4. OPERATION OF BREWER FACILITIES

4.1 GENERAL OVERVIEW

The Brewer Water Pollution Control Facility has numerous wastewater collection and treatment unit processes that must all be operated in an optimal manner in order to produce the cleanest possible effluent at the plant. It is essential that the treatment plant operators learn about the many features, controls, and operational options for each unit process. It is also critical that the operators consistently operate each process in the manner recommended by the accepted practice of the profession as well as the specific requirements established by each equipment or process manufacturer.

The purpose of this section is to provide a general overview of the operating features and requirements of each unit process at the Brewer facility. The recommendations set forth are not intended to replace or supercede the specific, detailed operating manuals for each piece of equipment that the equipment manufacturer has published. These manufacturer's manuals are voluminous and will not be repeated in this general manual. The plant operators are advised to read each equipment manual separately and to become familiar with the detailed operating recommendations of the manufacturer for each unit process.

The operation of the Brewer Water Pollution Control Facility represents very complex and responsible positions. The proper operation of the plant will result in an effluent that will protect the environment around Brewer and will protect residents of the Penobscot River Watershed from public health issues related to the effluent's discharge. The City has made a significant infrastructure investment in its treatment facilities that are worth millions of dollars. The actions of the plant operators in performing daily operational procedures will ultimately decide how well the plant will perform and will protect and prolong the City’s wastewater infrastructure investment.

4.2 ELEMENTS OF PROPER PROCESS OPERATION

The plant operators’ functions can be divided into several elements that must be addressed on both a daily and an as-needed basis. These functions include the following:

- A daily inspection of all wastewater pumping and treatment facilities and equipment should be made each morning to ensure that all systems are operating properly. This should be performed the first thing each day.

- A series of EPA and DEP discharge license compliance monitoring requirements must be performed each day. These include sampling the plant's influent and effluent, performing some basic process testing, and recording the data and observations on forms required for regulatory agency reporting. This should be the operators first priority each day after completing a basic walk-around inspection of the facility.

- The operators should then make daily process control adjustments to each unit process as required. These adjustments should be made in response to test results obtained by the operator and observations made at the facility.

- Several times per week, and in many cases daily, the operator will have to conduct additional BOD, TSS, and bacterial compliance tests on the plant's influent and effluent to meet monitoring requirements specified in the license. This will require that samples be taken and lab testing conducted following rigorous protocol published in Standard Methods.

- The operators must follow a detailed and consistent program of preventative maintenance in order to keep all systems functioning at their peak performance capacity. A good, aggressive program of preventative maintenance will pay for itself over time by minimizing costly emergency repairs and by prolonging the useful life of the equipment.

- Periodically, the operators will be required to schedule emergency or unforeseen maintenance at the facility. In any treatment plant, these types of repairs can quickly derail the facility's normal process operations schedule and consume a disproportionate amount of man-hours. To minimize this impact, we recommend that a strong preventative maintenance program be followed to reduce the likelihood of major emergency repairs. In addition, specialty subcontractors should be considered to make or assist with major repairs as needed.

- Detailed recordkeeping in the format of DEP and EPA mandated forms, daily log books, laboratory testing bench sheets, process control reports, maintenance records and monthly operating reports to the City Manager and City Council are an essential component of the operators' positions. The operators must always remember that all plant records represent legal documents that must be kept on file at the facility for at least three years.

- Safety is an important element of the plant's operation. All operator functions must be performed with safety as the number one priority.

- A daily walk around inspection of all facilities should be made at the end of the day before the operators leave the premises. This will ensure that all systems are operating properly at the time that the operators leave for the day.

Appendix B contains a daily operations check list to be used by the operators to ensure that all aspects of the facility are reviewed each day. A reduced scope checklist for weekend duty is also included.

4.3 WASTEWATER PUMPING STATIONS

Thirteen wastewater pumping stations convey raw wastewater to the treatment plant site on Oak Street. Of these stations, the three at Hardy Street, South Main Street, and Brewer Cove represent the main locations through which all flows that reach the plant must pass. These are significant pump station locations because of the relatively large flows that they carry. In addition, these pump stations lie along the interceptor sewer system and are associated with CSO points as are also the Oak Grove pump station and the James Street pump station. Any loss of function at these five locations will result in the discharge of untreated sewage to the Penobscot River. The remaining seven pump stations are satellite facilities that serve a smaller area.

Each pump station works on similar operating principles. Raw sewage flows into the wet well which is a concrete vessel designed to store water between pumping cycles. A level control system senses changes in the water level and sends a signal to the pump control panel to either start or stop the pumps at preset levels. Several general features are present in the City’s fourteen pump stations:

- The Pierce Road, North Main Street, Oak Grove, James Street and South Main Street pump stations have a flooded suction where the pumps are located below the wet well’s water level and, as a result, remain primed. These stations have a separate dry well that houses the pumps immediately adjacent to the wet well.

- The pump stations at Pine Ridge, Oak Grove Terrace, Craig Drive, Orrington Route 15, and Brewer Cove are wet well mounted pumps that are located above the water level and must be reprimed with each new cycle. The pumping equipment is mounted over the wet well and lifts water up into the pumps once priming has occurred. The Gorman-Rupp station at Orrington utilizes an internal check valve to hold sufficient water to reprime the pumps. The remaining wet well mounted stations are Smith & Loveless units that use a vacuum pump to prime the suction lines at each pump cycle.

- The stations at Sparks Avenue and Cove Street are submersible pumps where the pumping equipment is located in the wet well below the water level. These are low technology stations that were installed in areas of the sewer system that have relatively small flow rates.

- The Hardy Street pump station is a major pump system that is housed in a cast-in-place concrete building with a separate wet well and dry well. This station contains vertical turbine pumps with VFD control and is responsible to convey nearly seventy percent of all wastewater flow generated in Brewer.

- The City's older main stations use bubbler systems for level control. Air is pumped into a submerged tube. Pressure switches sense the resistance to air movement and relate it to the water level in the wet well. The stations' control panels converts this pressure data into depth readings. The newer station at Orrington utilizes pressure transducers to sense wet well levels instead of the bubblers. Some of the smaller stations use float switches to sense changes in the water level.

An alarm system monitors the operation of each major station and advises the operators of high and low water levels, control system failures, low temperature conditions, or vacuum pump failure. The stations' controllers automatically alternate their operation between each pump in order to balance the wear on the equipment. Some of the satellite stations are not connected to the control alarm system, but have remote horns and flashing strobe lights that signal a station failure.

4.3.1 DAILY OPERATION

The pump stations should be visited each day to ensure that they are operating properly. While at each station, the following observations should be made:

- Listen to the station as it operates and note the sound of the pump's operation and make note of any unusual noise that could be an early sign of a malfunction.

- Feel the pump motor to note any abnormally high temperature.

- Verify that the vacuum pump or check valve self-priming system is operating properly.

- Observe the operation of the air compressors that feed and control the pump's bubbler system as applicable. Check pressure transducer operation in stations with those systems.

- Check the operation of the station's heater in the winter and the fan in the summer to ensure that freezing and overheating problems will not occur.

- As the pump comes on, observe the movement of the check valve swing arm. As the station shuts off, observe the check valve's closure.

- Check the run-time hour meters on each pump to make sure that the pumps are alternating properly and that each pump is receiving equal operating time. The lack of equal run time is usually a sign of failure or impending failure of one of the pumps.

- Review the station's alarm system including main warning light, and LED displays for high wet well level, low wet well level controller failure, low temperature alarm, and vacuum prime pump failure as applicable.

- Read and record the running time meter display for each pump.

- Check the controller display for readings of zero, error, or blank output and refer to the detailed manufacturer's manual should such conditions be noted.

- Use the controller's keypad or controls to clear any previous alarms and to review the station's operation in detail. Instructions for operating the control panel can be found in the operations manual for each pump station.

- Enter data in the pump station's log pad or clipboard.

- Before leaving the station, verify that all control settings are in the automatic mode.

- Make sure that the station and site is locked and secure before leaving.

4.4 GRIT REMOVAL SYSTEM

4.4.1 PROCESS DESCRIPTION

The Brewer treatment facility was upgraded in 1998 to include a state-of-the art aerated grit removal system. The system consists of the following components:

- Two parallel aerated grit chambers are constructed with an uneven cross-section that causes the wastewater to roll and spiral in a longitudal direction as it passes through the reactor. The rolling pattern is caused by the injection of diffused air below the irregular shape of the tank.

- Three aeration blowers and a series of coarse bubble diffusers send air to each reactor to create a rolling pattern. The output of each blower is controlled by a VFD drive. Changing the air output from each blower adjusts the rolling pattern in the reactor and allows it to function over a wide range of flow loadings and grit loadings.

- A screw conveyor on the bottom of each grit chamber collects the settled grit and moves it towards a grit sump. If the air flow into the reactor is properly balanced, only grit should settle in the tank. Suspended organic solids should be discharged out of the reactor and into the treatment plant.

- Two Wemco grit slurry pumps operate periodically to remove grit from the reactor's grit sump and to pump the slurry upstairs to the grit classifiers. These pumps are able to move sand and gravel only because they create a low concentration slurry of large volumes of grit-containing water that the pumps can pass.

- The grit pumps pass the slurry through two Wemco vortex grit classifiers in the grit blower room. These units contain two features. First, a vortex separator causes the slurry to spin and create a centrifugal motion. The heavier grit is washed and falls in one direction while the organic solids that were captured in the grit flow in an opposite direction and are sent back to the plant's headworks. Second, the grit falls into an inclined screw conveyor that moves the grit up to a discharge hopper and leaves the water fraction behind. This action helps to first wash the grit and then discharge the clean grit onto a conveyor belt.

- The grit conveyor carries grit to a storage hopper with a pneumatically operated door above a truck bay. The grit can fall directly into the grit container or truck below or can be stored in the hopper while the truck leaves the site.

<u>4.4.2 DAILY OPERATIONS</u>

Brewer's aerated grit removal system is shown on Figure 12. Flows enter the system through the 20" Ø ductile iron force main into which the Hardy Street, South Main Street and Brewer Cove pump stations all discharge. The operators have the option to use both chambers of the grit system, to use either of the reactors while the other sits idle, or to bypass the entire grit system. With reference to Figure 12:

- SG-101 controls the flow rate into Grit Reactor No. 1.

- SG-102 controls the flow rate into Grit Reactor No. 2.

- SG-103 controls the use of the bypass channel around the grit reactors.

- Under normal conditions, SG-101 and SG-102 would be both open and SG-103 would be closed. During peak flow periods with high grit volumes in the sewer system, both clarifiers should be used. During low flow, dry weather periods, only one grit chamber may be needed.

Figure 12 – Brewers Aerated Grit Chamber

The operation of the grit screws at the bottom of each grit chamber is controlled by a timer in the grit control panel. The operators should set these timers on the basis of trial-and-error over time to determine the most appropriate grit screw settings for different plant flow conditions. If the screws operate too frequently, there will not be sufficient grit to pump. If the screws do not pump frequently enough, they may become overloaded and the grit may become septic and compacted.

Figure 12 shows the two grit slurry pumps that draw the grit and water solution from the reactors. The following valves and controls are noted:

- HV-101 is an isolation valve on the suction side of grit pump No. 1 and HV-102 is an isolation valve on the suction side of grit pump No. 2.

- HV-103 is an isolation valve on the discharge side of grit pump No. 1 and HV-104 is an isolation valve on the discharge side of grit pump No. 2.

- The operation of the two grit pumps is automatic and is controlled by timers in the grit control panel. The grit pumps will generally be cycled to operate in tandem with the screw conveyor out on the floor of each grit reactor.

- Each grit pump has a mechanical seal system with sealing water added. PRV-105 and PRV-106 control the sealing water pressure to each pump. EOV-101 and EOV-102 are electric solenoid valves that feed seal water to each pump only when the pumps are in the "on" position as called for by the grit control panel timer. PI-102 and PI-103 show the seal water pressure. HV-131 and HV-132 are manual ball valves on each seal water line. It is important that both pumps have proper amounts of seal water to protect their mechanical seals.

Figure 12 also shows two 4" Ø carbon steel air supply lines that feed air to a series of 22 coarse bubble diffusers in each tank. Figure 13 shows the layout of the grit aeration blowers in the grit control room. With reference to Figure 13:

- Aeration blower No. 1 feeds grit reactor No. 1 and aeration blower No. 2 feeds grit reactor No. 2. The third blower in the middle is redundant to both grit reactors.

Figure 13 – Grit Blowers and Classifiers

- Each blower has a discharge isolation valve and a discharge check valve. The following valve sequence should be used:

  - Open HV-105 and close HV-106 to use Blower No. 1 to feed grit reactor No. 1.

  - Open HV-109 and close HV-108 to use Blower No. 2 to send air to Grit Reactor No. 2.

  - If the redundant Blower No. 3 is to feed air to grit reactor No. 1, open HV-107 and HV-106 and Close HV-105 and HV-108.

