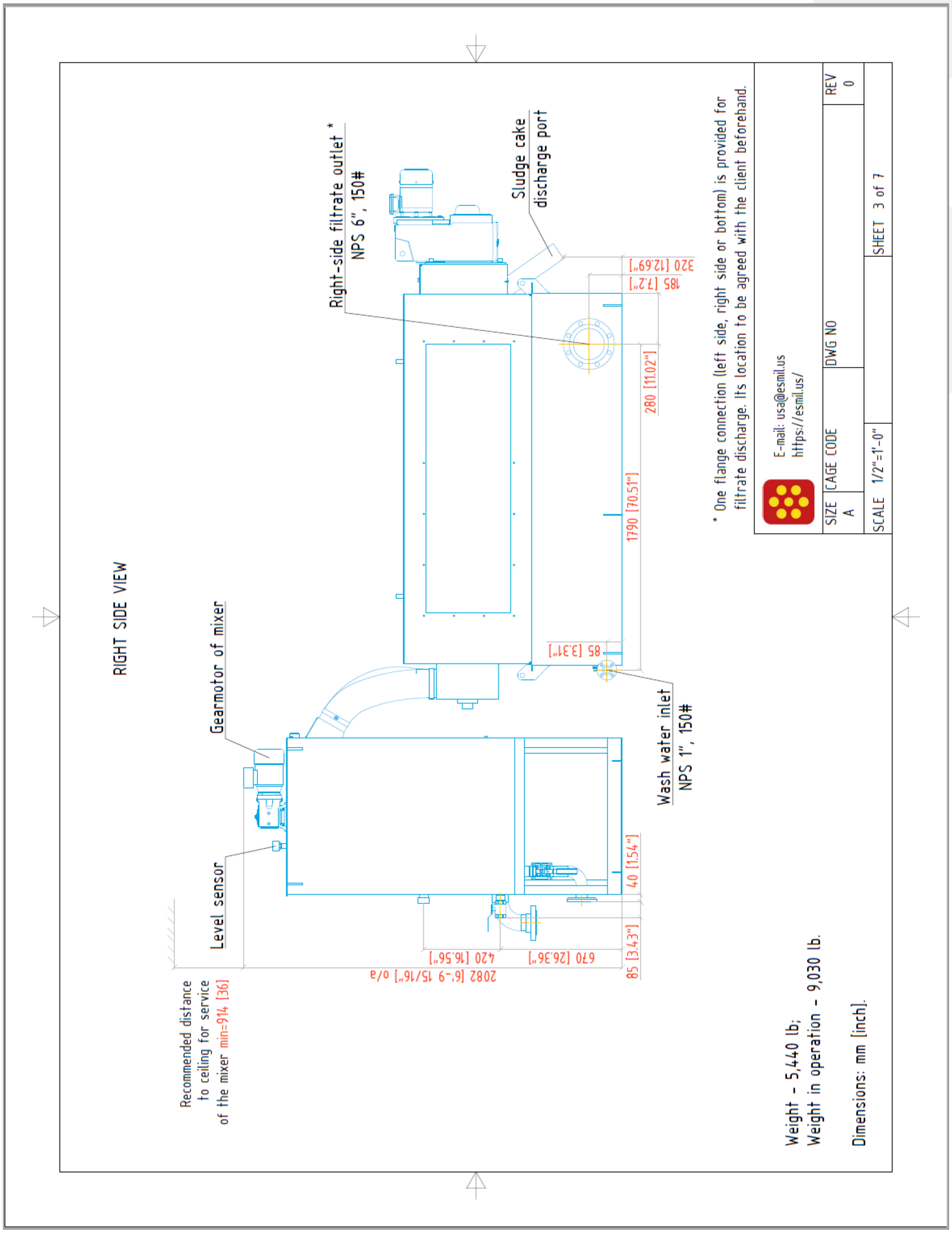

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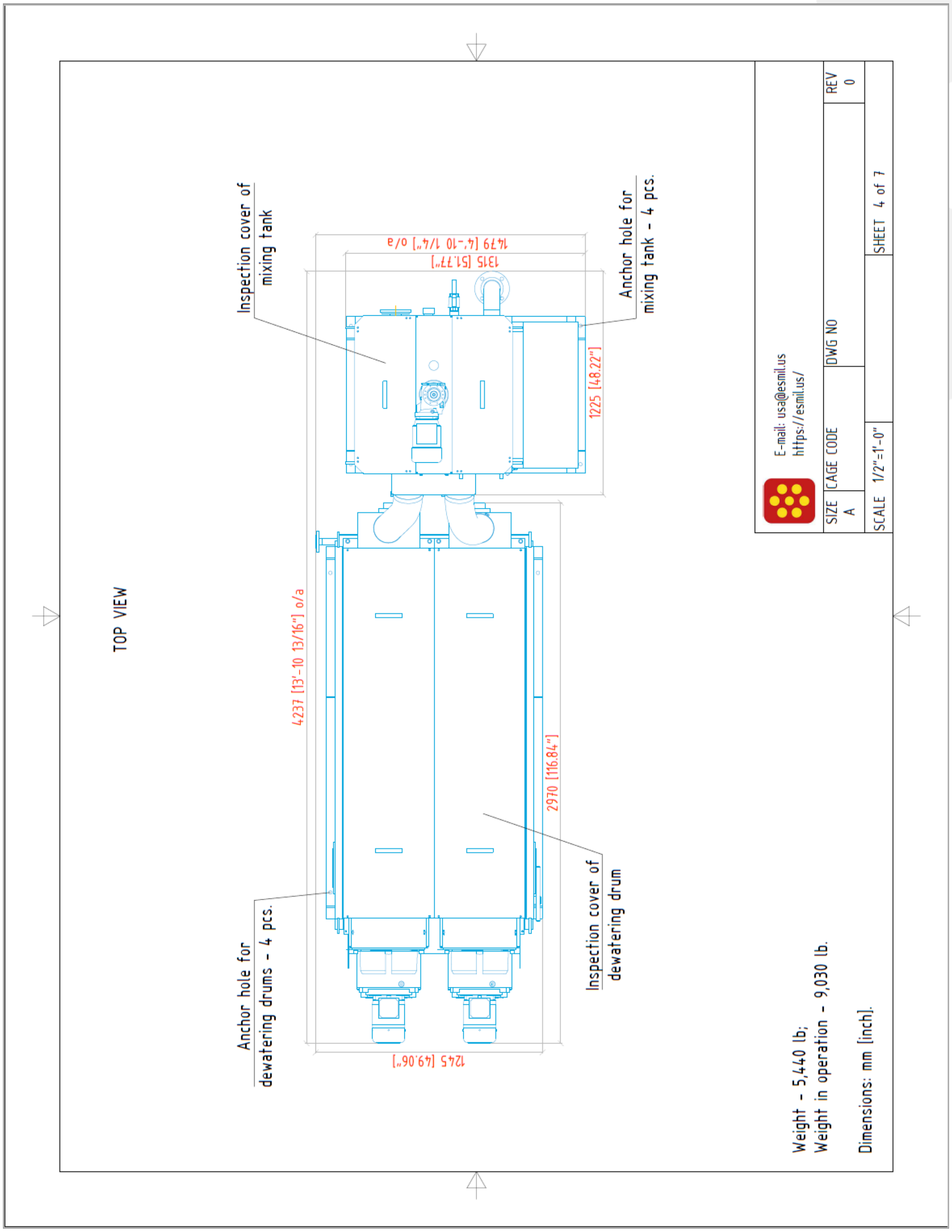

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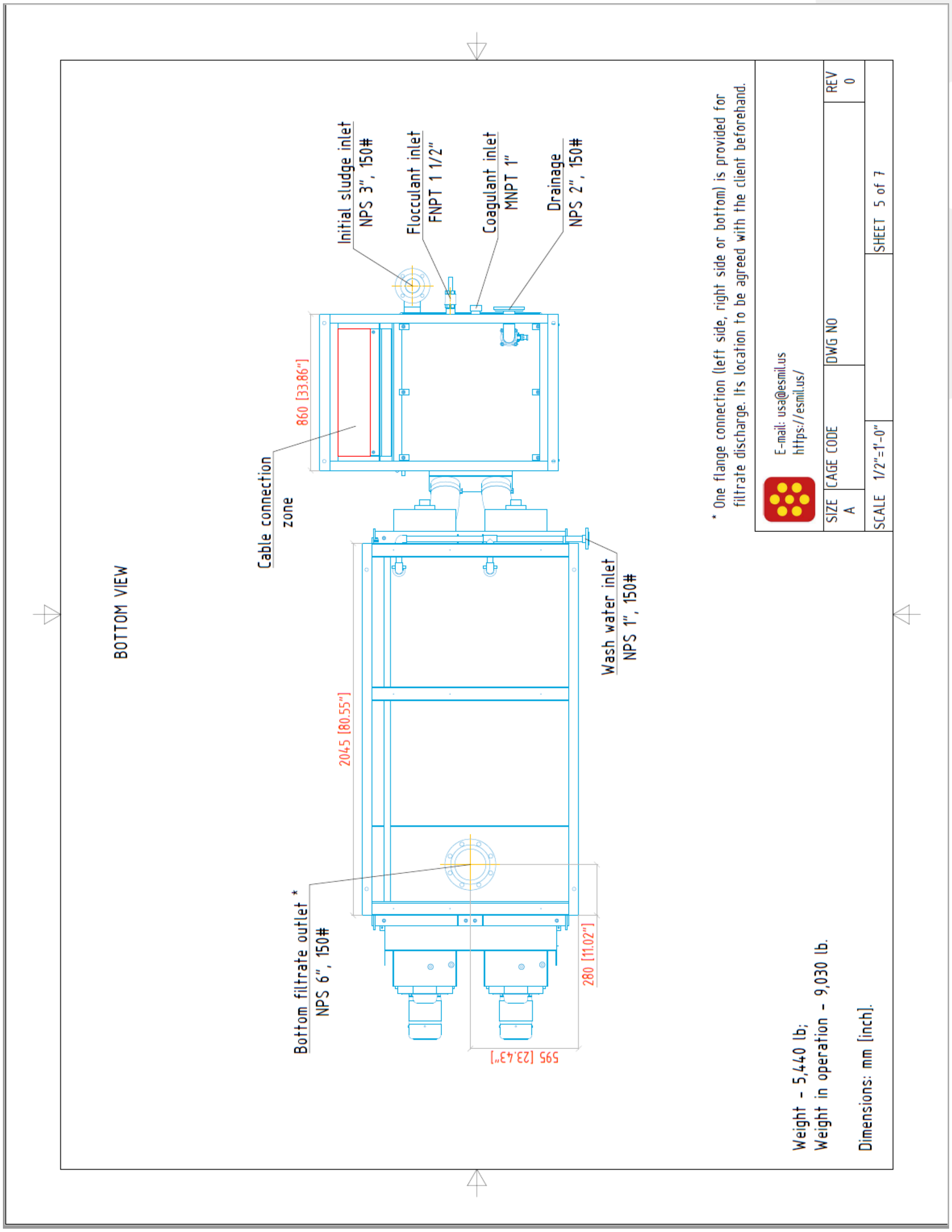