  - If the redundant Blower No. 3 is to feed air to grit reactor No. 2, open HV-107 and HV-108 and close HV-106 and HV-109.

Figure 13 shows the two grit classifiers that wash and refine the grit material. They operate automatically from the grit control panel and will come on and off with the grit pumps. Each grit classifier has a 1" Ø copper water line to keep the hopper flushed. EOV-103 is an automatic solenoid valve that opens when the unit is being operated. HV-114 is a manual isolation valve to the grit hopper water supply. The grit hopper also uses plant air to operate its pneumatic gate. The air flow is regulated by PRV-101 and HV-130.

The operators' daily observation of the overall grit removal system should include the following:

- The slide gates that control the flow to each grit chamber and to the bypass should be set to accommodate the number of grit reactors that will be on-line. This will be a function of the plant flow and incoming grit volume as previously discussed.

- The air rate to each grit chamber should be adjusted with the blower VFD to create an appropriate rolling pattern for the volume of grit that is being treated. The best blower settings for various flow and grit conditions will be determined over time by trial and error. To obtain optimal grit removal efficiency and a clean grit product, more air is needed at higher grit volumes at higher flows.

- Review and record the timer settings of the grit screw, the grit pumps, the grit classifier, and the grit belt conveyor. These settings will be established over time for various levels of plant flow and grit loadings. At higher flow rates and grit loadings, it will be necessary to operate the equipment more frequently.

- Make sure that all seal water equipment and valves are working properly and that seal water is reaching the grit pumps, the grit classifiers, and the grit hopper.

- Observe the operation of the system for one cycle. Make sure that all equipment is operating together and as required.

- Observe the aeration pattern in the grit reactors. If the pattern is uneven, the diffusers may be plugged or not level.

- Observe the chain drives that operate the grit screws in each reactor. If the chains become misaligned, they will wear prematurely and fail. Make periodic adjustments to their alignment as required and keep them properly lubricated.

- Observe the operation of all grit blowers, grit pumps, and conveyor motors. Feel the motors to make sure they are not operating hot and listen for abnormal sounds or noise.

- Inspect the grit classifiers to ensure that they are flowing freely and not plugged.

- Review the grit material being produced by the grit system as it falls onto the grit belt conveyor. The final grit product should be clean, free of organics, and dry.

- Operate the grit hopper door and make sure that it is moving freely.

- Inspect the amount of grit being held in the grit truck or container. It is important to keep space available in the truck prior to the onset of peak flow periods when grit production will be at its highest.

4.5 HEADWORKS GRINDING SYSTEMS AND FLOW METERS

4.5.1 PROCESS DESCRIPTION

The Brewer facility includes two separate headworks areas with influent grinders, one for the plant's municipal flows and one for Eastern's whitewater flows. Figure 14 shows the municipal headworks grinders and Figure 15 shows the whitewater grinder.

With reference to Figure 14, municipal flows can be divided into two parallel influent headworks channels, each having a separate grinder and flow meter.

- SG-201 controls the flow rate to municipal headworks channel No. 1 which contains grinder No. 1 and flow meter No. 1.
- SG-202 controls the flow rate to municipal headworks channel No. 2 which contains grinder No. 2 and flow meter No. 2.
- Grinder No. 1 is a Muffin Monster channel grinder with a traveling screen that directs debris to the grinder cutting area.
- Grinder No. 2 is a Muffin Monster channel grinder with rotating drums that directs debris to the grinder cutting area.
- Each channel has a 12" wide Parshall flume with an ultrasonic flow meter to measure flow. If both channels are on, the meters automatically add their flows together to obtain a composite influent reading for the plant.
- Each flow meter has a stilling well located adjacent to the Parshall flume. The stilling well is connected to the flume with a pipe that allows the stilling well's level to equalize with the flume's water level, and that helps to buffer out any sharp flow changes or turbulence.
- Influent flow samplers for the municipal portion of the plant are taken by sampling equipment located in the headworks channel area.

With reference to Figure 15, the whitewater headworks area consists of two parallel channels. Channel No. 1 contains a Muffin Monster grinder and flow

Figure 14 – Municipal Headworks Area

Figure 15 – Whitewater Headworks Area

meter that uses a 6" wide Parshall flume and an Isco bubbler flow meter. A second parallel channel contains a hand raked screen to be used in the event that the grinder is off-line for repairs. The grinder is located in an area of the plant that is subject to flooding. As a result, a hydraulic drive system is in use that uses fluid to turn the grinder. All electrical drive components that push the fluid through the grinder are located on the second floor above the flooding level.

- To operate the grinder, lift SG-110 and close SG-111.

- To operate the bypass channel, close SG-110 and lift SG-111.

- Sampling equipment for the whitewater influent draws a sample from the whitewater channel up into the adjacent pump room. It is important that this equipment is kept properly cleaned and calibrated in order to obtain representative samples.

- The Parshall flume utilizes a stilling well to buffer out sharp changes in the water levels in the flume.

4.5.2 DAILY OPERATION

The grinders should be inspected daily to ensure that they are operating properly. The operators should perform the following functions:

- Listen to the grinders motors and operation to note any unusual sounds.

- Feel the top of the motors to ensure that they are not abnormally hot.

- Check to see if the grinder control panel shows a green light to indicate normal operation.

- If the grinder's red lights are on either steadily or flashing, grinder failure has occurred. If the red light is steady, it indicates a motor failure condition. If the red light is flashing, it is a sign of grinder failure conditions. Refer to the Muffin Monster operating manual for more specific instructions.

- If the grinders are off-line, flow should be diverted to the emergency bar screens using the hand pull gates provided. The screens should be raked at least daily or whenever excess debris builds up.

- The operation of the traveling screen and the rotating drums in the municipal grinder areas should be checked. At least once per month, the channel to each grinder should be drained and checked for debris accumulation which can damage the screens or drums.

- The operators should check the water elevation flowing through each Parshall flume at least once per month and compare it to the calibration curves for the flumes included as Appendix C and D. If the flow meters are not reading properly, they should be recalibrated. At least once per year, and more often if necessary, a certified instrument technician should be brought to the plant site to calibrate the flow meters.

- The stilling wells below each flow meter should be checked once per month, or more often if necessary, to ensure that no debris has accumulated in the well. Such an accumulation could bias the accuracy of the flow measurement.

4.6 WHITEWATER LIFT PUMPS

Three vertical turbine pumps are utilized to lift Eastern's whitewater up into the main portion of the treatment plant. Whitewater falls into a wet well after passing through the whitewater headworks. As shown in Figure 16, two variable speed pumps and one constant speed pump are available to pump the mill's flow up into the primary splitter box. The pumps are operated automatically on the basis of water level in the wet well.

Normally, variable speed pumps No. 1 and No. 3 will operate in a lead/dry mode and the constant speed pump will be available as a standby pump for peak flow conditions. As shown on Figure 16, the following valve options are available:

- HV-100 and HV-107 isolate the two suction lines from the wet well.

- HV-106 and HV-103 allow the suction lines to be crossed over to any of the three pumps.

- HV-109, HV-105, and HV-102 are isolation valves for the discharge lines of Pump No. 1, Pump No. 2 and Pump No. 3, respectively.

- Each pump also has a check valve as denoted on Figure 16 as CK-101, CK-104, and CK-108.

Figure 16 white water pumps

- All three pumps discharge into a common header that feeds the primary flow splitter box.

4.6.1 DAILY OPERATION

The whitewater pumps should be checked each day to ensure that they are operating properly. The following observations should be made:

- Listen to the pumps as they operate and note the sound of the pump's operation and make note of any unusual noise that could be an early sign of a malfunction.

- Feel the pump motors to note any abnormally high temperature.

- Observe the operation of the air compressors that feed and control the pump's bubbler system as applicable.

- As the pump comes on, observe the movement of the check valve swing arm. As the station shuts off, observe the check valve's closure.

- Read and record the running time meter display for each pump.

- Check to ensure that the pumps are properly alternating and that each pump is running an equal amount of time.

- Enter data in the pump log pad or clipboard.

- Before leaving the pumps, verify that all control settings are in the automatic mode.

4.7 PRIMARY FLOW SPLITTER BOX

4.7.1 PROCESS DESCRIPTION

As shown in Figure 17, the headworks area ends with a primary flow splitter box that allows the operators to collect flow from all three headworks channels and then to allocate these flows to one of the three primary clarifiers or to secondary treatment. The primary splitter box consists of a series of weir gates and slide gates that allow plant flows to be rerouted as follows:

Figure 17 – Primary Splitter Box

- Eastern’s whitewater flow is intended to always receive primary treatment. As long as Primary Clarifier No. 1 is working, open SG-206 and close SG-207 to send all of Eastern’s flow to primary treatment.

- Should Eastern’s primary clarifier be down for repairs, one of the City’s primary clarifiers can be used exclusively for Eastern’s flows. To use Primary Clarifier No. 3 for temporary treatment of Eastern’s whitewater, close SG-206 and SG-203 and open SG-207. The closure of SG-203 is critical to avoid mixing of any peak municipal stormwater flows which might be bypassed around secondary treatment with the high strength Eastern flows that require secondary treatment at all times.

The primary splitter box contains three weir gates that allow the City’s municipal flows to be divided in different ways depending on the process control needs of the plant. With regard to Figure 17:

- SG-203 sends municipal flows to Primary Clarifier No. 3.

- SG-204 sends municipal flows to Primary Clarifier No. 2.

- SG-205 sends municipal flows directly to secondary treatment without any primary treatment.

- During peak flow wet weather periods, all of the City’s flows will normally receive primary treatment. In this case, SG-203 and SG-204 would be open and SG-205 would be closed.

- During dry weather and low loading periods, it may be optimal for the secondary treatment system to receive raw wastewater instead of primary effluent. It will not always be necessary to provide primary treatment for the full municipal wastewater stream. In this case, SG-203 and SG-204 should be closed fully or partially and SG-205 should be opened fully or partially.

- Because of the peak flow stormwater treatment feature of the plant, the municipal flow stream should never be mixed with Eastern’s whitewater flows in primary treatment. In the event that Eastern’s primary clarifier No. 1 is down for repairs, the mill will need to use primary clarifier No. 3. In this case, close SG-203 to prevent the municipal flow from reaching this clarifier.

Because some treatment plants have operated poorly in the past due to neglected equipment being left off-line, there has been some recent regulatory discussion that suggests it is inappropriate to leave any unit processes off-line. In our opinion, it would be incorrect to suggest that the City should not have the flexibility to control the F/M of its aeration basins by using the primary splitter box to send raw sewage directly to secondary treatment. Since this is how this plant was designed, having the primary system off-line during dry weather periods is consistent with the design intent of the Brewer facility and allows the plant to be operated at maximum efficiency.

4.7.2 DAILY OPERATION

During the daily check of the treatment plant, the operators should perform the following duties at the primary splitter box:

- Observe the box to ensure that all gates are properly set and that all flows are being sent to the proper destinations.
- Observe the water levels over the municipal primary clarifier influent weir gates to ensure that all flows are being divided equally.
- Periodically, exercise the weir gate and slide gate operators to ensure that they are well lubricated and functioning properly.
- Ensure that the gates are properly set to accept peak stormwater during wet weather events.
- Ensure that the gate settings are consistent with the plant's F/M process optimization needs during dry weather periods in which not all flow is being sent to primary treatment.

4.8 PRIMARY TREATMENT SYSTEM

4.8.1 PROCESS DESCRIPTION

The plant's three primary clarifiers are each 50 feet in diameter with a 10 foot side water depth. The floor slopes downward toward the center of the clarifiers with a slope of 12 horizontal to 1 vertical. Wastewater flows by gravity from the distribution box underneath the clarifier floor slab, rising into the center feed well. The wastewater is dispersed horizontally outward from the center well around the tank. Settleable solids sink to the bottom of the clarifier. Clarifier effluent continuously overflows weirs into a two foot wide effluent channel just inside the outer wall. Each effluent channel empties into a 24 inch line which runs to the secondary splitter box.

The sludge collecting mechanism for each clarifier consists of two structural steel arms from which adjustable brass squeegee blades are hung. The blades are supported by a rotating drive cage which is supported by the central drive mechanism. The collecting mechanism slowly rotates at about 0.053 rpm (revolutions per minute) and pushes all settled sludge to the center and into the sludge hopper. Primary sludge is pumped from this hopper for further treatment.

A skimming blade attached to the sludge scraper arms continuously moves the skimmings to the outside of the tank into the scum trough. The scum troughs from each primary clarifier empty into a common scum box located on the west end of the control building. Skimmings (scum) are pumped from the scum box for further treatment by blending the scum with the primary sludge flows.

The potential users of each primary clarifier are as follows:

- Primary clarifier No. 1 is dedicated to the treatment of whitewater and cannot treat municipal wastewater.

- Primary clarifier No. 2 is dedicated to the treatment of municipal wastewater and cannot treat Eastern's whitewater.

- Primary clarifier No. 3 can treat both Eastern's whitewater and the City's wastewater. Its use is intended to be primarily for the City's flows and to be used for Eastern's flows only on the rare occasions when clarifier No. 1 is off-line for repairs.

4.8.2 DAILY OPERATIONS

The operation of each primary clarifier should be checked once per shift as follows:

- Observe the rotation of the rake and skimmer arm to ensure that it is moving smoothly across the clarifier's surface area. If the rake is moving in a "jerking" or abrupt manner, this could signify potentially significant rake damage, debris in the reactor, or impending failure. The clarifier should be drained to allow the rake to be inspected.

- Listen for any unusual sounds around the clarifier rake motor and drive gears.

- Feel the clarifier motors and check then for excessive heat or vibration that might indicate process issues.

- Check the rake torque indicator to ensure that it is operating within normal range.

- Hose down the clarifier launders, weirs, water channel and effluent channels to remove any scum, solids or debris.

- Observe the operation of the scum rake on each clarifier and ensure that scum is flowing freely to the scum tank. Hose down the scum trough and lines as needed.

- Check the level of the scum tank and use the primary sludge pumps to remove scum as it accumulates.

- Measure and record the efficiency of the primary clarifiers by comparing the influent BOD, TSS or SS levels with the primary effluent levels.

- Periodically calculate the surface loading rate of the clarifiers and their detention time to compare them to standard design values.

- Check the primary effluent sampler to ensure that it is operating properly, is accurately calibrated, and that its hoses are clean.

4.9 SECONDARY FLOW SPLITTER BOX

4.9.1 PROCESS DESCRIPTION

Primary effluent is processed through the secondary flow splitter box as shown in Figure 18. The purpose of this splitter box is to control the flows of primary effluent into the plant's secondary treatment system. In the past, all primary effluent was automatically sent to the aeration basins for secondary treatment up to their capacity. However, in 1998, as part of the City's Master Plan for CSO Abatement implementation, the City was required to upgrade the plant to allow excess stormwater to enter the facility up to the capacity of the interceptor sewers. These excess stormwater flows must receive preliminary treatment, primary treatment, and disinfection, but are not required to receive secondary treatment. All of Eastern's primary effluent must receive secondary treatment. The secondary flow splitter box allows these flow allocations to be made.

With reference to Figure 18, the secondary flow splitter box serves the following functions:

- Primary effluent from Eastern's primary clarifier No. 1 does not enter the flow splitter box and flows directly into secondary treatment. This prevents this flow from being mixed with any peak stormwater flows that are slated to be bypassed around secondary treatment.

- In the event that Eastern's primary clarifier No. 1 is off-line for repairs and Eastern is using the City's primary clarifier No. 3 on a temporary basis, measures must be taken to keep Eastern's primary effluent separate from the plant's stormwater. These measures include:

    - Close SG-304, SG-302, SG-307, and SG-305.

    - Open SG-303. This diverts all of the effluent from clarifier No. 3 to the secondary treatment system and isolates Eastern's whitewater flows from the City's municipal wastewater flow.

- Under normal operating conditions, all municipal primary clarifier effluent will enter the secondary flow splitter box from both primary clarifier No. 2 and primary clarifier No. 3. In the splitter box, the operators have the option to route the primary effluent as follows:

    - Flow from primary clarifier No. 2 is regulated by SG-306 and SG-309.

    - If SG-306 is open and SG-309 is closed, all effluent from primary clarifier No. 2 flows to secondary treatment.

    - If flows begin to exceed the hydraulic capacity of the secondary system, some of the peak storm flow effluent from

Figure 18 – secondary flow splitter box.

primary clarifier No. 2 can be sent to the chlorine contact tank by dropping the weir gate shown as SG-309.

- If flow is to reach the chlorine contact tank from SG-309, it is also necessary to open SG-308 fully. The purpose for SG-308 is to allow the clarifier No. 2 section of the splitter box to be isolated from the 24” Ø bypass line in the event that clarifier No. 2 is drained for repairs or if the splitter box is being drained. Under normal conditions, SG-308 could be open. It should be noted that the elevations of the plant’s hydraulic profile may allow flow from the chlorine tank to back up into the bypass line. In those cases, SG-308 can remain closed to prevent stagnant water from accumulating.

- Flow from primary clarifier No. 3 is regulated by SG-302 and SG-303.

- If SG-303 is open and SG-302 is closed, all effluent from primary clarifier No. 3 flows to secondary treatment.

- If flows begin to exceed the hydraulic capacity of the secondary system, some of the peak storm flow effluent from primary clarifier No. 3 can be sent to the chlorine contact tank by dropping the weir gate shown as SG-302.

- If flow is to reach the chlorine contact tank from SG-302, it is also necessary to open SG-301 fully. The purpose for SG-301 is to allow the clarifier No. 3 section of the splitter box to be isolated from the 24” Ø bypass line in the event that the clarifier No. 3 is drained for repairs or if the splitter box is being drained. Under normal conditions, SG-301 could be open. It should be noted that the elevations of the plant’s hydraulic profile may allow flow from the chlorine tank to back up into the bypass line. In those cases, SG-301 can remain closed to prevent stagnant water from accumulating.

• The bypass sections of the secondary flow splitter box can be drained between peak flow bypass events to remove any water that is left standing due to the hydraulics of the 24” Ø bypass line with respect to the downstream chlorine contact tank’s water surface. To drain the bypass sections of the tank, do the following:

  - Raise the bypass weirs labeled as SG-302 and SG-309.

  - Close the sluice gates to the bypass line labeled SG-301 and SG-308.

  - Open the drain line valves to remove water from the bypass sections. Open SG-304 and SG-307 to drain the outlet section for clarifier No. 3. In order to do this, clarifier No. 3 must be briefly shutdown to allow water to pass through the common channel shown on Figure 18. Open SG-310 to drain the outlet section from primary clarifier No. 2.

- SG-305 can be used to equalize or isolate the primary effluent flows from clarifier No. 2 and No. 3. If both primary clarifier No. 2 and No. 3 are on-line to treat municipal flows, SG-305 can remain open. If one of the clarifiers is off-line, or if Eastern's whitewater is flowing through clarifier No. 3, SG-305 should be left closed. The operators may also choose to leave SG-305 closed if they do not wish to equalize the flows.

4.9.2 DAILY OPERATIONS

The following daily operations considerations should be taken at the secondary flow splitter box:

- The treatment plant is required to send at least 5.19 MGD to secondary treatment on an average daily basis and at least 9.27 MGD on a peak hourly basis prior to bypassing storm flows to the chlorine contact tank.

- Maximize the amount of flow to secondary treatment to these levels and even higher if possible.

- Adjust the secondary flow splitter box gates, as needed, to bypass peak flows above these levels to the chlorine contact tank.

- During any bypass event, start composite samplers to obtain a sample of primary clarifier effluent. Also, start sampler at secondary flume to collect effluent samples as required by the discharge license.

- Observe the box to ensure that all gates are properly set and that all flows are being sent to the proper destinations.

- Periodically, exercise the weir gate and slide gate operators to ensure that they are well lubricated and functioning properly.

- Ensure that the gates are properly set to accept peak stormwater during wet weather events.

4.10 SELECTOR BASIN

4.10.1 PROCESS DESCRIPTION

All effluent from the secondary flow splitter box is conveyed into the selector basin. All return sludge from the plant's final clarifiers also flows into the selector basin. The 100,000 gallon, mixed selector tank provides a brief period for microbes in the return sludge to react with organic food in the sewage prior to the combined streams flowing into the aeration basins. The selector's role is to provide an environment where floc-forming bacteria in the return sludge will have the opportunity to be exposed to a concentrated organic food supply prior to the aeration basins. Should the plant have filament problems, the filaments in the aeration basin will not be fed until after the floc formers in the selector have assimilated their food. This provides a slight advantage to the floc formers and helps to keep the filaments under control.

The selector is not aerated, but has mixers which operate continually to keep all of the RAS microbes in constant suspension with the incoming food. The lack of applied oxygen forces the microbes to operate in an anoxic mode. Many filaments are unable to fluctuate between alternating aerobic conditions in the aeration basin and anoxic conditions in the selector. This helps to promote the "selection" of floc formers over filaments.

The selector basin should be viewed as one tool in the plant's overall filament control program. It should not be viewed as insurance against all possible filament outbreaks.

Filaments can be caused by a number of waste characteristics or treatment plant conditions including:

- Old sludge from inadequate sludge wasting
- Oil and grease from incoming sewage
- Septic conditions from septic wastes or poor aeration or poor mixing
- Low dissolved oxygen in plant from poor aeration
- Low pH or high pH in plant or from incoming sewage
- High strength soluble wastes
- Low nitrogen content wastes

The best long term approach to filament control is to eliminate or reduce the above causes of filaments from both the sewer system and the treatment plant. However, this is often difficult to completely accomplish and selector basins have been demonstrated to be an effective tool in repressing filament growth.

Not all filaments are hindered by selector basins and the basin should not be viewed as a complete cure to the plant's filament problems. The following Table 16 lists different types of filaments, their causes, and whether a selector basin might be effective in controlling them.

TABLE 16:

SELECTOR EFFECTIVENESS FOR FILAMENT CONTROL

FILAMENT TYPE	TYPICAL CAUSES	SELECTOR EFFECTIVENESS
S. natans	Low dissolved oxygen High strength wastes	Effective
Type 1701	Low dissolved oxygen	Effective
Type 021N	Low nutrient wastes Septic wastes High strength wastes	Effective
Thiothrix spp.	Low nutrient wastes High strength wastes	Effective
N. limicola	High strength wastes	Effective
H. hydrossis	Low dissolved oxygen High strength wastes	Effective
Type 1851	High strength wastes	Effective
Norcardia spp.	Low pH wastes Old sludge age Oil and grease	Effective
Type 0041	Low nutrient wastes	Not effective
Type 0675	Low nutrient wastes	Not effective
Type 0092	Old sludge age	Not effective
M. parvicella	Old sludge age	Not effective

The selector basin has no adjustable operator functions other than the rate at which return sludge is brought into the reactor and the amount of sewage that is brought into the reactor basin. Each of these two flow streams is regulated by sluice gates. The operators have the choice of sending all of part of the return sludge flow to either the aeration basins or the selector. The operators also have the choice of sending all or part of the influent loading to the selector basin, or around the selector and into the aeration basin through the bypass. Initially, and for the most part in the future, the selector will be operated with all return sludge flow and all influent flow being mixed together. This is the simplest mode of operation and the way in which the reactor was designed.

The selector was designed to operate in a normally anoxic mode. This condition is created by not providing any external source of oxygen to the basin. However, there may be periods when measurable levels of oxygen can be found in the selector, most notably during cold weather when high levels of dissolved oxygen may be occurring in the aeration basin or in the influent. During the summer months when warm temperatures limit the amount of dissolved oxygen in the aeration basins and incoming sewer system, it is likely that no oxygen will be available in the selector which will indicate that anoxic conditions are occurring. This should not be a concern since the level of oxygen in the selector will self-regulate itself depending on:

- The level of septicity in the incoming sewage
- The amount of oxygen in the aeration basin
- The level of oxygen depletion that occurs in the clarifiers while settled solids are held before their return to the selector

Floc-former selection can occur in the basin under aerobic, anoxic, or anaerobic conditions. During the summer when the filament control is most critical, anoxic selection will likely occur.

Aerobic selectors rely on maintaining a high F/M ratio in the basin. These create preferential growth conditions for floc-formers such that they absorb food from the influent rapidly. Anoxic selectors utilize this same rapid growth rate and also have the advantage of causing the microbial population to convert from oxygen to nitrate for their respiration reactions. This shift is more intolerable to filaments than floc-formers and the filaments are selected against.

Figure 19 shows the configuration of Brewer’s selector basin. Primary effluent, or raw sewage, from the plant’s primary and secondary flow splitter boxes enters the selector basin via three 24” Ø lines, each terminating with a sluice gate at the selector influent box. The function of these gates is as follows:

- SG-201 is located on the discharge lines from the primary clarifier No. 2 side of the secondary flow splitter box.

- SG-202 is located on the discharge line that receives flows from Eastern's primary clarifier No. 1 and from the primary clarifier No. 3 side of the secondary flow splitter box.

- SG-203 is located on the primary bypass line from the primary flow splitter box. This line feeds municipal plant influent directly to the secondary treatment system in the event that F/M considerations in the aeration basins make is advantageous to increase the organic load to secondary treatment.

Figure 19 also shows the pathway by which return activated sludge from the final clarifiers enters the selector basin. The operators have the option to send the return sludge to either the selector basin or to the aeration basins.

- If SG-403 is open and SG-401 and SG-402 in Aeration Basin No. 1 are closed, then all return sludge from one of the plant's two RAS headers will flow to the selector basin. If SG-403 is closed and SG-401 and SG-402 are closed, the return flow bypasses the selector.

- If SG-404 is open and HV-457 and HV-458 from the plant's other RAS header are closed, then all return sludge flow from this line will be discharged to the selector basin. If SG-404 is closed and HV-457 and HV-458 are opened, the return sludge flow will bypass the selector.