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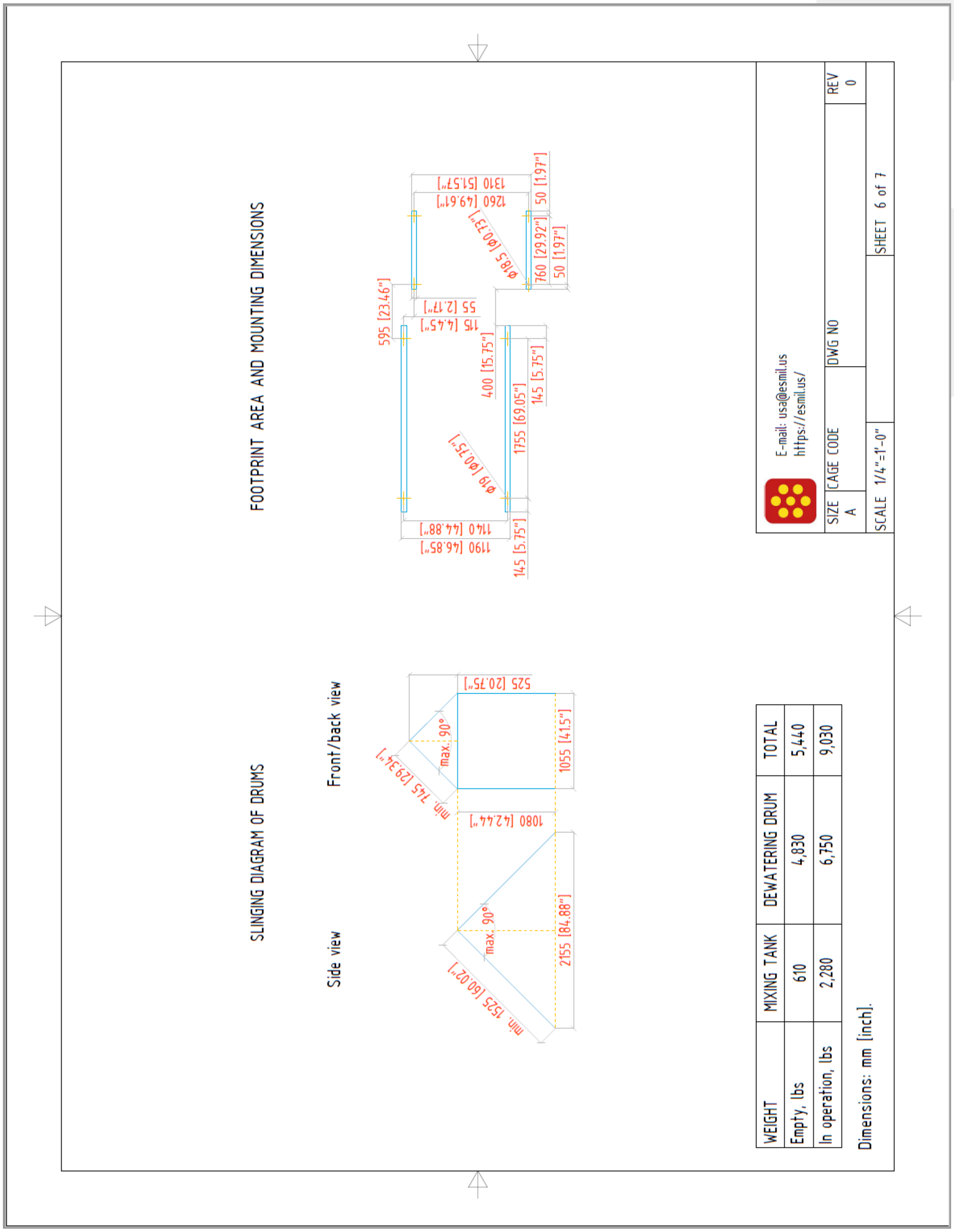

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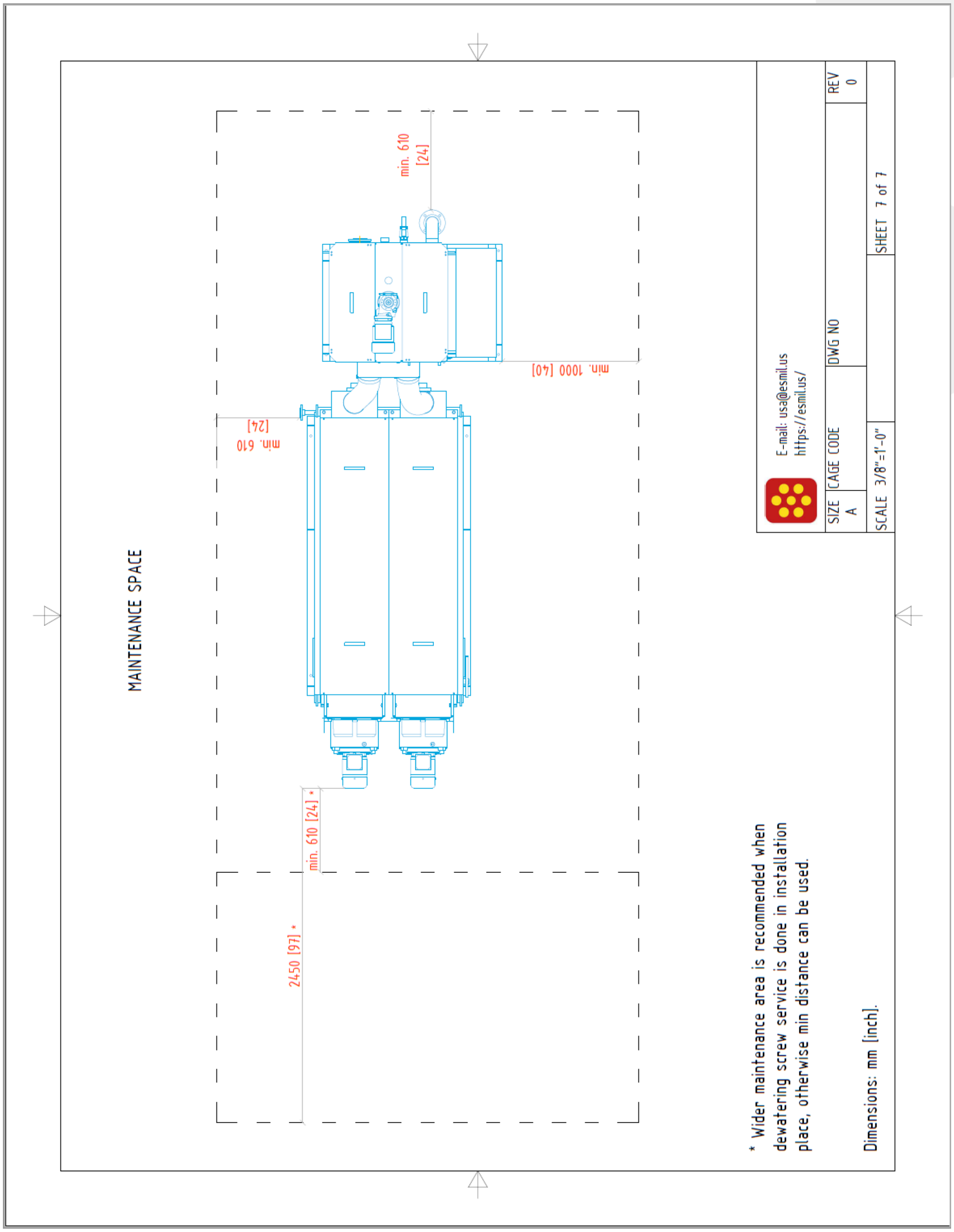


Attachment 2 – Technical description of the multi-disc screw press MDQ-352 CLS

Model		*MDQ-352 CLS*
Nominal screw diameter, in (mm) x qty. of screws, pcs.		*14 (350) x 2*
Drum discs thickness, in		*0.12*
Screw rotation speed, rpm		*0.4-2.7*
Liquid temperature, °F		*41…95*
Dimensions, ft-in	Length	*13'-10 13/16"*
	Width	*4'-10 1/4"*
	Height	*6'-9 15/16"*
	Cake discharge height	*1'-11/16"*
Dry weight, lb	Dewatering drums	*4,650*
	Mixing tank	*790*
Weight in operation, lb	Dewatering drums	*6,080*
	Mixing tank	*2,950*
Material of the main construction		*AISI 304*
Total installed power (without additional equipment), HP		*3*
Rinsing water		
Nominal consumption, gpm		*23.2*
Pressure, psi		*30-50*
Typical sum consumption, gph		*46.4*
Quantity of rinsing water valves, pcs.		*2*
Screw gearmotor		
Manufacturer		*NORD*
Quantity, pcs.		*2*
Nominal power, HP		*1*
Ingress protection, IP		*IP 55*
Explosion protection, EX		*No*
Agitator gearmotor		
Manufacturer		*NORD*
Quantity, pcs.		*1*
Nominal power, HP		*1*
Ingress protection, IP		*IP 55*
Explosion protection, EX		*No*
Control system		
Control panel		*Included*
Supply	Voltage, V	*480*
	Frequency, Hz	*60*
NEMA rating		*4X*
Explosion protection, EX		*No*

Attachment 3 – Complex based on multi-disc screw press MDQ-354 CL

ESMIL GROUP

Reference : Town of Lyon WWUP
Date: 17-Jun-24

Multi-Disc Screw Press Process Calculation

PREPARED FOR:	PREPARED BY:
Frank Henderson	ESMIL Corporation
Cogent	3939 Mogadore Ind PKWY
	Mogadore, OH 44260

US

Current operation conditions

DS concentration	1.40	%
Daily volume	19500	gal/day
Operation time	5	h/day
Operation days per week	3	day
Required productivity	65	gpm
Required DS productivity	456	lbDS/h

Selected model	MDQ-352CLS

Cake volume calculation by volume

Cake DS concentration (expected)	17	%
Cake volume per year	1240.35	yd^3/y
Cake volume per day	7.95	yd^3/day
Cake volume per hour	1.59	yd^3/h
Sludge volume reduction	12.14	times

Cake volume calculation by weight

Cake DS concentration	17	%
Cake mass per year	1045.33	ton/y
Cake mass per day	6.70	ton/day
Cake mass per hour	1.34	ton/h

Dry Solids volume calculation by weight

Dry Solids mass per year	177.71	dton/y
Dry Solids mass per day	1.14	dton/day
Dry Solids mass per hour	0.23	dton/h

Polymer consumption calculation

Polymer emulsion dose*	15.00	lb/dton
Daily polymer consumption	17.09	lb/day
Annual polymer consumption	1.33	ton/year

*Based on Dry Powder Polymer

Energy consumption

Unit name plate power	3	hp
System nominal power	2.25	hp
Daily energy consumption	8	kWh
Annual energy consumption	2181	kWh

SI

Current operation conditions

DS concentration	1.4	%
Daily volume	74	m^3/day
Operation time	5	h/day
Operation days per week	3	day
Required productivity	15	m^3/h
DS productivity	207	kgDS/h

Pilot Test Date	N/A

Cake volume calculation by volume

Cake DS concentration (expected)	17	%
Cake volume per year	948.31	m^3/y
Cake volume per day	6.08	m^3/day
Cake volume per hour	1.22	m^3/h
Sludge volume reduction	12.14	times

Cake volume calculation by weight

Cake DS concentration	17	%
Cake mass per year	948.31	mt/y
Cake mass per day	6.08	mt/day
Cake mass per hour	1.22	mt/h

Dry Solids volume calculation by weight

Dry Solids mass per year	161.21	dmt/y
Dry Solids mass per day	1.03	dmt/day
Dry Solids mass per hour	0.21	dmt/h

Polymer consumption calculation

Polymer emulsion dose	7.50	kg/dmt
Daily Polymer emulsion dose	7.75	kg/day
Annual Polymer emulsion dose	1.21	mt/year

Energy consumption

Unit name plate power	2.24	kW
System nominal Hp	1.68	kW
Daily energy consumption	8	kWh
Annual energy consumption	2181	kWh

Thetford Mines (Quebec)
June 17, 2024

JVA Consulting Engineers Inc.
Attn: Joe Ning
1319 Spruce Street
Boulder, CO 80302

Subject: Lyons, CO WWTP - Dewatering Equipment Budgetary Proposal

Further to your recent request to our local representative, Coombs-Hopkins Company, we are pleased to submit our budgetary proposal for the supply of sludge dewatering equipment and services for your project.

a) Sludge type and quantity

- Type: Aerobically digested sludge
- Total solid content of sludge: 0.5% to 2.0%
- Sludge Quantity: 470 lbs/hour

b) Anticipated performance (*)

- Throughput: 70 lbs/hour per channel
- Cake dryness: 16%
- Polymer use: 20 lbs/dry ton
- Capture rate: 93%

(*) Anticipated production rate is based on past experience with similar types of sludge.

To execute the above performance, the following equipment and service are suggested:

One (1) Rotary Press Model 8-900/8000CV, Eight-channel unit

Equipment and service

- One (1) Rotary Press model 8-900/8000CV
- One (1) Flocculator
- One (1) Lot of piping between flocculator and rotary press, c/w sludge sampler
- One (1) Sludge flowmeter
- One (1) Polymer flowmeter
- One (1) Filtrate collector pipes
- One (1) Air Compressor
- Eight (8) Cake Chutes
- Eight (8) Wash water solenoids for automatic wash sequence
- Eight (8) Cake sensors for safe unattended operation

Subject: Lyons, CO Budgetary Proposal (Cont'd)

- Two (2) 2-way air-actuated valves for automatic sludge re-circulation
- One (1) Control Panel c/w PLC Allen-Bradley CompactLogix Series L10 & Allen-Bradley PanelView Plus 10" touch screen HMI, and VFD's for both rotary press and flocculator
- On site start-up, commissioning and training assistance for a total of 64 man-hours, including 2 trips to the jobsite.
- One lot of Submittal and O&M

Price: US$570,000.00

The above suggested equipment is illustrated on drawing no. B-C-40888 Rev. 00.