The selector basin has additional valves and gates that allow its two chambers to be operated in series, in parallel, or bypassed as follows:

- If the two selector chambers are to be operated in series, the following valve sequence is used:

    - Open SG-206, SG-207 and SG-208.

    - Close SG-204, SG-205 and SG-209.

Figure 19 – Selector Basin

- If the two selector chambers are to be operated in parallel, the following valve sequence is used:
    - Open SG-204, SG-206 and SG-208.
    - Close SG-205 and SG-207.
- If both chambers of the selector are to be bypassed, flow can be sent directly to the aeration basins as follows:
    - Open SG-205.
    - Close SG-204, SG-206, SG-207, SG-208 and SG-209.
- The selector basin can be drained using mud valves on the floor as follows:
    - HV-201 drains the selector inlet box.
    - HV-202 drains the north selector chamber.
    - HV-203 drains the south selector chamber.

4.10.2 DAILY OPERATION

The selector basin is essentially a passive reactor with few operational controls. The following process control measures should be completed daily:

- Inspect the selector to determine if the mixers are operating properly.
- Ensure that all gates are in the proper position to achieve the desired flow pattern.
- Periodically, evaluate the detention time being provided in the reactor to determine if series or parallel operation is appropriate.
- Track the plant's filament population as measured by the SVI test and relate changes in SVI results to the selector's operating mode.

- If SVI levels decline and indicate a lack of filaments in the plant, consider switching to either a parallel selector operation or to a single chamber on-line. It may also be beneficial to occasionally remove the selector from service for short periods to maintain a filament macrostructure.

4.11 AERATION BASINS

4.11.1 PROCESS DESCRIPTION

The plant's two 450,000 gallon aeration basins represent the heart of the facility's biological treatment process. In these reactors, MLSS microbes are grown to biodegrade the influent organic food supply in the primary effluent. The operators must ensure that the aeration basin environment is optimal at all times for the growth of healthy, good-settling, floc former bacteria.

Surface air is supplied to each basin using two 75 HP mechanical mixers located on the walkway to each basin. Under normal conditions, both aeration mixers should be used for each aeration basin that is on-line in order to provide proper mixing.

Figure 20 shows the overall layout of Brewer’s aeration basins. Flow from the selector basin discharges into a center channel between the two aeration basins which allow the basins to be fed at a variety of locations as follows:

- The aeration basins represent a complete mix hydraulic pattern. Normally, it will be beneficial to add the influent feed at the head of the tank and then let it flow through the reactor to the discharge end. To accomplish this:
    - Open SLG-507 and/or SLG-508 depending on whether one or two basins are on-line.
    - Close SLG-509 in the center channel.
    - Close all other gates off the center channel including SG-501, SG-502, SG-503, SG-504, SG-505 and SG-506.
- The facility also has the ability to be fed in a step-feed manner where the influent to the basins can be added at multiple points. This approach

- Figure 20 – Brewers aeration basins

is often recommended for use where higher flows might wash out the plant or where toxic discharge might kill the microbes. The rationale of step-feed is that the adverse impacts of the high flow or toxic materials will not be as concentrated for the entire basin population if it is spread out over the tank. The step-feed prevents the harmful constituent from creating a plug flow wave through the tank. Step-feed is also recommended to balance loadings across the tank to create more uniform dissolved oxygen levels. In general, we do not see much benefit from using a step-feed approach in Brewer and it has seldom been used in the past. If it is used on an experimental basis, the following valving sequence is used:

  - Open SG-509 in the center channel.

  - Open the side inlet slide gates to each basin (SG-501 to SG-506) at whatever level is selected to distribute the flow along the basin's length.

  - Monitor the basin's performance over time and adjust the flow allocation between each gate accordingly.

- The aeration basins have mud valves on their floor which allow the tanks to be drained. HV-501 serves as the drain for Aeration Basin No. 2 and HV-502 serves as the drain for Aeration Basin No. 1.

4.11.2 PROCESS CONTROL STRATEGY

Brewer's treatment plant has historically operated in a moderate F/M, moderate MCRT, moderate MLSS mode since it opened in 1975. We recommend that the plant be continually operated in the conventional aeration zone with the target ranges shown in Table 17:

TABLE 17:

RECOMMENDED AERATION BASIN PROCESS CONTROL

PARAMETER	TARGET
F/M	0.20 to 0.40
MCRT	8 to 12 days
SVI	100 to 150
MLSS	
Loadings in one basin at current loads	2000 to 4000 mg/l
Loadings in two basins at current loads	1000 to 2000 mg/l
Loadings in one basin at design loads	Two basins needed
Loadings in two basins at design loads	2000 to 4000 mg/l
D.O. Levels	2.0 to 4.0 mg/l
Mixing	Both aerators on

4.11.3 DAILY OPERATIONS

The plant's two aeration basins should be inspected each morning and observed for normal operating issues including mixing patterns, foam, odors, and microscopic activity. We recommend that the following duties be performed by the operators:

- Obtain a MLSS sample and conduct a 5 minute and 30 minute settleometer reading in the lab. Good settling sludge will have a thirty minute reading of 200 to 300 ml/l.

- Conduct an MLSS solids test to determine the concentration of microbes in each reactor. If no volatile solids test is conducted, assume that 85% of the MLSS is MLVSS.

- Check the dissolved oxygen levels in the aeration basins. If the D.O. levels are at least 2.0 mg/l, the plant has adequate oxygen. If the D.O. rises above 2.0 mg/l in the winter when temperatures are cold, use caution in turning the VFD output or mixer speed to less than 50% (or 30 Hz). This low output may result in overheating of the mixer, poor mixing of the basin, settled solids, and the formation of low D.O. filaments. Excess oxygen is not detrimental to the plant.

- Calculate the SVI of the plant using the following equation:

$$\text{SVI} = \frac{(1000)(\text{30 MIN CONE TEST})}{\text{MLSS IN mg/l}}$$

- Calculate the F/M of the plant using the following equation:

$$F/M = \frac{\text{LBS/DAY INFLUENT BOD TO AERATION}}{\text{LBS MLVSS UNDER AERATION}}$$

- Calculate the MCRT of the plant using the following equation:

$$MCRT = \frac{\text{LBS MLSS UNDER AERATION}}{\text{EFFLUENT TSS + WAS TSS} \atop \text{(LBS/DAYS) (LBS/DAY)}}$$

- Calculate the hydraulic detention time of the aeration basins using the following equation:

$$HRT = \frac{\text{BASIN VOLUME IN MG}}{\text{PLANT FLOW IN MGD}}$$

- Look under the microscope at least once per day and make note of the most predominant form of microbes in the system. If filaments are noted and SVI values indicate bulking, send a MLSS sample to a laboratory to determine the species of filaments that are present.

- Conduct an oxygen uptake rate (OUR) test a few times each week to verify that the microbes are healthy.

- Based on the results of the SVI, MCRT, F/M and MLSS analysis, calculate the mass of sludge that must be wasted to maintain the system at its target levels.

- Listen for unusual noises at each aerator and check the aerator motors to make sure that they do not feel abnormally hot.

4.11.4 BIOLOGICAL TREATMENT CONSIDERATIONS

The following considerations may be of interest in optimizing the Brewer facility:

- The treatment plant was designed to function at a hydraulic detention time of 7 hours based on a design flow of 3.03 MGD and with two aeration basins of 450,000 gallons each. For much of the plant's recent life, only one basin has been used and hydraulic detention times have averaged about four hours at typical flows of 3.08 MGD. We recommend that the HRT of the plant be routinely calculated to develop future trends on which HRT values work best. Due to recent low loadings from Eastern, it makes sense to have one aeration basin on-line during low loading periods.

- Conventional wisdom suggests that dissolved oxygen levels of 1.0 to 2.0 mg/l are adequate in an aeration basin. Brewer’s aerators are designed to provide 2.0 mg/l at future design conditions, during peak loading days, when nitrification is occurring, and during hot summer temperatures. High D.O. levels above 2.0 mg/l may occur during cold weather events and on low loading days. There may be a tendency for the operators to reduce the aerator's output on these days, but caution should be used. Each basin needs to keep a sufficient level of mixing to avoid the formation of low D.O. filaments. There is no harm in having excess air in the system and we recommend against turning the aerators down much past 50% of their output.

- If the D. O. in the basin rises suddenly and if a lot of white foam and turbid effluent appears, the plant may be experiencing a toxic dump of acid, caustic, metals, chlorine, or other compounds. Check the oxygen uptake rate to determine if the MLSS is still viable and examine the MLSS under the microscope. If toxic conditions exist, the source of the toxics must be located upstream.

- Excessive white foam on the aeration basin's surface is a sign of over aeration, too little MLSS in the system, or a dead MLSS population after a toxic dump. White foam means that either too much oxygen is in the system or the MLSS microbes are not able to use oxygen.

- Dark brown foam is usually associated with a very old sludge and excessive MCRT, or may be the result of a Nocardia outbreak.

- The aeration basin should have a musty, earthy, humus smell at all times. Any objectionable odor from the basin is a warning sign that not enough oxygen is present. This may be due to low pH, septic conditions, low D.O., poor mixing, or high BOD overloads of the plant.

- The aeration basin's color should be a light to medium brown at all times. Gray colors are a sign of insufficient MLSS and recent solids washout. Dark brown colors indicate old sludge with a high MCRT. Black colors are the sign of emerging septic conditions.

- The biology of the process will change seasonally due to temperature fluctuations and seasonal microbial activity changes. In the summer, the MLSS will work faster in the warm water and less microbes may be needed to achieve the same treatment results as in cold winter conditions. Changes in the wasting rate and the aeration output may be needed to maintain the plant at its target levels.

- Microbes in the MLSS work best at a pH of 6.5 to 8.5. Low pH may cause filaments to form and high pH may result in the precipitation of the plant's nutrients out of solution. The operators should investigate the upstream causes of high or low pH conditions and take corrective action as required.

- Nitrogen and phosphorus represent critical nutrients that are essential for microbial growth. Low nutrient levels can lead to filament blooms. Generally, a ratio of 100/5/1 is required for BOD/N/P. Raw sewage usually has sufficient nutrients, but may be deficient under specific F/M or pH conditions.

4.12 SECONDARY CLARIFIER FLOW SPLITTER BOX

4.12.1 PROCESS DESCRIPTION

The Brewer facility has two aeration basins of equal size and four final clarifiers of unequal size. The two 450,000 gallon aeration basins discharge over an effluent weir and feed two 65’ Ø final clarifiers and two 55’ Ø final clarifiers. A splitter box system, as shown on Figure 21, allows the operators to balance the flow between the plant’s four final clarifiers.

Figure 21 – secondary clarifier from splitter box

- To send flow from Aeration Basin No. 1 to the final clarifier splitter box, open SG-219.

- To send flow from Aeration Basin No. 2 to the final clarifier splitter box, open SG-218.

- HV-301 equalizes the discharge flow between both aeration basins and their respective portions of the splitter box.

  - If both aeration basins are on-line, HV-301 would normally be open.

  - If either aeration basin is off-line, HV-301 would be closed.

- Four sluice gates are used to divide flow between the four final clarifier as follows:

  - SG-301 controls the flow to Final Clarifier No. 4.

  - SG-302 controls the flow to Final Clarifier No. 2.

  - SG-303 controls the flow to Final Clarifier No. 3.

  - SG-304 controls the flow to Final Clarifier No. 1.

- When different groups of clarifiers are brought on-line, SG-301, SG-302, SG-303, and SG-304 are adjusted to maintain the proper flow balance. The flow can be initially set by observing the splitter box gates, but should then be checked in more detail by observing the amount of water flowing over the clarifier weirs. It is important to balance all flows to allow even loading of the clarifiers.

- HV-302, HV-303, HV-304, and HV-305 allow the feed lines to each clarifier to be shut off in the event that a clarifier is off-line for service.

4.12.2 DAILY OPERATIONS

The following operational measures should be performed on the final clarifier flow splitter box:

- Observe the flow pattern in each box to ensure that flows are being sent to the proper clarifier configuration.

- Check the water level flowing over the weirs in each clarifier to determine if the clarifiers are properly balanced. Periodically exercise all valves and gates to make sure that they are well lubricated and functional.

4.13 FINAL CLARIFIERS

4.13.1 PROCESS DESCRIPTION

MLSS from the aeration basins flows from the secondary clarifier flow splitter box into the plant's four final clarifiers. Two units are 65’ Ø with a sidewall depth of 12’ feet and a sloped bottom while the other two are 55’ Ø with a 12’ sidewall depth. The clarifiers are designed to provide a quiescent settling zone in which MLSS will fall to the bottom of the tank and leave clean water behind. The operators remove sludge from the bottom of each clarifier using a return pump. Additional pumps can be used to waste excess sludge from the system. Floating solids and debris can be removed from the clarifier surface by a scum drawoff system.

Figure 22 shows the general layout of the plant’s four clarifiers. The plant may need to operate all four units during peak flow periods, but is designed to operate on two units if needed. The decision on how many units to operate should be made daily on the basis of the following factors:

- Flow rates into the plant.

- Amount of MLSS held under aeration.

- Settleability of the MLSS as measured by the SVI test.

- The return sludge rate of the plant.

- The solids flux loading created by the applied MLSS mass onto the available clarifier surface area.

Figure 22 – final clarifiers

The Brewer plant has the flexibility to alter the amount of surface area available by bringing clarifiers on-line or by taking them off-line as follows:

- Final clarifiers No. 1 and No. 2 have a 55’ Ø diameter each with a surface area of 2400 SF/each.

- Final clarifiers No. 3 and No. 4 have a 65’ Ø diameter each with a surface area of 3300 SF/each.

4.13.2 DAILY OPERATION

The plant operators should review the final clarifiers each day to assess their condition and to make process adjustments as needed. These duties include:

- The clarifier rake arms should be checked to verify that they are turning freely.

- The clarifier's sludge blanket depth should be checked. Blankets should ideally be one or two feet deep. Shallow blankets will result in dilute sludge for wasting. Deep blankets are prone to solids washout and may become septic. Return sludge pumping rates should be selected that maximize the solids concentration without causing septic conditions or rising sludge to occur. In general, sludge should not be held in the clarifier for more than one hour to prevent septic conditions from developing. The return sludge pump's VFD drives should never be operated at less than 50% output.

- A sample of the RAS flow should be collected daily and tested for solids concentration.

- The return sludge rate in GPM should be read off of the flow meters and expressed as a percentage of plant flow as follows:

$$\text{RAS Rate} = \frac{(\text{RAS in GPM})\ (100\%)}{\text{Plant flow in GPM}}$$

- Target values for the RAS rate should be 25 to 75 % for a conventional aeration system.

- The clarity of the plant's final effluent should be reviewed. If the effluent exhibits dispersed floc, the plant's F/M is too high and the MCRT is too low. If the plant exhibits pin floc, the F/M may be too low and the MCRT too high.

- Rising gas bubbles or clumps of sludge in the final clarifiers are signs of sludge dentitrification. This is the result of excessive sludge blanket depths, too low RAS rates, or problems with the return sludge withdrawal system.

- The solids flux of the final clarifiers should be checked daily as follows:

- If the solids flux approaches or surpasses 24 lbs/day/SF at an SVI of 100, the clarifier blanket may not be able to settle. The flux rate can be reduced by lowering the MLSS, by lowering the RAS flow, or by bringing additional clarifiers on-line. The allowable solids flux loading rate is a function of the settleability of the sludge as measured by the SVI test. Table 18 relates the allowable clarifier solids flux loading to the SVI of the sludge. As the SVI increases, the allowable solids loading rate decreases:

TABLE 18:

RELATIONSHIP OF APPLIED CLARIFIER SOLIDS FLUX TO SLUDGE SETTLEABILITY AND FILAMENT POPULATION

SVI (ml/g)	AVG. DAILY FLUX (LBS/DAY/SF)	PEAK HOURLY FLUX (LBS/DAY/SF)
75	30	60
100	24	48
125	23	46
150	20	40
175	18	36
200	15	30

The Table 18 data shows that, as filaments begin to take over the MLSS, the plant’s SVI increases and the sludge settleability is reduced. Under these conditions, the allowable applied solids flux limits decrease rapidly. Any time that filaments begin to take over the plant, it is important to take corrective action to remove them. The above data shows that the urgency of this action becomes more critical during high flow periods. If filaments are present when the plant is receiving high flows, the facility will become inherently unstable at much lower clarifier solids flux loadings.

- Scum from the final clarifiers should be wasted automatically. The operators should check to see that the scum tank has sufficient volume available. After all the scum has been wasted, additional water should be used to flush out the lines so they will not plug.

4.14 RETURN SLUDGE PUMPS AND FLOW METERS

4.14.1 PROCESS DESCRIPTION

Settled sludge from each final clarifier is removed from the clarifiers' bottom using a return sludge pump. Each pump withdraws solids and sends the sludge back to the plant's selector basin and aeration basins. The pump's output rate can be controlled using a VFD. Actual output rates can be measured using the flow meter on each line. More detailed operations and maintenance requirements for the RAS pumps and flow meters can be found in the manufacturer's manual for each process.

Figure 23 shows the schematic layout of Brewer's five return activated sludge (RAS) pumps. The pumps have extensive flexibility in their valving to allow various combinations of pump operation to occur. The plant's design intent is to have one RAS pump assigned to each final clarifier. The plant has several operating options for the RAS pumps as follows:

- All four clarifiers send their RAS sludge into a common header pipe. Each clarifier has an isolation valve into the header pipe as follows:
  - HV-401 isolates final clarifier No. 1 from the RAS header.
  - HV-402 isolates final clarifier No. 2 from the RAS header.
  - HV-403 isolates final clarifier No. 3 from the RAS header.
  - HV-404 isolates final clarifier No. 4 from the RAS header.

Figure 23 – return sludge pump configuration

    - These isolation valves will either be fully open or fully closed depending on whether the respective final clarifier is on-line or off-line.

- RAS Pump No. 1 is intended to be available to serve either final clarifier No. 1 or final clarifier No. 3 as follows:

    - If RAS Pump No. 1 is serving final clarifier No. 1, open HV-416 and close HV-406.

    - If RAS Pump No. 1 is serving final clarifier No. 3, RAS pump No. 3 must be off-line. Open HV-416, HV-406, and HV-407. Close HV-408 and HV-417.

- RAS Pump No. 2 is intended to be available to serve either final clarifier No. 2 or final clarifier No. 3 as follows:

    - If RAS Pump No. 2 is serving final clarifier No. 2, open HV-418, HV-409, and HV-410, and close HV-411 and HV-408.

    - If RAS Pump No. 2 is serving final clarifier No. 3, Open HV-418 and HV-408. Close HV-409 and HV-407.

- RAS Pump No. 3 is intended to be available to serve either final clarifier No. 1 or final clarifier No. 3 as follows:

    - If RAS Pump No. 3 is serving final clarifier No. 3, open HV-417 and HV-407. Close HV-408 and HV-406.

    - If RAS Pump No. 3 is serving final clarifier No. 1, RAS pump No. 1 must be off-line. Open HV-417 and HV-406. Close HV-407 and HV-416.

- RAS Pump No. 4 is intended to be available to serve either final clarifier No. 2 or final clarifier No. 4 as follows:

    - If RAS Pump No. 4 is serving final clarifier No. 2, open HV-420 and close HV-410 and HV-412.

- If RAS Pump No. 4 is serving final clarifier No. 4, RAS pump No. 5 must be off-line. Open HV-420 and HV-412. Close HV-422 and HV-411.

- RAS Pump No. 5 is intended to be available to serve final clarifier No. 4 as follows:

  - Open HV-422 and close HV-412.

- The above valving sequence is applicable for the use of all four clarifiers and four of the five RAS pumps at any one time. In the event that some of the clarifiers are down, additional RAS pump combinations can be achieved with the flexibility that is available on the RAS header.

All five RAS pumps ultimately tie into two common discharge headers that carry the return sludge back to the selector basin or aeration basins. The design intent of the plant is to have no more than two RAS pumps discharging into each of the two headers at any one time. In addition, the flow from each RAS pump must pass through a magnetic flow meter to allow it to be measured prior to reaching the header. There are four magnetic flow meters that must be allocated from the five possible RAS pump combinations. All of these pumps discharge into a common header that offers many valving possibilities in order to reach different flow meters or header locations. The following provides a general description of the typical valve sequences:

- RAS Pump No. 1 will normally discharge through RAS flow meter No. 1. Open HV-424 and HV-449 and close HV-442.

- RAS pump No. 2 will normally discharge high RAS flow meter No. 2 or No. 3 depending on whether RAS Pump No. 3 is on-line. If RAS pump No. 3 is operating along with RAS pump No. 2, then RAS pump No. 2 should use RAS flow meter No. 3. If RAS pump No. 3 is off, then RAS pump No. 2 should use RAS flow meter No. 2.

  - For RAS pump No. 2 to use RAS flow meter No. 2, open HV-426 and HV-444. Close HV-445 and HV-443.

  - For RAS Pump No. 2 to use RAS flow meter No. 3, open HV-426 and HV-445 and close HV-444 and HV-446.

- RAS Pump No. 3 will normally discharge into RAS flow meter No. 2. Open HV-425 and HV-443 and close HV-444 and HV-442. (This pump can also discharge into either RAS Flow meters No. 1 or No. 3 as long as either RAS Pump No. 1 or No. 2 are off-line).

- RAS Pump No. 4 will normally discharge into RAS Flow Meter No. 3 or RAS Flow Meter No. 4 depending on whether RAS Pump No. 5 or RAS Pump No. 2 are operating.

  - For RAS Pump No. 4 to use RAS Flow Meter No. 3, open HV-428 and HV-446 and close HV-447 and HV-445. (RAS Pump No. 2 must be shifted to RAS Flow meter No. 2 at the same time).

  - For RAS Pump No. 4 to use RAS Flow Meter No. 4, open HV-428, HV-447, and HV-452 and close HV-446 and HV-430. (RAS Pump No. 5 must be off during this sequence).

- RAS Pump No. 5 will normally use RAS Flow Meter No. 4. Open HV-430 and HV-452 and close HV-447. (RAS Pump No. 4 must be shifted to RAS Flow Meter No. 3 at the same time).

- The above RAS pump and flow meter sequences refer to the scenario where all four clarifiers are on-line. If one or more clarifiers are off-line, there are numerous other valving sequences that could be used given the versatility of the header system).

- Each RAS pump has a seal water line that flows from a 1” Ø copper water supply header. The seal water should be on whenever each RAS pump is operating.

4.14.2 DAILY OPERATION

The RAS pumps and flow meter systems should operate continuously. Each day, the plant operators should do the following:

- Observe the operation of the RAS pumps and make note of any unusual noises or temperatures that could indicate an impending problem.

- Adjust the RAS flow rate based on sludge blanket depth, solids content, MLSS settling characteristics, and plant flow rate. Under no circumstances should the VFD drive be turned below 50 % of its maximum output. Slowing the motor down to lower levels may cause it to burn out.

- The RAS flow rate should be measured and recorded.

- The RAS pump pressure should be observed and recorded.

- The RAS flow rate should be considered in terms of the applied solids flux rate to the final clarifiers. If flux rates are too high, the RAS rate should be lowered, especially during peak plant flow periods.

- A sample of the return sludge flow should be taken and measured for solids concentration each day.

4.15 EFFLUENT DISINFECTION SYSTEM

4.15.1 PROCESS DESCRIPTION

Effluent from Brewer's final clarifiers must be disinfected prior to its discharge into the Penobscot River. At present, the plant's discharge license requires that disinfection take place between May 15 and September 30 of each year. The plant's disinfection system consists of the following components:

- A 200,000 gallon chlorine contact tank divided into two sections of 100,000 gallons each.

- Metering pumps to feed sodium hypochlorite solution into the contact tank.

- Two Parshall flumes and ultrasonic flow meters at the head of the tank to measure flow and to flow pace the chlorine feed pumps.

- A dechlorination section after the chlorine contact tank that allows the plant to add sodium bisulfite, if needed, to reduce effluent chlorine residual levels.

Figure 24 shows the configuration of Brewer's chlorine contact tank. Flow enters the reactor through two 24" Ø lines, one from the final clarifiers that contains secondary effluent and one from the secondary flow splitter box that contains any peak wet weather flows that are being bypassed around secondary treatment. Each

Figure 24 - chlorine contact reactor

line has its own 18” wide Parshall flume for flow measurement, its own ultrasonic flow meter in a stilling well, and its own flow-paced sodium hypochlorite feed system for chlorine addition.

The normal flow path for the reactor is to blend both effluents and to then use the entire reactor volume in series. Under normal operation, the following valve sequence should be used:

- Open SG-401, SG-403, SG-406 and SG-405.

- Close SG-402 and SG-404.

In the event that it becomes necessary to isolate Chlorine Contact Tank No. 1 for service or cleaning, the following valve sequence is used:

- Open SG-402.

- Close SG-401 and SG-403.

- Close process water line HV-403 (if it is not already closed as it would normally be).

- Contact tank No. 1 is now isolated and ready to be drained by opening up either or both drain lined HV-401 or HV-404.

In the event that it becomes necessary to isolate Chlorine Contact Tank No. 2 for service or cleaning, the following valve sequence is used:

- Open SG-401, SG-403, and SG-404.

- Close SG-402, SG-406, and SG-405.

- Close process water line HV-407 and open process water line HV-403. (It should be noted that when Contact Tank No. 2 is off-line, the plant’s process water will have been disinfected over a shorter contact time than normal. It may be necessary to adjust the chlorine dose to compensate for the reduced contact time).

- Open the contact tank drain lines at HV-406, HV-408 and HV-409.