GENERAL NOTES:

1. Our budgetary price does not include the following items:
    a. Unloading and installation of the equipment on site.
    b. Sludge pump and its VFD
    c. Dilution Polymer system
    d. Conveyor (if required)
    e. Air compressor

2. Budgetary price is valid for a period of (90) days.

3. Budgetary price is Ex-works Thetford Mines (Quebec) Canada.

4. Standard Terms of Payment:
    - 15% of the total contract price: net 30 days after shop drawing submittal
    - 80% of the total contract price: net 30 days upon delivery
    - 5% of the total contract price: net 30 days upon successful start-up
    - No retainage on the above

5. Equipment delivery:
    - Shop drawings: (6) to (8) weeks after Purchase order acceptance.
    - Equipment: (25) to (27) weeks after drawings approval.

6. Cake Discharge Chutes will be supplied as per the Fournier Industries standard. The horizontal conveyor has to be designed to fit those standard chutes. Attachment detail will be supplied with the shop drawings submittals.

Subject: Lyons, CO Budgetary Proposal (Cont'd)

Should you need any specific arrangement or more detailed drawings, we will be pleased to provide them upon request.

Please do not hesitate to contact us for any additional information you may require. Hoping satisfaction, please accept our best regards.

FOURNIER INDUSTRIES INC.

SO/

Steven Oftelie
Regional Sales Manager

Encl. Appendix A - System Description and Features
Drawing

c.c.: Mr. Jason Morgan, Coombs-Hopkins Company
Mr. Mathieu Ouellette, P. Eng., Rotary Press Div., Fournier Industries inc., Ph. (418) 423-4241 X 3457

Subject: **Lyons, CO Budgetary Proposal (Cont'd)**

APPENDIX A

System Description and Features

The Rotary Press sludge dewatering equipment is an innovative technology manufactured by Fournier Industries Inc. The technology was introduced into the municipal market in Canada in the late 1980's and has been actively implemented in the municipal waste water treatment market in the United States since 1999.

The Rotary Press technology features several distinct advantages over conventional dewatering technologies:

- High cake dryness and solids capture rate.
- Simple, fully automated operation suitable for continuous and remote operation.
- Totally enclosed which controls odours and minimizes potential for operator exposure to pathogens.
- Slow rotating (3 RPM max.) and high energy efficiency.
- Low footprint reduces capital building costs - Minimal wash water requirements.

The Rotary Press technology involves the use of modules called "dewatering channels", composed of two (2) parallel screens, separated by spacers. Sludge is fed into the rectangular channel and rotated between the two (2) revolving stainless steel chrome plated screens.

The filtrate passes through the screens as the flocculated sludge advances within the channel. The sludge continues to dewater as it travels around the channel, eventually forming a cake near the outlet side of the press. The frictional force of the slow moving screens, coupled with the controlled outlet restriction, results in the extrusion of a very dry cake.

Subject: **Lyons, CO Budgetary Proposal (Cont'd)**

The Rotary Press technology presents multiple outstanding features compared to conventional dewatering devices, as outlined below:

Environmental Friendliness

- Process is totally enclosed, dramatically reducing odours, Volatile organic compounds (VOCs) and pathogen dispersion.
- Operations are quiet.
- Wash water usage is limited to 250 gallons per day, per dewatering channel. No wash water pump usually needs to be dedicated to the Rotary Press.
- Power usage is low. On normal operation on municipal biosolids, power consumption is typically 4 to 10 kW-hr/dry ton of biosolids.
- Cake dryness is high, resulting in less transportation and disposal.

Modularity

- Machine is composed of several modular units – the dewatering channels – that are independent and interchangeable.
- Different outlet pressures can be set on the different channels, providing in time data on resulting cake dryness and throughput.
- Each channel can be washed separately.
- It is the only continuous operation dewatering device that can be made expandable. An oversized unit can be fitted with supplementary dewatering channels in order to increase its capacity.

Subject: **Lyons, CO Budgetary Proposal (Cont'd)**

Safety & Health

- Noise is well under protection thresholds.
- No exposed rotating parts.
- No operator exposure to pathogenic micro-organisms or virus in aerosols from traditional technologies.
- Low-energy dewatering removes all of the free water without cycling the cell walls; re-growth and re-activation is minimal when compared with centrifugation.
- Cleanliness prevents slippery floors.

Low Operation Cost

- Dewatering operations are fully automated and operator assistance is limited to start-up, mainly in order to select the optimum polymer dosage.
- Polymer mixing is external to the machine and floc quality can be easily verified by the operator, resulting is optimized polymer usage.
- Power usage is low. On normal operation on municipal biosolids, power consumption is typically 4 to 10 kW-hr/dry ton of biosolids.

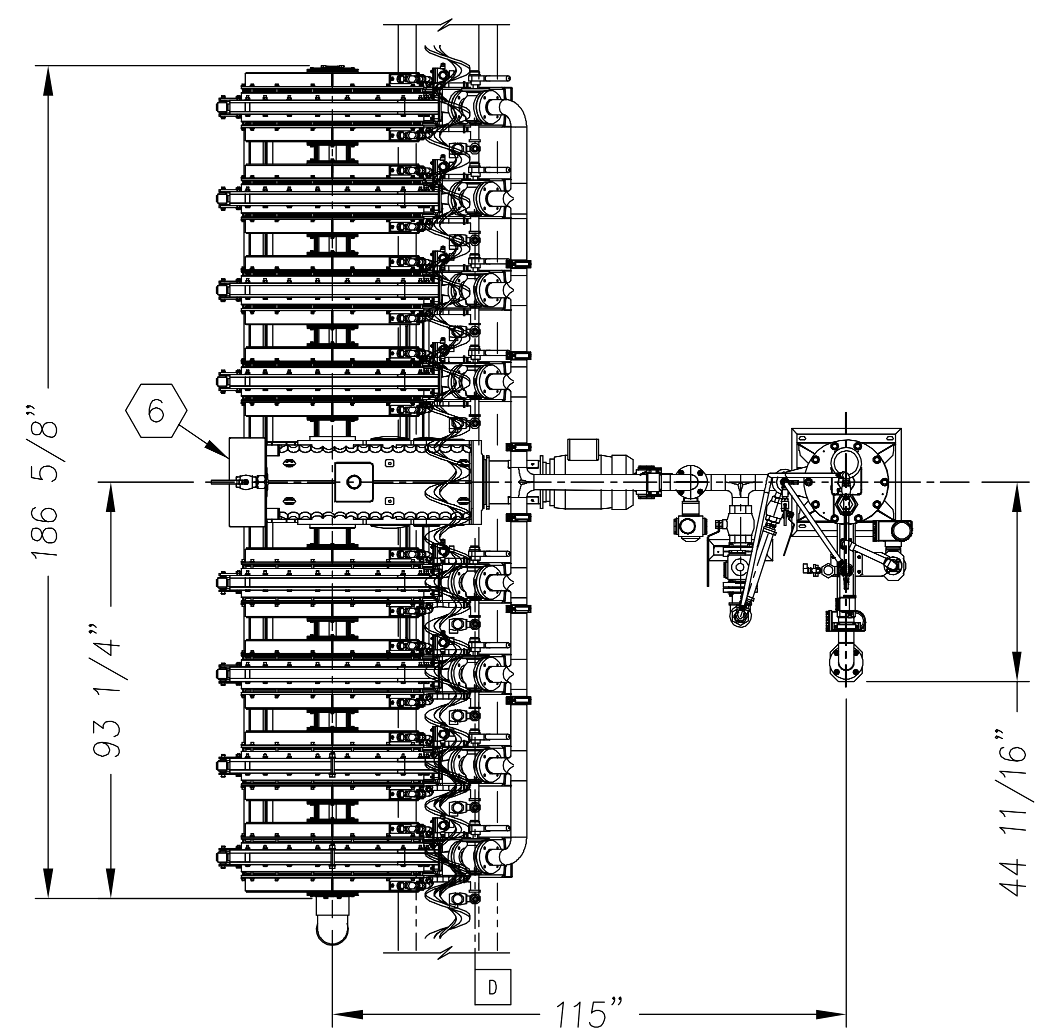
Low Maintenance Cost

- Robust construction.
- Limited number of mechanical parts.
- Slow rotation speed.
- Results in the lowest maintenance cost of any type of dewatering equipment.
- Reduced corrosive exposure to nearby equipment.
- Automated 5 minutes/day self-cleaning cycle.

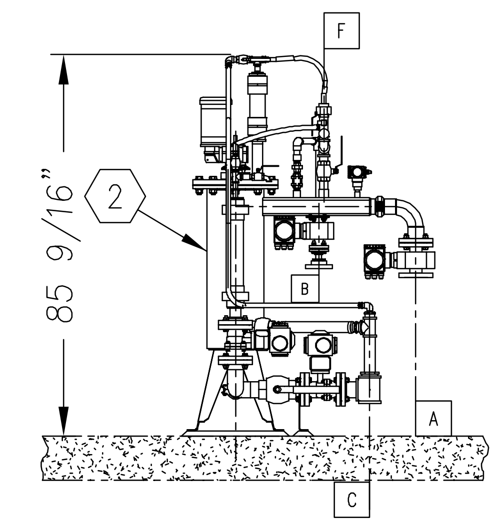
ITEM	REF.	QTY.	DESIGNATION	MAT.	DIM.	NOTES
1		1	ROTARY PRESS MODEL 8-900/8000CV			ESTIMATED WEIGHT: 18820 LBS (8 CHANNELS INCLUDED)
2		1	FLOCCULATOR			ESTIMATED WEIGHT: 830 LBS
3		1	FLOCCULATED SLUDGE SAMPLER			
4		1	MANIFOLD			ESTIMATED WEIGHT: 470 LBS
5		8	CAKE CHUTE			ESTIMATED WEIGHT: 10 LBS/Un.
6		1	JONCTION BOX			

INTERFACE BETWEEN PIPING OF ROTARY PRESS AND CUSTOMER PIPING (PER ROTARY PRESS)

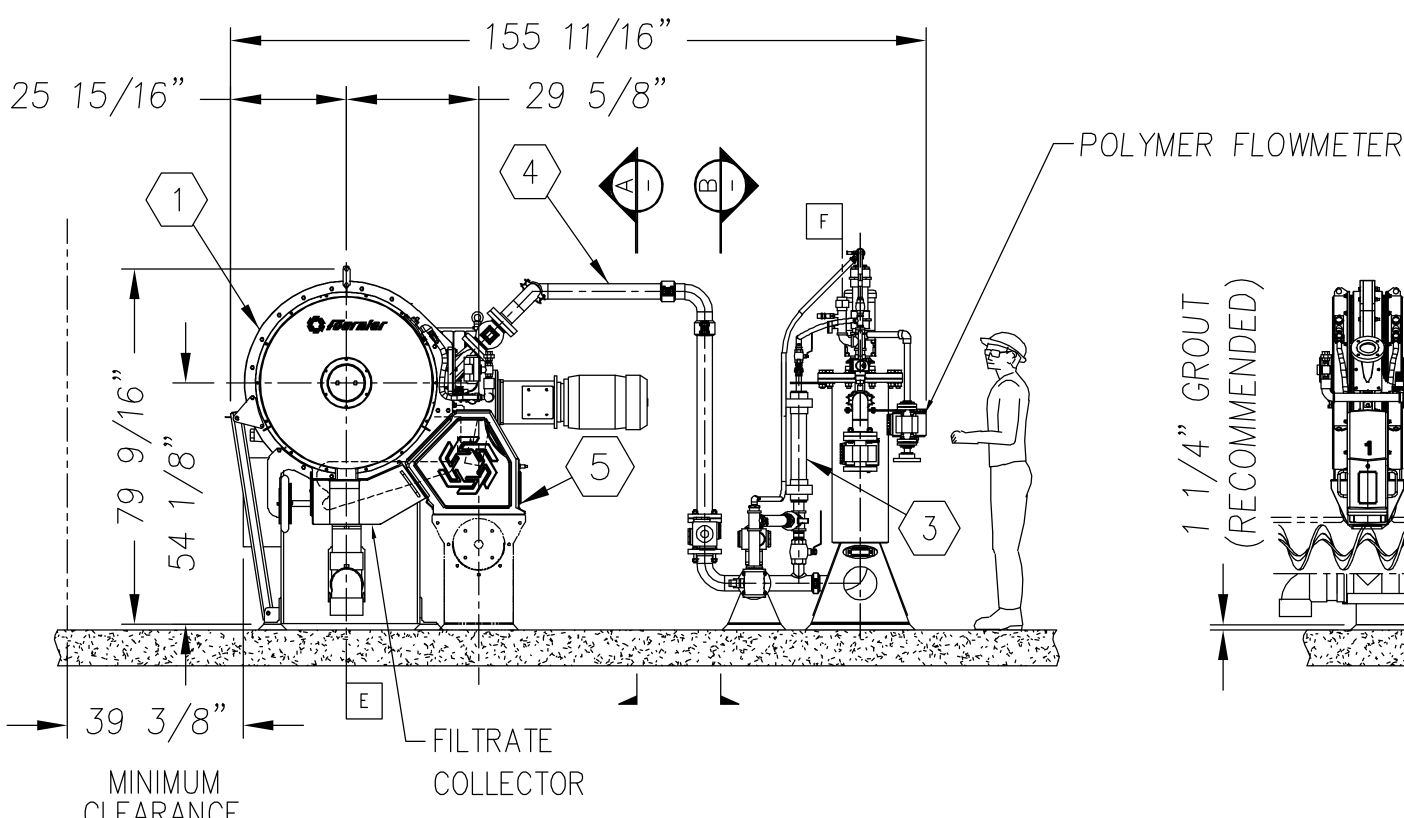
- A SLUDGE INLET ø3" (FLANGE)
- B POLYMER INLET ø2" (FLANGE)
- C SLUDGE RECIRCULATION OUTLET ø3"-NPT
- D WASH WATER INLET ø1"-NPT (8 PLACES) (ROTARY PRESS)
- E FILTRATE OUTLET ø6" PIPE
- F WASH WATER INLET ø1 1/2"-NPT (FLOCCULATOR)



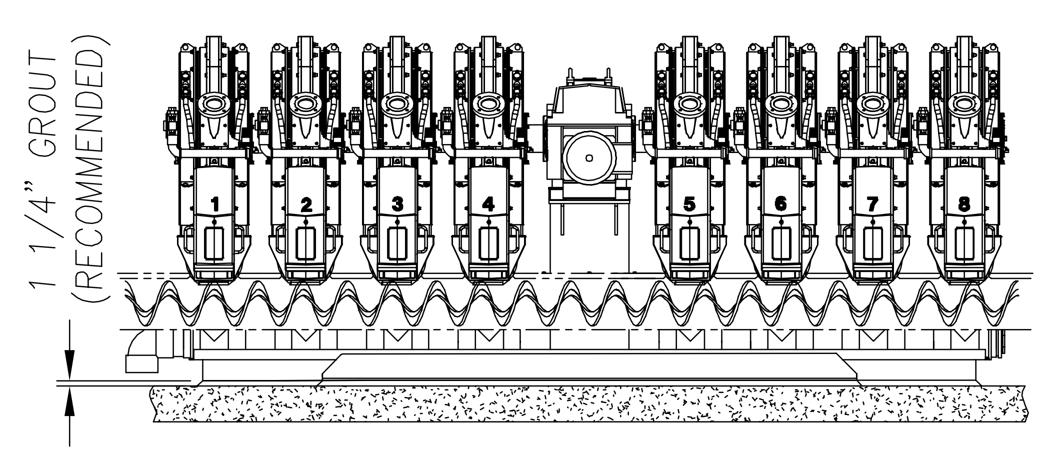
PLAN VIEW



SECTION B



SIDE VIEW



SECTION A

DIMENSIONS ARE GIVEN FOR INFORMATION ONLY. FINAL DIMENSIONS AND LAYOUT TO BE CONFIRMED BY CERTIFIED DRAWINGS.

ESTIMATED TOTAL WEIGHT (EQUIPMENT): 20200 LBS
ESTIMATED SLUDGE WEIGHT: 732 LBS

fournier

DEWATERING SYSTEM
ROTARY PRESS 8-900/8000CV
GENERAL ARRANGEMENT

Echelle/Scale 1:45	Des./By: M.CHRÉTIEN	Dossier/File	Pièce no/Part no. R-C-40888	REV. 00
Date 28-11-2016	Ver.: / App.:			

INPUT POWER / CONTROL PANEL INPUT FUSES CALCULATION

Voltage used 480V

	Rotary press model 1-900/1000CV	Rotary press model 2-900/2000CV	Rotary press model 3-900/3000CV	Rotary press model 4-900/4000CV	Rotary press model 5-900/5000CV	Rotary press model 6-900/6000CV	Rotary press model 7-900/7000CV	Rotary press model 8-900/8000CV
Security factor (1,75 X Highest motor FLA)	2,325	3,6	5,7	5,7	8,25	8,25	10,5	10,5
Sub total	2,325	3,6	5,7	5,7	8,25	8,25	10,5	10,5
Motor description	Motor HP / Motor FLA	Motor HP / Motor FLA	Motor HP / Motor FLA	Motor HP / Motor FLA	Motor HP / Motor FLA	Motor HP / Motor FLA	Motor HP / Motor FLA	Motor HP / Motor FLA
Rotary press	1,5 / 3	3 / 4,8	5 / 7,6	5 / 7,6	7,5 / 11	7,5 / 11	10 / 14	10 / 14
Flocculator	1 / 2,1	1 / 2,1	1 / 2,1	1 / 2,1	1 / 2,1	1 / 2,1	1 / 2,1	1 / 2,1
Transformer	3,1	3,1	3,1	3,1	3,1	3,1	3,1	3,1
Sub total	8,2	10	12,8	12,8	16,2	16,2	19,2	19,2
Grand total	11 A	14 A	19 A	19 A	24 A	24 A	30 A	30 A
Fuses/Input power to be used	**10**	**10**	**15**	**15**	**20**	**20**	**30**	**30**

If air compressor to be connected to Rotary press control panel

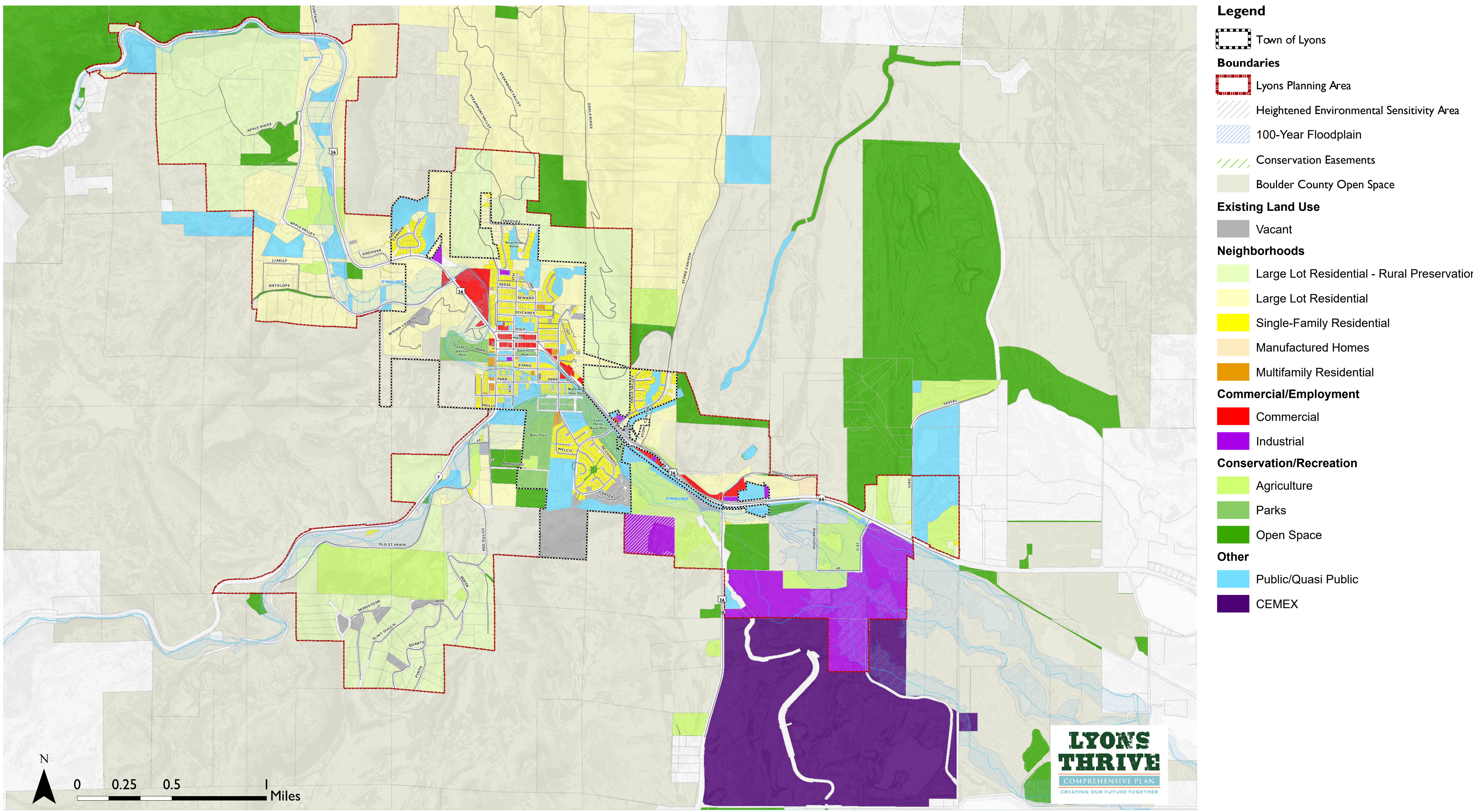
	1-900/1000CV	2-900/2000CV	3-900/3000CV	4-900/4000CV	5-900/5000CV	6-900/6000CV	7-900/7000CV	8-900/8000CV
Air compressor	3 HP / 4,8	3 HP / 4,8	3 HP / 4,8	3 HP / 4,8	3 HP / 4,8	3 HP / 4,8	3 HP / 4,8	3 HP / 4,8
Total Amps	16	19	24	24	29	29	35	35
Fuses/Input power to be used	**15**	**15**	**20**	**20**	**25**	**25**	**35**	**35**

If pumps (polymer or sludge) or conveyors or any other equipement to be connected to the rotary press control panel, the calculation has to be redone according to all equipements.

Rev 03
9-6-2022
Vincent Gilbert

APPENDIX B – FIGURES

Existing Land Use



Town of Lyons WWTF Updated Floodplains

8/11/2024, 5:58:27 PM

Flood Hazard Areas (Boulder County)

- Floodway
- 100-Year Floodplain
- 500-Year Floodplain
- Building Footprints
- Boulder County Parcels
- Boulder County Municipalities

1:2,866

0 0.03 0.06 0.11 mi

0 0.04 0.09 0.17 km

Maxar, Microsoft, Esri, HERE, Garmin, iPC

APPENDIX C – DESIGN CALCULATIONS

DIGESTER SIZING CALCULATIONS FOR 1,900 PPD

Variable	Description	Value	Unit
Step 1: Determine Influent Flow to Digester			
MMF	Permitted influent capacity	253,000	gpd
BOD_{avg}	Average BOD Concentration	900	mg/L
Y	Yield (lb VSS produced/lb BOD removed)	0.600	lb VSS/lb BOD
BOD_{INF_Mass}	Mass of influent BOD	1,900	lb BOD/day
	Do you know the waste stream (quantity and quality) to the digester?	No Use the 'Digester Influent' tab to calculate the waste stream in QINF(stream to the digester (ex. If you are designing a new plant and nee from the new secondary treatment	
Q_{INF}	Influent Flow to Digester	0 0	gpd cfd
$Q_{INF(calc)}$	Influent Flow to Digester	22,926 3,065	gpd cfd
X_{INF}	Influent solids concentration	7,000	mg/L
$X_{INF\text{-}\%}$	Influent solids concentration as percent	0.70%	-
SG_{INF}	Specific Gravity of the Digester Influent	1.01	-
M_{INF}	Mass of Solids in Influent	0	lb solids/day
$M_{INF\ (calc)}$	Mass of Solids in Influent	1,338	
P_{VSS}	Volatile fraction of digester solids	85.0%	-
M_{VSS}	Mass of Volatile Solids in Influent	0	lb VSS/day
$M_{VSS(calc)}$	Mass of Volatile Solids in Influent	834	lb VSS/day
P_{DIG}	Percent solids in digester	100.0%	-
X_{DIG}	Concentration of solids in the digester under complete mix conditions	7,000	mg/L
$X_{DIG\text{-}\%}$	Concentration of solids in the digester under complete mix conditions as percent	0.700%	-
SG_{DIG}	Specific Gravity of the Digester (Complete Mix Conditions)	1.01	-
$C_{SLUDGE\text{-}\%}$	Digester effluent concentration as percent	1.50%	-
C_{SLUDGE}	Digester effluent concentration	15,000	mg/L
Step 2: Determine Decant Flow and WAS Flow Leaving Digester			
M_{INF}	Mass of solids to digester	1,338	lb/day
M_{VSS}	Mass of volatile suspended solids in feed flow	834	lb/day
% RED	Volatile Solids Reduction	40.0%	-
M_{RED}	Mass VSS Reduced	333.4	lb/day
M_{SLUDGE}	Mass of dry solids in sludge	1,005	lb/day
SG_{SLUDGE}	Specific gravity of digester sludge	1.02	-
Q_{SOLIDS}	Flowrate of solids leaving digester	7,915	gpd
	Do you plan to decant daily using the influent volume each day, or do you plan to decant a set height?	Decant Daily	
	What height do you want to decant?	4	ft
V_{DECANT}	Daily Decant Volume	22,926	gal