If it becomes necessary to clean debris out of the dechlorination section of the tank, drain line HV-405 can be used for this purpose.

Three process water pumps are used to provide carrier water to help disperse chlorine solution into the diffusers which are located just upstream of the two Parshall flumes. These pumps take plant process water off a common 4” Ø header and feed three booster pumps. Each pump has a suction valve labeled as HV-450, HV-451 and HV-452 on Figure 24. A series of discharge valves labeled HV-453 to HV-457 and HV-442 to HV-443 allows the process water from any pump to be sent to either flume. The purpose of the carrier water is to help disperse the chlorine solution more uniformly across the flume. Chlorine is injected to each carrier line at HV-440 and HV-441.

The contact tank has a series of drain valves along its west side. Under normal operations, these drains should be closed as labeled on Figure 24 as HV-401, HV-404, HV-405, HV-406, HV-408 and HV-409.

The contact tank also has a series of valved drawoff points along its west wall that allows treated effluent to be used as process water in the plant. Under normal operating conditions, process water should be taken off the end of the tank as follows:

- HV-407 is normally open as long as the full chlorine tank volume is in use.

- HV-403 is normally closed as long as the full chlorine tank volume is in use.

4.15.2 DAILY OPERATION

During chlorination season, the plant’s chlorine contact tank and chemical feed system should be checked frequently to ensure that it is operating properly and effectively disinfecting the plant’s effluent. As previously discussed, water quality classifications in the Penobscot River are primarily based on dissolved oxygen and bacteria levels. Brewer’s effluent is more likely to impact bacteria levels in the river than dissolved oxygen. This makes the plant’s disinfection system one of the most important processes in the entire treatment plant.

Since excess solids and foam in the plant’s effluent greatly reduces the disinfection efficiency of the process, it is essential that the cleanest possible effluent be sent into the chlorine contact tank. Solids and foam create a high chlorine demand which makes much of the applied chlorine dose unavailable for downstream disinfection. In addition, pathogens may be harbored in the solids and foam and can pass through the tank without ever being fully disinfected. The plant's contact tank is intended to process clean water and should not be used as a final location for solids and scum capture. Upstream systems designed for the removal of scum, foam, and solids should be used for that purpose. The chlorine tank should be pumped out twice per year to ensure that any residual effluent solids are removed. Any floating solids should be removed on a daily basis using a skimmer.

The operators should perform the following daily duties in the disinfection area of the plant:

- Inspect the chlorine tanks, flow meters, process water pumps, chemical feed pumps and chemical feed lines to ensure that all systems are operating properly.

- Measure and record the amount of sodium hypochlorite consumption at the plant to note the amount of disinfection chemicals used.

- Check the available chemicals in the active feed tank to make sure that the plant does not run out of chlorine especially over nights or weekends.

- Check the inventory of chemicals to make sure that sufficient supply is available. The operators should note that sodium hypochlorite has a short shelf life and degrades in strength when exposed to light or heat.

- The operator should check the water elevation flowing over the Parshall flumes at least once per month and compare it to the calibration curve for the flumes included as Appendix E. If the flow meters are not reading properly, they should be recalibrated. At least once per year, and more often if necessary, a certified instrument technician should be brought to the plant site to calibrate the flow meter.

- At least twice per year, the tank should be pumped out and cleaned. This should be done during the off-season period when disinfection is not required.

- The chlorine metering pumps are designed to be flow-paced off the effluent flow meters. The operators have the ability to adjust both the pump's output and stroke rate to alter the amount of chlorine that is pumped. A starting dose of 10 mg/l should be used for the secondary effluent and 20 mg/l for the bypass effluent and then adjusted by trial and error. More detailed operating information on the chlorine feed pumps can be found in the manufacturer's operating manual.

- The operator must conduct chlorine residual tests before the dechlorination chamber and in the plant's final effluent. The present license requires these tests to be conducted during chlorination season.

- All sluice gates, buried plug valves, drain and process water valves, and chemical feed valves should be periodically expressed to ensure that they function properly. All valve stems should be properly lubricated.

4.16 PRIMARY SLUDGE WASTING AND THICKENING

4.16.1 PROCESS DESCRIPTION

Primary sludge removed in the primary clarifiers consists of raw pollutants that are settleable within the detention time allowed in the reactors. Since no upstream stabilization has occurred, sludges created in the primary clarifiers represent raw municipal or papermill waste with a high organic compared. To prevent odorous or nuisance conditions from developing in the clarifiers, it is important to remove the settled primary sludge on a frequent basis. Sludge is pulled from the clarifier bottom using one of four centrifugal sludge pumps.

Figure 25 shows the general layout of Brewer's primary pump system. The design intent of the plant is to operate one sludge pump for each active clarifier and to use the fourth pump as a spare unit. Sludge flows from the clarifiers are sent to either the municipal or the Eastern gravity thickener. Flow meters on the discharge side of each pump allow the primary sludge flow rates to be measured.

Primary sludge is pumped from the clarifiers into two 20' Ø gravity thickeners. One unit is reserved for Eastern's whitewater sludge from Primary Clarifier No. 1 while the other unit is used for municipal sludge from Primary Clarifiers No. 2 and No. 3. The thickeners function as second sludge settling reactors where the solids previously settled in the primary clarifiers are given a second opportunity to settle and compact. This allows the solids concentration of the sludge to increase. Water decanted from the reactors is allowed to overflow weirs around the thickener's periphery and is returned to the plant's headworks for further treatment.

With reference to Figure 25, primary sludge from all three clarifiers enters a common header pipe in the primary pump room. While a variety of pump sequencing options are possible, the following is the typical mode of operation:

- Primary sludge pump No. 1 will typically be used to send Eastern's primary sludge to gravity thickener No. 1. To accomplish this:
    - Open HV-601, HV-602, HV-603, HV-604, and HV-605.
    - Close HV-617 and HV-606.
- If primary sludge room No. 1 fails, primary sludge pump No. 2 can be used to pump Eastern's sludge from Primary Clarifier No. 1 to gravity thickener No. 1 using the following sequence:
    - Open HV-601, HV-617, HV-618, HV-619, HV-612, HV-606, HV-604 and HV-605.
    - Close HV-602, HV-621, HV-620, HV-608 and HV-603.
- Primary sludge from municipal Primary Clarifier No. 2 is typically pumped to municipal gravity thickener No. 2 using primary sludge pump No. 4 with the following valve sequence:
    - Open HV-636, HV-628, HV-629, HV-630, HV-633, HV-634, and HV-635.
    - Close HV-625, HV-611, HV-632 and HV-631.
- If primary sludge pump No. 4 fails, sludge from Primary Clarifier No. 2 can be pumped to gravity thickener No. 2 as follows:
    - Open HV-636, HV-625, HV-623, HV-624, HV-626, HV-632, HV-633, HV-634 and HV-635.
    - Close HV-628, HV-622, HV-620, HV-630 and HV-631.

Figure 25- primary sludge pump configuration

- Municipal primary sludge from Primary Clarifier No. 3 is typically pumped to municipal gravity thickener No. 2 using either primary sludge pump No. 2 or No. 3. If pump No. 2 is used:

    - Open HV-627, HV-621, HV-618, HV-619, HV-620, HV-626, HV-632, HV-633, HV-634, and HV-635.

    - Close HV-622 and HV-612. Also, close either HV-624 or HV-630 depending on whether primary pump No. 3 or No. 4 is off.

- If Primary sludge Pump No. 3 is used to pump municipal sludge from Primary Clarifier No. 3 to gravity thickener No. 2, use the following sequence:

    - Open HV-627, HV-622, HV-623, HV-624, HV-626, HV-632, HV-633, HV-634 and HV-635.

    - Close HV-621, HV-620, and HV-631. Also close HV-619 or HV-630 depending on if either primary pump No. 2 or No. 4 are off.

- On rare occasions, Primary Clarifier No. 1 may be off-line for service and Eastern may have to use Primary Clarifier No. 3 to treat its wastes. In order to use Primary Sludge Pump No. 2 to send Eastern's sludge from Primary Clarifier No. 3 to gravity thickener No. 1, use the following sequences:

    - Open HV-627, HV-621, HV-617, HV-602, HV-603, HV-604, and HV-605.

    - Close HV-622, HV-618, HV-611, HV-610, and HV-606.

- The valve layout in the primary pump room allows additional operator flexibility which will not typically be needed including the following:

    - Depending on which primary clarifiers are on-line or off-line, multiple combinations of pump use with various clarifiers can be achieved.

    - It is possible to pump sludge from any clarifier using any sludge pump to any thickener.

- It is possible to pump sludge directly to the belt presses and bypass the thickeners.

- It is possible to pump sludge outside to the primary scum tank from where a septic tank truck could haul it away for disposal should the sludge presses fail.

- The primary sludge pump room also contains a scum pump which is used to remove scum from the primary scum storage tank and pump it to the belt filter presses using the following sequence:

  - Open HV-610, HV-609, HV-613 and HV-614.

  - Close HV-611 and HV-608.

- Should the primary scum pump ever fail, primary sludge pump No. 4 can be used as a temporary backup by opening HV-611 and closing HV-610. The scum can be discharged from primary sludge pump No. 4 to the press by opening HV-631 and closing HV-613, HV-632 and HV-633. While the scum is being pumped by Pump No. 4, it may be necessary to stop pumping primary sludge.

4.16.2 DAILY OPERATIONS

The primary sludge pumps, gravity thickeners and flow meter systems should operate continuously. Each day, the plant operators should do the following:

- Observe the operation of the primary sludge pumps and make note of any unusual noises or temperatures that could indicate an impending problem.

- Adjust the pumps flow rate based on sludge blanket depth, solids content, and plant flow rate. Under no circumstances should the VFD drives be turned down below 50 % of their maximum output. Slowing the motors down to lower levels may cause them to burn out.

- The primary sludge flow rate should be measured and recorded.

- The primary pump's pressure should be observed and recorded.

- A sample of the primary sludge flow should be taken and measured for solids concentration each day.

- The gravity thickeners should be inspected. Any solids or scum accumulations should be hosed down.

4.17 BIOLOGICAL SLUDGE WASTING AND THICKENING

4.17.1 PROCESS DESCRIPTION

Wasting excess sludge from the plant's activated sludge process is one of the most important operational tools available to control the quality of the final effluent produced by the facility. As previously discussed, sludge wasting allows the F/M and MCRT to be maintained in a range determined to be the most successful in producing good settling floc-formers and a clear effluent.

Based on the type of process control methods selected to operate the plant, the operators will determine the total amount of excess sludge mass that must be removed from the facility. This mass will, in turn, be converted to gallons of required liquid sludge that must be pumped from the plant. In order to calculate the volume in waste gallons needed to remove the target sludge mass, the operators will also need to calculate the return sludge solids concentration which is equal to the waste sludge concentration. There will also need to be a direct measurement or estimate of the MLVSS content of the MLSS if wasting is to be based on an F/M calculation.

The plant's waste sludge pumps are connected to the same common header used to return sludge. The return sludge flow becomes the waste sludge flow when the waste sludge pumps are activated. Waste sludge is sent to a DAF sludge thickener and briefly held in a storage tank to allow further thickening and water separation to occur. Polymer coagulants are added to enhance this process. Sludge is then transferred into the sludge belt presses after thickening while the decant water is returned to the aeration basins. The amount of sludge wasted can be measured using the waste sludge flow meters during the period that sludge is being transferred to the wasting system.

4.17.2 SLUDGE WASTING CALCULATIONS

Over time, operators generally get a good feel of how much sludge they need to waste to keep their biological process at the required equilibrium level. Plants often operate around a loose target level of wasting and are then checked the next day to see what effect the wasting had on the process. This then allows wasting adjustments on the subsequent day in response to the previous observations made based on the effect that the previous wasting approach had. While this method is somewhat unscientific, it works in many plants because it originates with a scientific basis, it evolved to current arbitrary targets by trial and error over time, and the influent loading rates to most plants are fairly constant. In Brewer's case, the plant's wasting operation may evolve to a viewpoint that wasting about "X" gallons per day of sludge at "Y" concentration seems to provide a good effluent. Prior to that occurring, a scientific wasting basis can be used to establish initial targets. The plant can then be adjusted by trial and error to more arbitrary wasting ranges. It is important to note that arbitrary sludge wasting can only be successful if the plant's influent BOD loading is relatively constant.

a) F/M WASTING BASIS EXAMPLE

All sludge wasting approaches ultimately are based on F/M even if organic food is not implicitly measured due to the five-day delay in obtaining BOD results. In essence, all wasting methods are attempting to control the MLVSS population (M) in order to keep it in balance with the incoming BOD food (F) supply.

Suppose it is determined that an optimal target F/M is 0.30, the BOD into the aeration basin is 2800 lbs/day and the RAS concentration is 0.5% or 5000 mg/l. The operators measure the MLSS in the aeration basins with two basins on-line and find that the MLSS is 2000 mg/l. How much sludge should be wasted?