V_{DECANT}	Calculated Decant Volume based on Height	115,012	gal
t_{DECANT}	Decant Time	12.0	hr
Q_{DECANT}	Decant Flow	31.84	gpm
Q_{DECANT}/MMF	Decant Flow to Influent Flow Ratio	18.12%	-
Step 3: Size Digesters based on Metcalf & Eddy Eqn 13-25			
Y	fraction infl BOD_5 consisting of primary sludge	0.000%	-
S_i	influent BOD_5	0.000	mg/L
K_{20}	BOD rate constant at 20°C	0.075	/day
θ	Temperature coefficient	1.135	-
K_d	BOD rate constant at temperature T	0.0398	/day
P_{VSS}	Volatile fraction of digester suspended solids	0.850	-
T	Minimum temperature	15.0	ºC
SRT	Solids retention time	60.0	day
DD_{min}	Minimum Degree Days	900	°C day
V_{MIN_REQ}	Required volume of aerobic digester	60,678	ft^3
		453,872	gal
Step 3b: Mass Rate Check on Volume			
Q_{SOLIDS}	Flowrate of solids leaving digester	7,915	gpd
SRT	Required SRT Per EPA Regulations	60.0	day
V	Volume required based on SRT and mass of solids leaving the digester	474,885	gal
Step 4: Actual Digester Dimensions			
SWD	Side Water Depth	16.0	ft
FB	Freeboard	1.50	ft
D	Total Depth	17.5	ft
L	Length	62.0	ft
W	Width	62.0	ft
D/W	Total Depth to Width Ratio	0.282	-
V_{DIG}	Total Digester Volume	61,504	ft^3
		460,050	gal
	Does it meet required volume according to Step 3?	Yes	-
	Does it meet required volume according to Step 3b?	No	-
SF_V	What is the safety factor selected?	1.0	-
M_{VSS}/V_{actual}	Volatile solids loading rate	0.01	-
V_{actual}	Total Digester Volume	460,050	gal
		61,504	ft^3
SRT	Solids retention time	58.1	day

Step 5: Check Digester Sludge Age & VSS Reduction

SRT	Solids Retention Time	62.5	day
T_{D_MIN}	Minimum digester temp during winter	15.0	°C
SRT * T_{D_MIN}	Sludge Age x Temperature	938	°C day
VR	Anticipated VSS reduction	40.0%	-
$DD_{40\%}$	Requirement for 40% VSS reduction	550	°C day
SRT_{15}	Min SRT at 15 deg°C	36.7	day
V_{MIN_check}	Minimum volume for required °C-days	375,110	gal
V_{actual}	Actual volume	460,050	gal
	Is the proposed digester volume greater than the minimum volume required for 550 deg°C-days?	Yes	-

Step 6: Summary of calculated volumes

V_{actual}	Actual volume	460,050	gal
V	Required volume of aerobic digester	453,872	gal
V	Min digester volume for 550°C-days	375,110	gal
V	Volume required based on SRT and mass of solids leaving the digester	474,885	gal
	Does the actual volume exceed the other methods of calculating volume?	No	

Step 7: Determine aeration requirements in SCFM (MIXING ONLY)

a_{MIX}	Aeration requirement for mixing	20.0	scfm/1000 ft^3
V_{actual}	Total Digester Volume	460,050	gal
		61,504	ft^3
Q_{MIX_AIR}	Total Air Required	1,230	scfm

Step 8.1: Convert SCFM to ACFM for SUMMER CONDITIONS for Digester (MIXING ONLY)

		68.0	°F
T_S	Standard Temperature	528	°R
		293	°K
		75.0	°F
T_A	Actual Temperature at location	535	°R
		297	°K
P_S	Standard Pressure	14.7	psia
z_b	Elevation of site	5,370	ft
P_B	Atmospheric Pressure at site	12	psia
P_Δ	Pressure Drop across filter/silencer	0.300	psi
P_A	Actual pressure at blower	11.8	psia
RH_S	Standard relative humidity	36.0%	-
RH_{A_summer}	Actual relative humidity at location	70.0%	-
PV_S	Saturated vapor pressure of water at T_s	0.339	psi
H_{VAP}	Heat of Vaporization	40,700	J/mol
R	Rankine constant	8.31	J/(mol K)
PV_{A_summer}	Saturated vapor pressure of water at Actual Temp	0.422	psi
$ACFM_{summermix}$	Actual blower discharge (summer)	1,581	acfm

Step 8.2: Convert SCFM to ACFM for WINTER CONDITIONS for Digester (MIXING ONLY)

		0.000	°F
T_A	Actual Temperature at location	460	°R
		255	°K
RH_{A_winter}	Actual relative humidity at location	70.0%	-
PV_{A_winter}	Saturated vapor pressure of water at T_A	0.0287	psi
$ACFM_{wintermix}$	Actual blower discharge (winter)	1,328	acfm

Step 9: Check Air Required for Oxygen Requirements

M_{RED}	Mass VSS Reduced	333.4	lb/day
a_{REQ}	Aeration requirement for oxidizing biomass	2.30	lb O_2 /lb Biomass
M_{oxy_req}	Oxygen requirements to oxidize biomass	767	lb O_2 / day
		31.95	lb O_2 / hr
OTR_f	Actual oxygen transfer rate at site	767	lb O_2 / day
		14.49	kg O_2 / hr
alpha	Relative transfer rate to clean water	0.700	-
Beta	Relative DO saturation to clean water	0.950	-
F	Diffuser fouling factor	1.00	-
C_{st*}	Sat DO at sea level and operating temp	10.1	mg/L
C_{s20*}	Saturated DO at sea level and 20°C	9.09	mg/L
d_e	Mid-depth correction factor	0.400	-
T	Aeration basin temperature	15.0	°C
P_a	Standard pressure at sea level	10.3	m H_2O
g	Gravity	9.81	m/s^2
M	Molecular weight of air	29.0	kg/(kg mol)
z_b	Elevation of site	5370	ft
		1637	m
z_a	Sea Level	0.000	m
R	Universal gas constant	8314	kg $m^2/(s^2$ kg mol K)
T	Aeration basin temperature	288	K
P_b	Pressure at site based on elevation	8.51	m H_2O
		12.1	psi
SWD	Basin sidewater depth	15.0	ft
		4.57	m
H_d	Diffuser height above the basin floor	0.50	ft
		0.2	m
D_f	Depth of diffusers in basin	14.5	ft
		4.42	m
C	Operating DO in the basin	2.00	mg/L
$C_{\infty,20*}$	Sat DO at sea level, 20°C for diffused air	10.6	mg/L
C_{st*}/C_{s20*}	Ratio of C_{st*}/C_{s20*}	1.11	-
P_b/P_a	Ratio of P_b/P_a	0.824	-
SOTR	Standard Oxygen Transfer Rate	34.28	kg/hr
P	Standard atmospheric pressure	101,325	N/m^2
d_a	density of air	1.009	kg/m^3

SOTE	Assumed SOTE per foot of water depth	1.00%	
E	Transfer Efficiency	15%	-
O_w	Oxygen by weight	0.234	kg/m^3
A	Air flowrate	16.85	m^3/min
SF	Air flowrate safety factor	1.00	-
V_{air_oxy}	Oxygen requirement	595.0	scfm
$ACFM_{summeroxy}$	Actual blower discharge (summer)	764.7	acfm
$ACFM_{winteroxy}$	Actual blower discharge (winter)	642.5	acfm

Step 10: Select Mixing Requirement **(Note: This is to help the user decide on what size blower and/or mechanical mixer to use)**

Mechanical Mixing

HP_{mix}	Horsepower requirement for mechanical mixing	1.5	$hp/1000\ ft^3$
		92.26	hp
Q_{blower_mech}	Blower sized to provide just oxygen when combined with mechanical mixing	595.0	scfm

Air Mixing

Q_{MIX_AIR}	Air required for mixing	1,230	scfm

Legend

Input
Calculation
Linked Cell

DIGESTER SIZING CALCULATIONS FOR 1,535 PPD

Variable	Description	Value	Unit
Step 1: Determine Influent Flow to Digester			
MMF	Permitted influent capacity	253,000	gpd
BOD_{avg}	Average BOD Concentration	727	mg/L
Y	Yield (lb VSS produced/lb BOD removed)	0.600	lb VSS/lb BOD
BOD_{INF_Mass}	Mass of influent BOD	1,535	lb BOD/day
	Do you know the waste stream (quantity and quality) to the digester?	No Use the 'Digester Influent' tab to calculate the waste stream in QINF stream to the digester (ex. If you are designing a new plant and nee from the new secondary treatment	
Q_{INF}	Influent Flow to Digester	0	gpd
		0	cfd
$Q_{INF(calc)}$	Influent Flow to Digester	19,710	gpd
		2,635	cfd
X_{INF}	Influent solids concentration	7,000	mg/L
$X_{INF-\%}$	Influent solids concentration as percent	0.70%	-
SG_{INF}	Specific Gravity of the Digester Influent	1.01	-
M_{INF}	Mass of Solids in Influent	0	lb solids/day
$M_{INF\ (calc)}$	Mass of Solids in Influent	1,151	
P_{VSS}	Volatile fraction of digester solids	85.0%	-
M_{VSS}	Mass of Volatile Solids in Influent	0	lb VSS/day
$M_{VSS(calc)}$	Mass of Volatile Solids in Influent	674	lb VSS/day
P_{DIG}	Percent solids in digester	100.0%	-
X_{DIG}	Concentration of solids in the digester under complete mix conditions	7,000	mg/L
$X_{DIG-\%}$	Concentration of solids in the digester under complete mix conditions as percent	0.700%	-
SG_{DIG}	Specific Gravity of the Digester (Complete Mix Conditions)	1.01	-
$C_{SLUDGE-\%}$	Digester effluent concentration as percent	1.50%	-
C_{SLUDGE}	Digester effluent concentration	15,000	mg/L
Step 2: Determine Decant Flow and WAS Flow Leaving Digester			
M_{INF}	Mass of solids to digester	1,151	lb/day
M_{VSS}	Mass of volatile suspended solids in feed flow	674	lb/day
% RED	Volatile Solids Reduction	40.0%	-
M_{RED}	Mass VSS Reduced	269.6	lb/day
M_{SLUDGE}	Mass of dry solids in sludge	881	lb/day
SG_{SLUDGE}	Specific gravity of digester sludge	1.02	-
Q_{SOLIDS}	Flowrate of solids leaving digester	6,939	gpd
	Do you plan to decant daily using the influent volume each day, or do you plan to decant a set height?	Decant Daily	
	What height do you want to decant?	4	ft
V_{DECANT}	Daily Decant Volume	19,710	gal

V_{DECANT}	Calculated Decant Volume based on Height	113,165	gal
t_{DECANT}	Decant Time	12.0	hr
Q_{DECANT}	Decant Flow	27.38	gpm
Q_{DECANT}/MMF	Decant Flow to Influent Flow Ratio	15.58%	-
Step 3: Size Digesters based on Metcalf & Eddy Eqn 13-25			
Y	fraction infl BOD_5 consisting of primary sludge	0.000%	-
S_i	influent BOD_5	0.000	mg/L
K_{20}	BOD rate constant at 20°C	0.075	/day
θ	Temperature coefficient	1.135	-
K_d	BOD rate constant at temperature T	0.0398	/day
P_{VSS}	Volatile fraction of digester suspended solids	0.850	-
T	Minimum temperature	15.0	ºC
SRT	Solids retention time	60.0	day
DD_{min}	Minimum Degree Days	900	°C day
V_{MIN_REQ}	Required volume of aerobic digester	52,167	ft^3
		390,211	gal
Step 3b: Mass Rate Check on Volume			
Q_{SOLIDS}	Flowrate of solids leaving digester	6,939	gpd
SRT	Required SRT Per EPA Regulations	60.0	day
V	Volume required based on SRT and mass of solids leaving the digester	416,338	gal
Step 4: Actual Digester Dimensions			
SWD	Side Water Depth	16.0	ft
FB	Freeboard	1.50	ft
D	Total Depth	17.5	ft
L	Length	61.5	ft
W	Width	61.5	ft
D/W	Total Depth to Width Ratio	0.285	-
V_{DIG}	Total Digester Volume	60,516	ft^3
		452,660	gal
	Does it meet required volume according to Step 3?	Yes	-
	Does it meet required volume according to Step 3b?	Yes	-
SF_V	What is the safety factor selected?	1.0	-
M_{VSS}/V_{actual}	Volatile solids loading rate	0.01	-
V_{actual}	Total Digester Volume	452,660	gal
		60,516	ft^3
SRT	Solids retention time	65.2	day

Step 5: Check Digester Sludge Age & VSS Reduction

SRT	Solids Retention Time	103.1	day
T_{D_MIN}	Minimum digester temp during winter	15.0	°C
SRT * T_{D_MIN}	Sludge Age x Temperature	1,547	°C day
VR	Anticipated VSS reduction	40.0%	-
$DD_{40\%}$	Requirement for 40% VSS reduction	550	°C day
SRT_{15}	Min SRT at 15 deg°C	36.7	day
V_{MIN_check}	Minimum volume for required °C-days	322,496	gal
V_{actual}	Actual volume	452,660	gal
	Is the proposed digester volume greater than the minimum volume required for 550 deg°C-days?	Yes	-

Step 6: Summary of calculated volumes

V_{actual}	Actual volume	452,660	gal
V	Required volume of aerobic digester	390,211	gal
V	Min digester volume for 550°C-days	322,496	gal
V	Volume required based on SRT and mass of solids leaving the digester	416,338	gal
	Does the actual volume exceed the other methods of calculating volume?	Yes	

Step 7: Determine aeration requirements in SCFM (MIXING ONLY)

a_{MIX}	Aeration requirement for mixing	20.0	scfm/1000 ft^3
V_{actual}	Total Digester Volume	452,660	gal
		60,516	ft^3
Q_{MIX_AIR}	Total Air Required	1,210	scfm

Step 8.1: Convert SCFM to ACFM for SUMMER CONDITIONS for Digester (MIXING ONLY)

		68.0	°F
T_S	Standard Temperature	528	°R
		293	°K
		75.0	°F
T_A	Actual Temperature at location	535	°R
		297	°K
P_S	Standard Pressure	14.7	psia
z_b	Elevation of site	5,370	ft
P_B	Atmospheric Pressure at site	12	psia
P_Δ	Pressure Drop across filter/silencer	0.300	psi
P_A	Actual pressure at blower	11.8	psia
RH_S	Standard relative humidity	36.0%	-
RH_{A_summer}	Actual relative humidity at location	70.0%	-
PV_S	Saturated vapor pressure of water at T_s	0.339	psi
H_{VAP}	Heat of Vaporization	40,700	J/mol
R	Rankine constant	8.31	J/(mol K)
PV_{A_summer}	Saturated vapor pressure of water at Actual Temp	0.422	psi
$ACFM_{summermix}$	Actual blower discharge (summer)	1,556	acfm

Step 8.2: Convert SCFM to ACFM for WINTER CONDITIONS for Digester (MIXING ONLY)

		0.000	°F
T_A	Actual Temperature at location	460	°R
		255	°K
RH_{A_winter}	Actual relative humidity at location	70.0%	-
PV_{A_winter}	Saturated vapor pressure of water at T_A	0.0287	psi
$ACFM_{wintermix}$	Actual blower discharge (winter)	1,307	acfm

Step 9: Check Air Required for Oxygen Requirements

M_{RED}	Mass VSS Reduced	269.6	lb/day
a_{REQ}	Aeration requirement for oxidizing biomass	2.30	lb O_2 /lb Biomass
M_{oxy_req}	Oxygen requirements to oxidize biomass	620	lb O_2 / day
		25.84	lb O_2 / hr
OTR_f	Actual oxygen transfer rate at site	620	lb O_2 / day
		11.72	kg O_2 / hr
alpha	Relative transfer rate to clean water	0.700	-
Beta	Relative DO saturation to clean water	0.950	-
F	Diffuser fouling factor	1.00	-
C_{st*}	Sat DO at sea level and operating temp	10.1	mg/L
C_{s20*}	Saturated DO at sea level and 20°C	9.09	mg/L
d_e	Mid-depth correction factor	0.400	-
T	Aeration basin temperature	15.0	°C
P_a	Standard pressure at sea level	10.3	m H_2O
g	Gravity	9.81	m/s^2
M	Molecular weight of air	29.0	kg/(kg mol)
z_b	Elevation of site	5370	ft
		1637	m
z_a	Sea Level	0.000	m
R	Universal gas constant	8314	kg $m^2/(s^2$ kg mol K)
T	Aeration basin temperature	288	K
P_b	Pressure at site based on elevation	8.51	m H_2O
		12.1	psi
SWD	Basin sidewater depth	15.0	ft
		4.57	m
H_d	Diffuser height above the basin floor	0.50	ft
		0.2	m
D_f	Depth of diffusers in basin	14.5	ft
		4.42	m
C	Operating DO in the basin	2.00	mg/L
$C_{\infty,20*}$	Sat DO at sea level, 20°C for diffused air	10.6	mg/L
C_{st*}/C_{s20*}	Ratio of C_{st*}/C_{s20*}	1.11	-
P_b/P_a	Ratio of P_b/P_a	0.824	-
SOTR	Standard Oxygen Transfer Rate	27.72	kg/hr
P	Standard atmospheric pressure	101,325	N/m^2
d_a	density of air	1.009	kg/m^3

SOTE	Assumed SOTE per foot of water depth	1.00%	
E	Transfer Efficiency	15%	-
O_w	Oxygen by weight	0.234	kg/m^3
A	Air flowrate	13.62	m^3/min
SF	Air flowrate safety factor	1.00	-
V_{air_oxy}	Oxygen requirement	481.1	scfm
$ACFM_{summeroxy}$	Actual blower discharge (summer)	618.3	acfm
$ACFM_{winteroxy}$	Actual blower discharge (winter)	519.5	acfm

Step 10: Select Mixing Requirement (Note: This is to help the user decide on what size blower and/or mechanical mixer to use)

Mechanical Mixing

HP_{mix}	Horsepower requirement for mechanical mixing	1.5	$hp/1000\ ft^3$
		90.77	hp
Q_{blower_mech}	Blower sized to provide just oxygen when combined with mechanical mixing	481.1	scfm

Air Mixing

Q_{MIX_AIR}	Air required for mixing	1,210	scfm

Legend

Input

Calculation

Linked Cell

Job Name: Town of Lyons WWUP
Job Number: 240558.ENV
Date: 7/24/2024
Prepared By: MLW
Reviewed By: JPM

DEWATERING SIZING CALCULATIONS

Variable	Description	Value	Unit	Notes
Step 1: Design Values				
M	Dry Solids Loading Rate	1,005	lb/day	From Digester Calcs for 1,900 ppd
Q_{prod}	Volumetric Slurry Production	7,876	gal/day	$=M/(\%_{inf}*8.34\ lb/gal\ H_2O*SG_{inf})$
$\%_{inf}$	Assumed Dewatering Influent Solids Content	1.50%	NA	
SG_{inf}	Assumed Specific Gravity of Dewatering Influent	1.02	NA	
Step 2: Operations				
D	Days per Week	3	run/week	Assuming one run per day
H	Hours per Day	5.00	hr/run	
Step 3: Sizing Calculations				
M	Dry Solids Loading Rate	7,035	lb/week	1 week = 7 days
$M_{dw\text{-}dry}$	Dry Solids Loading to Dewatering	469	lb/hr	$=M/(D*H)$
M_{dw}	Total Slurry Loading to Dewatering	31,266	lb/hr	$=M_{dw\text{-}dry}/\%_{inf}$
Q_{prod}	Volumetric Slurry Production	55,132	gal/week	1 week = 7 days
Q_{dw}	Volumetric Slurry Loading to Dewatering	61.3	gal/min	$=Q_{prod}/(D*H*60\ min/hr)$
Step 4: Cake Production Calculations				
	What type of dewatering equipment are you considering?	Screw Press		
-	Recommended Cake Solids Content	14-24%		
	Recommended Capture Rate	95%+		
$\%_{cake}$	Assumed Cake Solids Content	16.0%	NA	
$\%_{cap}$	Capture Rate	90.0%	NA	
SG_{cake}	Assumed Specific Gravity of Cake	1.03	NA	
$M_{cake\text{-}dry}$	Mass of Dry Solids Leaving Dewatering in Cake	422	lb/hr	$=M_{dw\text{-}dry}*\%_{cap}$
		1.055	ton/run	$=(M_{cake\text{-}dry}*H)/2000\ lb/ton$
M_{cake}	Mass of Cake Solids (includes water weight)	2,638	lb/hr	$=M_{cake\text{-}dry}/\%_{cap}$
Q_{cake}	Volume of Cake Solids	307	gal/hr	$=M_{cake}/(8.34\ lb/gal\ H_2O*SG_{cake})$
		4,607	gal/week	$=Q_{cake}*D*H$
		616	ft^3/week	$=Q_{cake}/7.48\ gal/ft^3$
		22.81	yd^3/week	$=Q_{cake}/27\ ft^3/yd^3$
Step 5: Pressate Production Calculations				
M_p	Mass of Filtrate	28,628	lb/hr	$=M_{dw}-M_{cake}$
Q_p	Volume of Filtrate	3,433	gal/hr	$=M_p/8.34\ lb/gal\ H_2O$
		57.2	gal/min	1 hour = 60 min
		51,490	gal/week	$=Q_p*D*H$
		6,884	ft^3/week	$=Q_p/7.48\ gal/ft^3$
		254.9	yd^3/week	$=Q_p/27\ ft^3/yd^3$
Step 6: Dewatering Design Summary				
$M_{dw\text{-}dry}$	Solids Loading to Dewatering	469	lb/hr	
Q_{dw}	Volumetric Loading to Dewatering	61.3	gal/min	

Legend

- Input
- Calculation
- Linked Cell

Appendix D – Opinion of Probable Costs

Job Name: Town of Lyons WWUP
Job Number: 240558.ENV
Date: 7/24/2024
Prepared By: JZN
Checked By: MAL

OPINION OF PROBABLE COST FOR CONSOLIDATION WITH LONGMONT

Description	Quantity	Units	Unit Cost	Total Cost
Division 00 and 01 - General Conditions and Requirements				
Mobilization/Demobilization	1	LS	$1,000,000	$1,000,000
			General Requirements Subtotal	**$1,000,000**
Division 02 - Sitework				
Erosion Control	1	LS	$500,000	$500,000
Demolition	1	LS	$220,000	$220,000
Seeding	123000	SF	$4	$492,000
Asphalt Sawcut	5000	SF	$4	$20,000
Gravel Patch	5000	SY	$3	$15,000
Asphalt Patch	500	SF	$7	$3,500
Horizontal Directional Drilling (HDD)	500	LF	$500	$250,000
Rock Excavation	3000	CY	$145	$435,000
Force Main to Gravity Sanitary Sewer	1000	LF	$70	$70,000
Precast Manholes	82	EA	$6,000	$492,000
12" Sewer Line	41000	LF	$100	$4,100,000
			Sitework Subtotal	**$6,597,500**
Division 11 - Equipment				
Existing Influent Lift Station Modification	1	LS	$100,000	$100,000
Metering Manhole	1	EA	$50,000	$50,000
			Equipment Subtotal	**$150,000**
Division 16 - Electrical				
Electrical and Controls	1	LS	$45,000	$45,000
			Electrical Subtotal	**$45,000**

Construction Subtotal	**$7,792,500**
Contingency (30%)	$2,338,000
Contractor's OH&P and General Conditions (15%)	$1,520,000
Engineering, Permitting and Design (15%)	$1,748,000
Bidding and Construction Administration (8%)	$932,040
Construction Total	**$14,340,000**
Building Permit Wastewater Development Fee	$200,000
30' Wide Strip Easement from Cemex Site to Longmont in Railroad	$1,904,000
Existing Collection System Fee	$2,215,000
Treatment Capacity Fee	$1,533,000
Consolidation Total	**$20,200,000**

Legend

Input
Calculation
Linked Cell

Job Name: Lyons WWUP
Job Number: 240558.ENV
Date: 8/12/2024
Prepared By: JZN
Check By: JPM/MAL

OPINION OF PROBABLE COST FOR SBR ALTERNATIVE				
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Division 00 and 01 - General Conditions and Requirements				
Mobilization/Demobilization	1	LS	$500,000	$500,000
			General Requirements Subtotal	**$500,000**
Division 02 - Sitework				
Excavation / Fill	1	LS	$100,000	$100,000
Erosion Control	1	LS	$25,000	$25,000
Site Grading	1	LS	$50,000	$50,000
Chainlink Fence	200	LF	$25	$5,000
Dewatering	1	LS	$250,000	$250,000
			Sitework Subtotal	**$430,000**
Division 03 - Concrete				
Cast-in-Place Concrete for New SBR Tanks	800	CY	$2,000	$1,600,000
Cast-in-Place Concrete for Blowers	30	CY	$2,000	$60,000
			Concrete Subtotal	**$1,660,000**
Division 05 - Miscellaneous Metals				
Walkway	1	LS	$25,000	$25,000
Handrails / Railings / Stairs	1	LS	$25,000	$25,000
Pipe Supports / Hanger	1	LS	$25,000	$25,000
Ladders	4	EA	$1,500	$6,000
Catwalks	1	LS	$75,000	$75,000
			Miscellaneous Metals Subtotal	**$156,000**
Division 09 - Coatings				
Pipe Coatings	1	LS	$150,000	$150,000
			Painting Subtotal	**$150,000**
Division 11 - Equipment				
SBR Equipment Package (blowers, fine bubble aeration, SS decanters, air control valves, pumps, OSCAR package, PLC upgrades)	1	LS	$1,262,983	$1,263,000
Replace Diffusers (Exist Basins)	1	LS	$100,000	$100,000
			Equipment Subtotal	**$1,363,000**
Division 13 - Special Construction				
Pre-Engineered Metal Building - Blower Building	750	SF	$85	$63,800
			Special Construction Subtotal	**$63,800**
Division 15 - Mechanical				
Aeration Headers and Process Piping	1	LS	$400,000	$400,000
HVAC for Blower Building	1	LS	$200,000	$200,000
			Mechanical Subtotal	**$600,000**
Division 16 - Electrical				
Electrical, Instrumentation and Controls	1	LS	$408,900	$408,900
			Electrical Subtotal	**$408,900**