First, the operators must determine how much MLSS should be in the basins to maintain the target F/M of 0.30. This can be found from the following equation:

$$\frac{F}{M} = \frac{\text{LBS/DAY INFLUENT BOD INTO AERATION}}{\text{LBS MLVSS IN AERATION BASIN}}$$

At an F/M target of 0.30 and at a BOD loading of 2800 lbs/day, the required MLVSS can be found to be 9350 lbs as follows:

$$\frac{F}{M} = 0.30 = \frac{2800}{\text{MLVSS}}$$

MLVSS = 9350 LBS

The operators either measure or estimate the volatility of the MLSS. Assuming that it is determined that MLVSS is about 85% of the MLVSS, the operator must then calculate the MLSS target as follows:

$$MLSS = \frac{MLVSS}{\%\ VOLATILITY}$$

$$= \frac{9350\ LBS}{0.85}$$

$$= 11{,}000\ LBS$$

This means that 11,000 lbs. of MLSS are required in the two aeration basins to maintain an F/M of 0.30 at a BOD loading rate of 2800 lbs/day.

The operators have measured the actual MLSS contained in the two 450,000 gallon aeration basins and have found that 2000 mg/l of MLSS are present. The pounds of MLSS in the basins can be found as follows:

$$LBS=(MG)(mg/l)(8.34)$$

Therefore,

$$LBS\ MLSS = (0.90)(2000)(8.34)$$

$$= 15{,}000\ LBS\ MLSS$$

The operator has 15,000 pounds of MLSS but only wants to keep 11,000 pounds. This means that there are 4,000 pounds of excess MLSS in the aeration basins that must be wasted. This mass can be converted to gallons using the following equation:

$$GPD = \frac{LBS\ MASS}{(\%\ SOLIDS)(8.34)}$$
FRACTION

Since the return and waste sludge concentrations are 0.5%, or 0.005 if expressed as a fraction, the required wasting rate in gallons is:

$$\text{GPD WAS} = \frac{\text{4000 LBS}}{(0.005)(8.34)}$$

$$= \text{95,000 gallons per day}$$

In order to waste 95,000 gallons of sludge, the operators would need to pump about 200 gallons of sludge per minute for about eight hours. The waste sludge flow meters can be used to measure the exact amount of sludge wasted.

b) MCRT WASTING BASIS EXAMPLE

Because of the five-day delay required for the BOD test results used in F/M calculations, MCRT has emerged as an alternative method of process control for calculating required sludge wasting. The MCRT represents the average sludge age of the system and can be related to F/M; however, it requires only TSS and MLSS laboratory data which can be obtained in just a few hours instead of the five days needed to obtain BOD data.

Suppose the operators found over time that the plant works best at an MCRT of 8 days. The MLSS in the plant's aeration basins was 2000 mg/l and the RAS was 5000 mg/l on a day when the plant flow was 3.00 MGD and the effluent TSS was 5 mg/l. How much sludge should be wasted to maintain an MCRT of 8 days?

The equation for MCRT is:

$$\text{MCRT} = \frac{\text{LBS MLSS}}{\text{LB/DAY WAS + LB/DAY EFFLUENT TSS}}$$

The MLSS under aeration is:

$$\text{LBS MLSS} = (0.90)(2000)(8.34)$$

$$= \text{15,000 LBS}$$

The effluent TSS loss is:

$$\text{LBS EFF TSS} = (3.00)(5)(8.34)$$

$$= 125 \text{ LBS /DAY}$$

Substituting into the above equation yields the required lbs/day of wasting as follows:

$$8 = \frac{15,000}{\text{WAS} + 125}$$

$$\text{WAS} = 1750 \text{ LBS/DAY}$$

The value can be converted to gallons per day as follows using an RAS concentration of 0.5%:

$$\text{GPD WAS} = \frac{1750}{(0.005)(8.34)}$$

$$= 42,000 \text{ GPD}$$

c) <u>CONSTANT MLSS WASTING RATE</u>

The operators may also waste based upon a constant MLSS rate that, over time, is found to provide the cleanest effluent. For example, suppose the operators find that an MLSS of 3000 mg/l in one basin or of 1500 mg/l in the two aeration basins yields the best plant effluent. On a given day, the aeration basins are found to contain 2000 mg/l of MLSS with an RAS concentration of 5000 mg/l (0.5%). How much sludge should be wasted?

The operator wants 1500 mg/l, but has 2000 mg/l in the two basins. This is an excess of 500 mg/l in the 900,000 gallons of active aeration basin volume. The operator must first convert this excess concentration amount to mass:

$$\text{LBS WAS} = (500 \text{ MG/L})(0.90 \text{ MGD})(8.34)$$

$$= 3750 \text{ LBS}$$

This mass can then be converted to gallons as follows:

$$\text{GPD WAS} = \frac{3750 \text{ LBS}}{(0.005)(8.34)}$$

$$= 90{,}000 \text{ GPD}$$

Ultimately, the exact strategy used for sludge wasting is not as important as having regular process wasting a strategy that is followed meticulously. All sludge wasting strategies result in maintaining the proper amount of MLSS for the amount of BOD food entering the plant. It is recommended that several methods of wasting be tracked concurrently until the best operating parameters are found over time.

4.17.3 WASTE SYSTEM ACTIVATION

Once the gallons per day of required sludge wasting have been determined, the operators must open the WAS pump valves to the DAF unit and then allow the proper amount of sludge to be wasted.

The Brewer treatment facility utilizes three waste activated sludge (WAS) pumps to draw sludge off of the common RAS/WAS pump suction header. As shown on Figure 26, the normal WAS pump configuration is to have two pumps operating with one pump acting as a spare. The typical design configuration is as follows:

- WAS Pump No. 1 normally draws off the RAS header portion that originates from final clarifiers No. 1 and No. 3.

- WAS Pump No. 3 normally draws off the RAS header portion that originates from final clarifiers No. 2 and No. 4.

- WAS Pump No. 2 is positioned in the middle of the header to act as a spare pump in the event that either WAS Pump No. 1 or No. 3 fail.

- The plant has two WAS flow meters in the discharge lines from WAS Pumps No. 1 and No. 3. When in use, WAS Pump No. 2 can reach either flow meter via a cross-over header pipe system.

Figure 26 – waste activated sludge pumps

- If WAS Pump No. 1 is being used through WAS flow meter No. 1, the following valve sequences should be used:

    – Open HV-415, HV-423, HV-436 and HV-437.

    – Close HV-432.

- If WAS Pump No. 3 is being used through WAS flow meter No. 2, the following valve sequences should be used:

    – Open HV-421, HV-429, HV-438, and HV-439.

    – Close HV-433.

- If WAS Pump No. 2 is being used through WAS flow meter No. 1, the following valve sequence should be used:

    – Open HV-419, HV-427, HV-432, HV-436, and HV-437.

    – Close HV-433 and HV-423.

- If WAS Pump No. 2 is being used with WAS flow meter No. 2, the following valve sequence should be used:

    – Open HV-419, HV-427, HV-433, HV-438, and HV-439.

    – Close HV-432 and HV-429.

- The waste sludge system also contains a scum pump, as shown in Figure 26, to remove oil and grease from the final clarifier scum manhole. Whenever scum is to be removed to the sludge storage tank, use the following valve sequence:

    – Open HV-459 and HV-461.

- The WAS and scum pumps all have a ½” Ø copper seal water line to lubricate the pump’s seals. The seal water should be on at all times when the pumps are operating.

4.17.4 DAILY WASTE SLUDGE PUMP OPERATION

The following measures should be taken each day with regard to the plant's waste sludge pumping system:

- Calculate the volume of waste sludge to be removed based on the plant's process control strategy.

- Determine the amount of time that the waste pumps must operate to achieve the daily wasting goal.

- Observe the operation of the WAS and scum pumps and make note of any unusual noises or temperatures that could indicate an impending problem.

- Adjust the WAS flow rate based on sludge wasting calculations. Under no circumstances should the VFD drive be turned down below 50% of its maximum output. Slowing the motor down to lower levels may cause it to burn out.

- The WAS flow rate should be measured and recorded.

- The WAS pump pressure should be observed and recorded.

- A sample of the waste sludge flow should be taken and measured for solids concentration each day.

4.17.5 WASTE SLUDGE FLOTATION THICKENING SYSTEM

The purpose of the flotation thickener is to collect and concentrate wasted secondary (activated) sludge and scum. The concentrated sludge and skimmings are discharged to sludge storage tanks located in the basement of the control building. Elements of this system include the flotation unit, recycle pump, pressure tank, and air feed system.

The flotation thickener system is located in the sludge thickening room on the first floor of the control building. The flotation unit is a rectangular welded steel tank with an overhead scraper mechanism for the removal of floating solids and a bottom scraper collector to capture settled solids.

As shown in Figure 27, the flow enters the unit through an inlet mixing chamber with baffles. Here the influent sludge and scum are mixed with recycled flotation tank clarified effluent that has been pressurized to 40-45 psi. This pressure is released when the recycled effluent is discharged into the mixing compartment of the tank. Upon release of pressure, the air comes out of solution as fine bubbles. These bubbles become attached to the suspended solids in the sludge and scum, floating them to the surface.

To pressurize the clarified flotation thickener liquid effluent, it is pumped into a pressure tank under 40-45 psig by a recycle pump. The recycle pump, located beside the flotation unit, is flexibly coupled with a vertically split case. The plant's process water system provides an auxiliary connection to provide a backup source of water for the recycle flow.

Air is fed into the pressure tank by a pipe from the air compressor. The air connection includes a pressure reducing valve and an air flow indicator and measuring device.

Polymer is also added as a flotation aid. It increases the coagulation of the sludge solids and also helps the air bubbles attach themselves to the sludge particles. Floated solids (thickened sludge) are removed by the top skimmer collecting mechanism to two lines which discharge downward to the waste sludge storage tanks directly below. Treated effluent (clarified wastewater) is discharged under a baffle and over an adjustable weir at the end of the flotation unit. Flow of activated sludge to the DAF process is controlled through the WAS pump. Flow through the DAF unit, and its hydraulic loading, is dependent upon the sludge wasting rate.

Valving arrangements on the DAF sludge discharge line can be set to route flow to either or both waste activated storage tanks located in the basement. Clarified (decant) effluent runs by gravity through a common drain (used also for decant from the thickened waste activated storage tanks) to the headworks.

4.17.6 DAILY DAF UNIT OPERATIONS

The process is controlled from the flotation thickener control panel located in the thickener room on the first floor of the control building.

Figure 27 – Dissolved air flotation unit

The following procedures should be followed in operating the flotation unit:

- Check all gears, pumps, and drives for proper lubrication, alignment, and check for rotation. Correct if required.
- Clean out all foreign matter from the flotation unit.
- Close all drain lines from the unit and pressure tank.
- Isolate pressure tank by closing gate valves on its intake and discharge lines.
- Fill flotation unit with clear water or plant effluent (process water) and check for leaks.
- Start polymer feed pumps.
- Use polymer mixed to required concentration.
- Refer to manufacturer's information for detailed pressure tank and recycle start-up procedure.
- Open unit influent valve or start feed pump and adjust to calculated feed rate.
- Check rise rate and adjust polymer feed and influent feed accordingly.
- Upon formation of a sludge blanket, start skimmer.
- Open sludge discharge valve.
- Adjust skimming blade on-off interval for proper sludge removal and minimum water carry-over. Units are supplied with a timer to regulate the skimming time. The limit switch is wired so that a blade on the beaching plate will continue until it is off before the skimmer shuts off. The sludge blanket for thickening of waste activated sludge should be 12" thick minimum.
- Adjust adjustable weir as required for most effective sludge removal.

- Check rise rate, effluent clarity, recycle flow, operating pressures, air flow, and flight speed periodically and make necessary adjustments.

- If the flotation unit becomes overloaded, the operator should:

  - Stop the influent sludge and scum flows.

  - Increase the polymer dosage.

  - Activate the auxiliary recycle system using process water for recycle.

  - Monitor until proper operation is restored.

4.18 SLUDGE DEWATERING SYSTEM

4.18.1 PROCESS DESCRIPTION

Brewer's sludge dewatering system consists of several unit processes which work in conjunction with each other to reduce the water content of the plant's final sludge product prior to its disposal. Sludge leaving the gravity thickeners and DAF flotation thickener will likely be in the three to five percent solids range. The dewatering system removes additional water and brings the sludge's solids concentration into a typical range of 25 to 30 percent solids.

Brewer's sludge dewatering system includes the following components:

- Three Komline piston plunger pumps with VFD control to convey thickened primary sludge from the gravity thickeners to the belt filter presses.

- Three Komline piston plunger pumps with VFD control to convey thickened secondary waste activated sludge from the sludge storage tanks to the belt filter presses.

- Two in-line Muffin-Monster grinders to shred debris in the sludge prior to it reaching the sludge presses.

- Two blend tanks to homozonize the primary and secondary sludge streams prior to the presses.

- Two magnetic sludge flow meters, one for each press.

- Two 2.0 meter wide stainless steel Komline-Sanderson belt filter presses.