Project Subtotal	**$5,331,700**
Contingency (30%)	$1,600,000
Contractor's OH&P (15%)	$1,040,000
Engineering, Permitting and Design (10%)	$797,000
Bidding and Construction Administration (6%)	$478,302
Start-Up Costs (0.5%)	$40,000
Project Total	**$9,290,000**

Legend

Input
Calculation
Linked Cell

Job Name: Lyons WWUP
Job Number: 240558.ENV
Date: 7/24/2024
Prepared By: JZN
Check By: JPM/MAL

OPINION OF PROBABLE COST FOR AGS ALTERNATIVE

Description	Quantity	Units	Unit Cost	Total Cost
Division 00 and 01 - General Conditions and Requirements				
Mobilization/Demobilization	1	LS	$500,000	$500,000
			General Requirements Subtotal	**$500,000**
Division 02 - Sitework				
Retrofit SBR Basins to AGS	1	LS	$300,000	$300,000
Demolition (exsiting air piping, diffusers)	1	LS	$150,000	$150,000
			Sitework Subtotal	**$450,000**
Division 05 - Miscellaneous Metals				
Pipe Supports / Hanger	1	LS	$25,000	$25,000
Grating	1	LS	$20,000	$20,000
Catwalks	1	LS	$75,000	$75,000
			Miscellaneous Metals Subtotal	**$120,000**
Division 09 - Coatings				
Pipe Coatings	1	LS	$150,000	$150,000
			Painting Subtotal	**$150,000**
Division 11 - Equipment				
Nereda Equipment Package (Level sensor assemblies, influent vavles, influent distribution system, diffusers, blowers, instrumentation, pumps, PLC controls)	1	LS	$2,327,611	$2,327,700
			Equipment Subtotal	**$2,327,700**
Division 15 - Mechanical				
Aeration Headers and Process Piping	1	LS	$400,000	$400,000
			Mechanical Subtotal	**$400,000**
Division 16 - Electrical				
Electrical, Instrumentation and Controls	1	LS	$698,310	$698,400
			Electrical Subtotal	**$698,400**

Project Subtotal	**$4,646,100**
Contingency (30%)	$1,394,000
Contractor's OH&P and General Conditions (15%)	$906,000
Engineering, Permitting and Design (10%)	$695,000
Bidding and Construction Administration (6%)	$416,766
Start-Up Costs (0.5%)	$35,000
Project Total	**$8,100,000**

Legend

Input
Calculation
Linked Cell

OPINION OF PROBABLE COST FOR MBR ALTERNATIVE

Description	Quantity	Units	Unit Cost	Total Cost
Division 00 and 01 - General Conditions and Requirements				
Mobilization/Demobilization	1	LS	$500,000	$500,000
			General Requirements Subtotal	**$500,000**
Division 02 - Sitework				
Retrofit SBR Basins and Post EQ Tank	1	LS	$200,000	$200,000
Demolition (exsiting air piping, diffusers)	1	LS	$150,000	$150,000
			Sitework Subtotal	**$350,000**
Division 05 - Miscellaneous Metals				
Pipe Supports / Hanger	1	LS	$50,000	$50,000
Grating	1	LS	$20,000	$20,000
Catwalks	1	LS	$75,000	$75,000
			Miscellaneous Metals Subtotal	**$145,000**
Division 09 - Coatings				
Pipe Coatings	1	LS	$150,000	$150,000
			Painting Subtotal	**$150,000**
Division 11 - Equipment				
MBR Equipment Package (biological system equipments, membrane system, filtration pump system, RAS pump system, membrane blower system, compressed air system, chemical transfer system, control system, manufacturing services)	1	LS	$1,813,500	$1,813,500
Replace Existing Screen with 2mm	1	LS	$200,000	$200,000
			Equipment Subtotal	**$2,013,500**
Division 14 - Hoists				
Monorail for MBRs	1	LS	$33,000	$33,000
			Hoists Subtotal	**$33,000**
Division 15 - Mechanical				
Aeration Headers and Process Piping	1	LS	$400,000	$400,000
			Mechanical Subtotal	**$400,000**
Division 16 - Electrical				
Electrical, Instrumentation and Controls	1	LS	$604,050	$604,100
			Electrical Subtotal	**$604,100**

Project Subtotal	**$4,195,600**
Contingency (30%)	$1,259,000
Contractor's OH&P and General Conditions (15%)	$818,000
Engineering, Permitting and Design (10%)	$627,000
Bidding and Construction Administration (6%)	$376,356
Start-Up Costs (0.5%)	$31,000
Project Total	**$7,310,000**

Legend

Input
Calculation
Linked Cell

Job Name: Lyons WWUP
Job Number: 240558.ENV
Date: 8/12/2024
Prepared By: JZN
Check By: MAL/ACS

OPINION OF PROBABLE COST FOR DIGESTION IMPROVEMENTS

Description	Quantity	Units	Unit Cost	Total Cost
Division 00 and 01 - General Conditions and Requirements				
Mobilization/Demobilization	1	LS	$250,000	$250,000
			General Requirements Subtotal	**$250,000**
Division 02 - Sitework				
Excavation / Fill	1	LS	$100,000	$100,000
Erosion Control	1	LS	$25,000	$25,000
Site Grading	1	LS	$50,000	$50,000
Chainlink Fence	200	LF	$25	$5,000
Dewatering	1	LS	$275,000	$275,000
			Sitework Subtotal	**$455,000**
Division 03 - Concrete				
Cast-in-Place Concrete for Digester	1200	CY	$2,000	$2,400,000
			Concrete Subtotal	**$2,400,000**
Division 05 - Miscellaneous Metals				
Walkway	1	LS	$20,000	$20,000
Handrails / Railings / Stairs	1	LS	$27,000	$27,000
Pipe Supports / Hanger	1	LS	$27,000	$27,000
Ladders	2	EA	$1,500	$3,000
Catwalks	1	LS	$75,000	$75,000
			Miscellaneous Metals Subtotal	**$152,000**
Division 09 - Coatings				
Pipe Coatings	1	LS	$150,000	$150,000
			Painting Subtotal	**$150,000**
Division 11 - Equipment				
Blowers for Digester (50 hp)	3	EA	$100,000	$300,000
Coarse Bubble Diffuser Grid	1	LS	$100,000	$100,000
			Equipment Subtotal	**$400,000**
Division 13 - Special Construction				
Pre-Engineered Metal Building - Blower Building	750	SF	$85	$63,800
			Special Construction Subtotal	**$63,800**
Division 15 - Mechanical				
Process Piping	1	LS	$400,000	$400,000
			Mechanical Subtotal	**$400,000**
Division 16 - Electrical				
Electrical, Instrumentation and Controls	1	LS	$120,000	$120,000
			Electrical Subtotal	**$120,000**

Project Subtotal	**$4,390,800**
Contingency (30%)	$1,317,000
Contractor's OH&P and General Conditions (15%)	$856,000
Engineering, Permitting and Design (10%)	$656,000
Bidding and Construction Administration (6%)	$393,828
Start-Up Costs (1%)	$44,000
Project Total	**$7,660,000**

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JSA CONSULTING ENGINEERS

Job Name: Lyons WWUP
Job Number: 240558.ENV
Date: 7/24/2024
Prepared By: JZN
Check By: JPM/MAL

OPINION OF PROBABLE COST FOR SCREW PRESS DEWATERING ALTERNATIVE				
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Division 00 and 01 - General Conditions and Requirements				
Mobilization/Demobilization	1	LS	$10,000	$10,000
			General Requirements Subtotal	**$10,000**
Division 02 - Sitework				
Demolition of Existing Centrifuge	1	LS	$10,000	$10,000
			Sitework Subtotal	**$10,000**
Division 11 - Equipment				
ESMIL Screw Press Equipment Package (multi-disc screw press, agitator, dewatering drums, gearmotors, rinsing water system, level/pressure sensors, control panel, start up and training)	1	LS	$346,288	$346,300
			Equipment Subtotal	**$346,300**
Division 15 - Mechanical				
Process Piping	1	LS	$20,000	$20,000
Fittings and Appurtenances	1	LS	$10,000	$10,000
			Mechanical Subtotal	**$30,000**
Division 16 - Electrical				
Electrical, Instrumentation and Controls	1	LS	$103,890	$103,900
			Electrical Subtotal	**$103,900**

Project Subtotal	**$500,200**
Contingency (30%)	$150,000
Contractor's OH&P and General Conditions (15%)	$98,000
Engineering, Permitting and Design (10%)	$75,000
Bidding and Construction Administration (6%)	$44,892
Start-Up Costs (1%)	$5,000
Project Total	**$880,000**

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Calculation
Linked Cell

Job Name: Lyons WWUP
Job Number: 240558.ENV
Date: 7/24/2024
Prepared By: JZN
Check By: JPM/MAL

OPINION OF PROBABLE COST FOR FAN PRESS DEWATERING ALTERNATIVE

Description	Quantity	Units	Unit Cost	Total Cost
Division 00 and 01 - General Conditions and Requirements				
Mobilization/Demobilization	1	LS	$10,000	$10,000
			General Requirements Subtotal	**$10,000**
Division 02 - Sitework				
Demolition of Existing Centrifuge	1	LS	$2,000	$2,000
Site Piping	1	LS	$1,000	$1,000
			Sitework Subtotal	**$3,000**
Division 11 - Equipment				
Fournier Rotary Press Equipment Package (rotary press, flocculator, flowmeters, collector pipes, air compressor, solenoids, sensors, actuated valves, contro panel, start up/commissioning/training)	1	LS	$741,000	$741,000
			Equipment Subtotal	**$741,000**
Division 15 - Mechanical				
Process Piping	1	LS	$20,000	$20,000
Fittings and Appurtenances	1	LS	$10,000	$10,000
			Mechanical Subtotal	**$30,000**
Division 16 - Electrical				
Electrical, Instrumentation and Controls	1	LS	$222,300	$222,300
			Electrical Subtotal	**$222,300**

Project Subtotal	**$1,006,300**
Contingency (30%)	$302,000
Contractor's OH&P and General Conditions (15%)	$196,000
Engineering, Permitting and Design (10%)	$150,000
Bidding and Construction Administration (6%)	$90,258
Start-Up Costs (1%)	$10,000
Project Total	**$1,760,000**

Legend

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Calculation
Linked Cell

Job Name: Lyons WWUP
Job Number: 240558.ENV
Date: 7/24/2024
Prepared By: MAL
Checked By: ACS

OPINION OF PROBABLE COST FOR IPS SCREEN				
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Division 02 - Sitework				
Excavation / Fill	1	LS	$15,000	$15,000
Erosion Control	1	LS	$15,000	$15,000
Site Grading	1	LS	$20,000	$20,000
Chainlink Fence	250	LF	$25	$6,300
Dewatering	1	LS	$150,000	$150,000
			Sitework Subtotal	**$206,300**
Division 03 - Concrete				
Cast-in-Place Concrete	10	CY	$2,000	$20,000
			Concrete Subtotal	**$20,000**
Division 04 - Masonry				
Building for Screen	1000	SF	$65	$65,000
			Masonry Subtotal	**$65,000**
Division 08 - Doors and Windows				
Single Doors and Frame	1	EA	$4,000	$4,000
			Doors and Windows Subtotal	**$4,000**
Division 11 - Equipment				
Mechanical Screen	1	EA	$200,000	$200,000
			Equipment Subtotal	**$200,000**
Division 13 - Special Construction				
Odor Control - Building - Carbon Scrubber	1	LS	$50,000	$50,000
			Special Construction Subtotal	**$50,000**
Division 16 - Electrical				
Electrical, Instrumentation and Controls	1	LS	$60,000	$60,000
			Electrical Subtotal	**$60,000**