- A belt conveyor to move dewatered sludge from the presses to the sludge transport container.

- A lime feed and screw conveyor system to deliver lime to a lime addition system to raise the pH of the dewatered sludge.

- Two washwater pumps that deliver process water to the belt filter presses to keep the fabric on the belts clean.

- Two air compressors, dryers, and filters that provide instrument air to the presses to operate their pneumatic control systems.

- Two polymer systems that provide liquid polymer to the belt presses.

- A central control panel with PLC computer logic that controls the entire press operation and ties all of the above systems together with logic program startup and shutdown sequences.

4.18.2 THICKENED PRIMARY SLUDGE PUMPS

Figure 28 shows the layout of the three thickened primary sludge pumps. The normal operating sequence of the pumps is as follows:

- Primary thickened sludge pump No. 1 is used to pump Eastern's sludge from gravity thickener No. 1 to the belt presses.

- Primary thickened sludge pump No. 2 is used to pump municipal sludge from gravity thickener No. 2 to the belt presses.

- Primary thickened sludge pump No. 3 is a spare pump that can work on either thickener.

Figure 28 – Primary treatment sludge pumps

The normal valve sequencing and configuration for these pumps is as follows:

- To pump Eastern's sludge from gravity thickener No. 1 to the belt presses using primary thickened sludge pump No. 1:
    - Open HV-104, HV-105, HV-108, HV-112, HV-124, HV-129 and HV-133.
    - Close HV-111, HV-110, and HV-130.
- To pump Eastern's sludge from gravity thickener No. 1 to the belt presses with primary thickened sludge pump No. 3, use the following:
    - Open HV-104, HV-105, HV-108, HV-112, HV-124, HV-129, and HV-133.
    - Close HV-111, HV-110, and HV-130.
- To pump municipal sludge from gravity thickener No. 2 to the belt presses with primary thickened sludge pump No. 2, use the following:
    - Open HV-106, HV-107, HV-113, HV-125, HV-131 and HV-134.
    - Close HV-110 and HV-130.
- To pump municipal sludge from gravity thickener No. 2 to the belt presses with primary thickened sludge pump No. 3, use the following:
    - Open HV-106, HV-107, HV-110, HV-112, HV-124, HV-130, and HV-134.
    - Close HV-113, HV-109, HV-129 and HV-131.

When the primary thickened sludge pumps are running, the operators should do the following:

- Observe the piston stroke of each pump to ensure that the pump is operating smoothly.

- Make sure that the pump's oilers are full and that the pumps are being properly lubricated.

- Observe the pressure gauges on each pump. If pressures are abnormal, shut down the pumps and clean debris from the ball valves.

- Listen for any unusual sounds that might suggest potential problems.

- Check the pump motors for excessive temperature.

- Do not turn the VFD down to less than 50% of the pump's maximum output.

- Record the pump stroke counters on each pump.

- Take a sample of thickened sludge and test its solids content.

- Write all pump operating data down in the log book.

4.18.3 THICKENED SECONDARY SLUDGE PUMPS

Figure 29 shows the layout of the plant's three thickened secondary sludge pumps. These pumps convey thickened sludge from the secondary sludge storage tanks to the belt filter presses. These pumps work in the following sequence:

- Secondary thickened sludge pump No. 1 pumps sludge from storage tank No. 1 to the belt filter presses.

- Secondary thickened sludge pump No. 2 pumps sludge from storage tank No. 2 to the belt filter presses.

- Secondary thickened sludge pump No. 3 can pump from either storage tank to the belt presses.

The normal valve sequencing for the operation of these pumps is as follows:

- To use secondary thickened sludge pump No. 1 to pump sludge from storage tank No. 1:

    – Open HV-212, HV-216, and HV-221.

Figure 29 – secondary thickener sum pumps

  - Close HV-213 and HV-229.

- To use secondary thickened sludge pump No. 2 to pump sludge from storage tank No. 2:

  - Open HV-219, HV-220, and HV-227.

  - Close HV-215 and HV-230.

- To use secondary thickened sludge pump No. 3 to pump sludge from storage tank No. 1:

  - Open HV-212, HV-213, HV-218, HV-223, and HV-229.

  - Close HV-216, HV-214, HV-230 and HV-221.

- To use secondary thickened sludge pump No. 3 to pump sludge from storage tank No. 2:

  - Open HV-219, HV-215, HV-214, HV-218, HV-223 and HV-230.

  - Close HV-220, HV-213, HV-229, and HV-227.

When the secondary thickened sludge pumps are running, the operators should do the following:

- Observe the piston stroke of each pump to ensure that the pump is operating smoothly.

- Make sure that the pump's oilers are full and that the pumps are being properly lubricated.

- Observe the pressure gauges on each pump. If pressures are abnormal, shut down the pumps and clean debris from the ball valves.

- Listen for any unusual sounds that might suggest potential problems.

- Check the pump motors for excessive temperature.

- Do not turn the VFD down to less than 50% of the pump's maximum output.

- Record the pump stroke counters on each pump.

- Take a sample of thickened sludge and test its solids content.

- Write all pump operating data down in the log book.

4.19 BELT FILTER PRESSES

Waste sludge is periodically removed from the Brewer plant by dewatering on two belt filter presses. Sludge is transferred from the gravity thickeners and storage tanks with piston pumps and fed to the press. Polymer is added to the sludge to condition and flocculate the solids. The belt press consists of a gravity zone to enhance the removal of water from the flocculated sludge followed by a compression zone where water is squeezed out of the press by passing the moving belts between a series of pressure rollers.

When sludge is to be wasted to the belt filter presses for dewatering, follow these procedures:

- Start sludge press equipment at master sludge press control panel which operates feed pumps, polymer system, air system, washwater system, lime system, and conveyors. The entire press operation is sequenced by a PLC in the press panel.

- Adjust the polymer system output in order to obtain optimal visual flocculation on the press gravity zone.

- Adjust dilution water to polymer system to modify rate of delivery to press.

- Keep all polymer tubing clean between press runs.

- Adjust the press speed in response to the extent of dewatering that is to be achieved. As the press speed slows, it will take longer to dewater, but a dryer sludge product will be achieved.

- Monitor the belt tracking system to ensure that proper alignment of belt is maintained.

- Adjust belt tension and pressure to modify dryness of sludge. If belts are blinded or sludge is extruding between belts, reduce pressure.

- Follow all detailed procedures in belt press manufacturer's operating guide.

- Observe press flow meter to monitor feed rate to press.

- Observe grinder operation to make sure that it is operating properly without excessive noise, vibration, or heat.

- Observe sludge blend tanks to ensure that mixers are working properly.

- Observe conveyor belt system to ensure that it is tracking properly.

- Observe lime feed system, lime conveyors and pug mill to ensure proper delivery of lime.

- Review operation of press washwater pumps to ensure proper water delivery and belt cleaning.

- Review operation of press instrument air system to ensure proper pneumatic tracking.

Figure 30 shows an overall layout of Brewer's two sludge belt filter presses and its auxiliary equipment. While there are many complex systems that must work together to operate the press, the operation is sequenced by the PLC system in the press control panel that starts and stops all equipment automatically. The press control panel performs the following functions:

1. Automatically controls the start-up and shut-down sequence for the belt press systems and auxiliary equipment.

2. Displays total machine run time.

3. Automatically maintains the filter belts in alignment under all operating conditions.

Figure 30 – belt filter press schematic

4. Continuously monitors the belt press for the following fault conditions:

    a. Belt off track
    b. Belt broken
    c. Belt tracking system failure
    d. Low washwater pressure
    e. Drive motor overload trip
    f. Low hydraulic or air pressures
    g. Flooded sludge feed

5. Continuously monitors the liquid polymer make-down units for polymer pump shutdown or failure.

6. Continuously monitors the conveyor system for circuit overload.

7. Continuously monitors the lime feed system and the lime pug mill for system failure.

8. Continuously monitors the sludge feed system for primary and secondary sludge feed pumps, blend tank mixers, or sludge grinders failure.

9. Provides for automatic selective shut-down of the belt press and auxiliary equipment under fault conditions.

10. Provides single switch sequenced automatic start-up and shutdown of the following systems:

    <u>a) In dedicated press control panel for each press</u>

    - Belt drive motors
    - Belt washwater booster pump
    - Sludge grinder
    - Blend tank mixer
    - Air compressor or hydraulic equipment

    <u>b) In common equipment control panel</u>

    - Lead primary sludge pump dedicated to each press
    - Spare primary sludge pump shared with backup press if selected
    - Lead secondary sludge pump dedicated to each press

- Spare secondary sludge pump shared with backup press if selected
- Lead liquid polymer system dedicated to each press
- Second polymer system for second press and flotation system
- Lime feed system shared by both presses
- Lime pug mill shared by both presses
- Dewatered sludge conveyor shared by both presses
- Remote plant main/spare water supply pumps shared by both presses

11. Provide control and display of both primary and secondary sludge feed pump output rates for all six pumps using remote signals from variable frequency controls for each of the sludge pumps. In addition, a manual selector switch for selecting between the lead/spare sludge pump for both primary and secondary sludge feeds for each press is provided. One of two primary thickened sludge pumps is dedicated to each press while the third primary sludge pump serves as a spare for either press. One of two secondary thickened sludge pumps is dedicated to each press while a third secondary sludge pump serves as a spare for either press.

12. Controls and displays for the two liquid polymer units are provided. Polymer system start-up of the main liquid polymer system is sequenced as part of the press automatic start-up and shut-down procedure of both presses and polymer system failure conditions is relayed back to the press shut-down and warning system of both presses.

13. Control and display of belt speed in feet/minute is located at remote panel near press. Duplicate controls and display are provided for second press.

14. Control and display of belt tension in pounds/inch is located at remote panel near press. Duplicate controls and display are provided for second press.

15. Manual override of belt tracking (left/right) is located at remote panel near press. Duplicate controls are provided for second press.

16. Manual override of conveyor (on/off).

17. Manual override of lime feed system (on/off).

18. Manual override of lime pug mill (on/off).

19. Manual override of blend tank mixers (on/off).

20. Manual override of sludge grinders (on/off).

21. Audible alarm horn on each panel.

22. Alarm acknowledge/silence push bottom on each panel.

23. Alarm reset/lamp test push bottom on each panel.

24. Automatic system start-up based on external run signal.

4.20 SECONDARY SCUM DECANT TANK

4.20.1 PROCESS DESCRIPTION

The secondary scum decant tank provides a means for the plant operators to remove undesirable floating scum, oil, grease, and debris from the treatment plant. This material has no biological treatment benefit for the plant's bacteria, is odorous and unsightly, and can plug equipment and pumps. If allowed to proceed through the plant, it can fuel Nocardia growth in the aeration basins, cause high levels of foam in the clarifiers, and create thick layers of debris in the chlorine contact tank. Scum enters the decant tank from the final clarifiers and is discharged to the DAF unit and ultimately the sludge press.

In the scum tank, there is a submersible scum pump and scum mixer. The pump and mixer can be operated separately. If the operators wish to pump the entire contents of the tank, the mixer is used to homogenize the full tank and the blended scum is pumped. If the operator wishes to decant the scum and pump only the cleaner water off the tank’s bottom, the pump should be operated with the mixer off.

The tank’s contents may be pumped to two destinations as follows:

- Occasionally, the operators may wish to have a septic hauler pump out the tank and remove the material from the system altogether. While this is the best way to be rid of this undesirable material, it may prove to be expensive in the long run.

- The homogenized scum mixture can be pumped directly into the plant’s DAF system or sludge storage tanks.

Because of its nature, scum can readily plug pipes, pumps, and valves. Any time that scum is being pumped, the operator should send an additional charge of water behind the scum flow to keep the lines flushed out.

4.20.2 DAILY OPERATION

The plant's scum system should be checked on a daily basis. As scum accumulates in the plant, it should be removed regularly. The operators should perform the following duties daily:

- Check the level of the scum tank to determine how much material is in the tank and how much volume remains.

- Check the surfaces of each final clarifier. If excess scum is present, check that the scum flushing system is working. Sufficient excess water should be conveyed to ensure that the entire scum lines have been flushed.

- If the aeration tanks have a Nocardia outbreak, the Nocardia foam should be wasted into the scum tank and dosed with chlorine to kill these filaments. Operate the plant's mixer during the chlorination process and mix the tank's contents for at least one hour. At the end of this period, the mixture should be dechlorinated.

- If the tank's contents are to be removed by a septic hauler, this can be done by pumping from the open tank hatch.

- If the tank's contents are to be pumped to the sludge thickening system, the mixer should be operated to homogenize the scum while pumping. It is important to add water behind the scum to keep the lines flushed. This water can be obtained from the clarifiers by lowering the automatic flushing valve.

- If the operators wish to prolong the scum tank's capacity and minimize the amount of water sent to the plant, the scum tank should be decanted. Scum will float to the top of the tank leaving a layer of water below the scum. This water can be sent to the plant by operating the pump without the mixer turned on.