Project Subtotal	**$605,300**
Contingency (30%)	$182,000
Contractor's OH&P and General Conditions (15%)	$118,000
Engineering, Permitting and Design (10%)	$91,000
Bidding and Construction Administration (6%)	$54,318
Start-Up Costs (0.5%)	$3,000
Project Total	**$1,050,000**

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Calculation
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Job Name: Lyons WWUP
Job Number: 240558.ENV
Date: 7/24/2024
Prepared By: MAL
Checked By: ACS

OPINION OF PROBABLE COST FOR WETWELL EXPANSION				
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Division 02 - Sitework				
Excavation / Fill	1	LS	$25,000	$25,000
Erosion Control	1	LS	$15,000	$15,000
Site Grading	1	LS	$25,000	$25,000
Chainlink Fence	200	LF	$25	$5,000
Dewatering	1	LS	$175,000	$175,000
			Sitework Subtotal	**$245,000**
Division 03 - Concrete				
Cast-in-Place Concrete	40	CY	$2,000	$80,000
			Concrete Subtotal	**$80,000**

Project Subtotal	**$325,000**
Contingency (30%)	$98,000
Contractor's OH&P and General Conditions (15%)	$63,000
Engineering, Permitting and Design (10%)	$49,000
Bidding and Construction Administration (6%)	$29,160
Project Total	**$560,000**

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Calculation
Linked Cell

CONSULTING ENGINEERS

Job Name: Lyons WWUP
Job Number: 240558.ENV
Date: 7/24/2024
Prepared By: MAL
Checked By: ACS

OPINION OF PROBABLE COST FOR SPLITTERBOX REHAB				
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Division 02 - Sitework				
Splitter Box Rehab	1	LS	$50,000	$50,000
			Sitework Subtotal	**$50,000**
Division 03 - Concrete				
Cast-in-Place Concrete	10	CY	$2,000	$20,000
			Concrete Subtotal	**$20,000**

Project Subtotal	**$70,000**
Contingency (30%)	$21,000
Contractor's OH&P and General Conditions (15%)	$14,000
Engineering, Permitting and Design (10%)	$11,000
Bidding and Construction Administration (6%)	$6,300
Project Total	**$120,000**

Legend

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Calculation
Linked Cell

Job Name: Lyons WWUP
Job Number: 240558.ENV
Date: 7/24/2024
Prepared By: MAL
Checked By: ACS

OPINION OF PROBABLE COST FOR REDIRECT SIDESTREAM FLOWS				
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Division 02 - Sitework				
Site Piping	1	LS	$75,000	$75,000
			Sitework Subtotal	**$75,000**
Division 03 - Concrete				
Concrete Patching	4	CY	$2,000	$8,000
			Concrete Subtotal	**$8,000**

Project Subtotal	**$83,000**
Contingency (30%)	$25,000
Contractor's OH&P and General Conditions (15%)	$16,000
Engineering, Permitting and Design (10%)	$12,000
Bidding and Construction Administration (6%)	$7,440
Project Total	**$140,000**

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Calculation
Linked Cell

Job Name: Lyons WWUP
Job Number: 240558.ENV
Date: 7/24/2024
Prepared By: MAL
Checked By: ACS

OPINION OF PROBABLE COST FOR SBR RERATING UPGRADES				
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Division 00 and 01 - General Conditions and Requirements				
Mobilization/Demobilization	1	LS	$50,000	$50,000
			General Requirements Subtotal	**$50,000**
Division 02 - Sitework				
Demolition	1	LS	$50,000	$50,000
			Sitework Subtotal	**$50,000**
Division 03 - Concrete				
Cast-In-Place Concrete	8	CY	$2,000	$16,000
			Concrete Subtotal	**$16,000**
Division 04 - Masonry				
Pipe Penetrations	2	EA	$25,000	$50,000
			Masonry Subtotal	**$50,000**
Division 11 - Equipment				
Aerzen Hybrid Rotary Lobe Blowers	2	EA	$90,000	$180,000
Upgrades to Existing Blowers	2	EA	$30,000	$60,000
VFD for new Blowers	2	EA	$20,000	$40,000
Diffusers	1	LS	$100,000	$100,000
			Equipment Subtotal	**$380,000**
Division 15 - Mechanical				
Air Intake	1	EA	$10,000	$10,000
SST Blower Piping - 10" - SCH 10 - 309L	25	LF	$1,000	$25,000
SST Blower Piping - 8" - SCH 10 - 309L	100	LF	$500	$50,000
SST Blower Piping - 6" - SCH 10 - 309L	75	LF	$350	$26,300
6" Butterfly Valve	4	EA	$3,500	$14,000
Miscellaneous Appurtenances	1	LS	$75,000	$75,000
			Mechanical Subtotal	**$200,300**
Division 16 - Electrical				
Electrical, Instrumentation and Controls	1	LS	$152,000	$152,000
			Electrical Subtotal	**$152,000**

Project Subtotal	**$898,300**
Contingency (30%)	$269,000
Contractor's OH&P and General Conditions (15%)	$175,000
Engineering, Permitting and Design (10%)	$134,000
Bidding and Construction Administration (6%)	$80,538
Start-Up Costs (0.5%)	$4,000
Project Total	**$1,560,000**

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Job Name: Lyons WWUP
Job Number: 240558.ENV
Date: 7/24/2024
Prepared By: MAL
Checked By: ACS

OPINION OF PROBABLE COST FOR POST EQ PUMPS UPGRADE				
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Division 00 and 01 - General Conditions and Requirements				
Mobilization/Demobilization	1	LS	$10,000	$10,000
			General Requirements Subtotal	**$10,000**
Division 11 - Equipment				
VFD for post EQ pumps	2	EA	$45,000	$90,000
			Equipment Subtotal	**$90,000**
Division 16 - Electrical				
Electrical, Instrumentation and Controls	1	LS	$75,000	$75,000
			Electrical Subtotal	**$75,000**

Project Subtotal	**$175,000**
Contingency (30%)	$53,000
Contractor's OH&P and General Conditions (15%)	$34,000
Engineering, Permitting and Design (10%)	$26,000
Bidding and Construction Administration (6%)	$15,720
Project Total	**$300,000**

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CONSULTING ENGINEERS

Job Name: Lyons WWUP
Job Number: 240558.ENV
Date: 7/24/2024
Prepared By: MAL
Checked By: ACS

OPINION OF PROBABLE COST FOR REPLACE AND UPGRADE UV SYSTEM				
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Division 00 and 01 - General Conditions and Requirements				
Mobilization/Demobilization	1	LS	$10,000	$10,000
			General Requirements Subtotal	**$10,000**
Division 11 - Equipment				
UV System	1	LS	$140,000	$140,000
			Equipment Subtotal	**$140,000**
Division 16 - Electrical				
Electrical, Instrumentation and Controls	1	LS	$42,000	$42,000
			Electrical Subtotal	**$42,000**

Project Subtotal	**$192,000**
Contingency (30%)	$58,000
Contractor's OH&P and General Conditions (15%)	$38,000
Engineering, Permitting and Design (10%)	$29,000
Bidding and Construction Administration (6%)	$17,280
Start-Up Costs (0.5%)	$1,000
Project Total	**$340,000**

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Job Name: Lyons WWUP
Job Number: 240558.ENV
Date: 7/24/2024
Prepared By: MAL
Checked By: ACS

OPINION OF PROBABLE COST FOR NPW SYSTEM RELOCATE				
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Division 00 and 01 - General Conditions and Requirements				
Mobilization/Demobilization	1	LS	$20,000	$20,000
			General Requirements Subtotal	**$20,000**
Division 02 - Sitework				
Erosion Control	1	LS	$10,000	$10,000
Demolition	1	LS	$10,000	$10,000
Excavation / Fill	1	LS	$10,000	$10,000
Site Piping	1	LS	$25,000	$25,000
			Sitework Subtotal	**$55,000**
Division 03 - Concrete				
Cast-In-Place Concrete	50	CY	$2,000	$100,000
			Concrete Subtotal	**$100,000**
Division 15 - Mechanical				
NPW Piping	1	LS	$40,000	$40,000
			Mechanical Subtotal	**$40,000**
Division 16 - Electrical				
Electrical, Instrumentation and Controls	1	LS	$35,000	$35,000
			Electrical Subtotal	**$35,000**

Project Subtotal	**$250,000**
Contingency (30%)	$75,000
Contractor's OH&P and General Conditions (15%)	$49,000
Engineering, Permitting and Design (10%)	$37,000
Bidding and Construction Administration (6%)	$22,440
Project Total	**$430,000**

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Linked Cell

Job Name: Lyons WWUP
Job Number: 240558.ENV
Date: 7/24/2024
Prepared By: MAL
Checked By: ACS

OPINION OF PROBABLE COST FOR ASHT UPGRADES				
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Division 00 and 01 - General Conditions and Requirements				
Mobilization/Demobilization	1	LS	$200,000	$200,000
			General Requirements Subtotal	**$200,000**
Division 02 - Sitework				
Demolition	1	LS	$25,000	$25,000
			Sitework Subtotal	**$25,000**
Division 03 - Concrete				
Cast-In-Place Concrete	10	CY	$2,000	$20,000
			Concrete Subtotal	**$20,000**
Division 11 - Equipment				
Decanter	1	EA	$75,000	$75,000
			Equipment Subtotal	**$75,000**
Division 15 - Mechanical				
Piping and Appurtenances	1	LS	$15,000	$15,000
			Mechanical Subtotal	**$15,000**
Division 16 - Electrical				
Electrical, Instrumentation and Controls	1	LS	$37,500	$37,500
			Electrical Subtotal	**$37,500**

Project Subtotal	**$372,500**
Contingency (30%)	$112,000
Contractor's OH&P and General Conditions (15%)	$73,000
Engineering, Permitting and Design (10%)	$56,000
Bidding and Construction Administration (6%)	$33,450
Project Total	**$650,000**

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Job Name: Lyons WWUP
Job Number: 240558.ENV
Date: 7/24/2024
Prepared By: MAL
Checked By: ACS

OPINION OF PROBABLE COST FOR REPLACE ODOR CONTROL SYSTEM				
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Division 00 and 01 - General Conditions and Requirements				
Mobilization/Demobilization	1	LS	$25,000	$25,000
			General Requirements Subtotal	**$25,000**
Division 02 - Sitework				
Demolition	1	LS	$50,000	$50,000
			Sitework Subtotal	**$50,000**
Division 11 - Equipment				
Odor Control System	1	LS	$400,000	$400,000
			Equipment Subtotal	**$400,000**
Division 16 - Electrical				
Electrical, Instrumentation and Controls	1	LS	$120,000	$120,000
			Electrical Subtotal	**$120,000**

Project Subtotal	**$595,000**
Contingency (30%)	$179,000
Contractor's OH&P and General Conditions (15%)	$116,000
Engineering, Permitting and Design (10%)	$89,000
Bidding and Construction Administration (6%)	$53,400
Start-Up Costs (0.5%)	$3,000
Project Total	**$1,040,000**

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Job Name: Lyons WWUP
Job Number: 240558.ENV
Date: 7/24/2024
Prepared By: MAL
Checked By: ACS

OPINION OF PROBABLE COST FOR NEW INSTRUMENTATION				
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Division 16 - Electrical				
New Instrumentation	1	LS	$95,000	$95,000
Installation	1	LS	$5,000	$5,000
			Electrical Subtotal	**$95,000**

Project Subtotal	**$97,500**
Contingency (0%)	$0
Contractor's OH&P and General Conditions (0%)	$0
Engineering, Permitting and Design (0%)	$0
Bidding and Construction Administration (0%)	$0
Start-Up Costs (0%)	$0
Project Total	**$100,000**

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Linked Cell

Job Name: Lyons WWUP
Job Number: 240558.ENV
Date: 7/24/2024
Prepared By: MAL
Checked By: ACS

OPINION OF PROBABLE COST FOR BACKUP GENERATOR				
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**
Division 00 and 01 - General Conditions and Requirements				
Mobilization/Demobilization	1	LS	$30,000	$30,000
			General Requirements Subtotal	**$30,000**
Division 16 - Electrical				
Electrical, Instrumentation and Controls	1	LS	$30,000	$30,000
Generator and ATS	1	LS	$120,000	$120,000
			Electrical Subtotal	**$30,000**

Project Subtotal	**$120,000**
Contingency (30%)	$36,000
Contractor's OH&P and General Conditions (15%)	$23,000
Engineering, Permitting and Design (10%)	$18,000
Bidding and Construction Administration (6%)	$10,740
Start-Up Costs (0.5%)	$1,000
Project Total	**$210,000**

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Appendix E – Other Documentation

1. JVA 2019 Rerating Report
2. JVA 2011 Wastewater Feasibility Study
3. Town of Lyons 2023 Comprehensive Plan
4. Town of Lyons 2023 Housing Future Plan
5. Town of Lyons 2023 Housing Future Plan Addendum