Luttrell Water Treatment Plant Operating Procedures

The contents of this Operations and Maintenance (O&M) manual are based on standard operations and procedures as of 7/19/2021 and are subject to review and revision as new information becomes available or as operations are optimized.

Contents

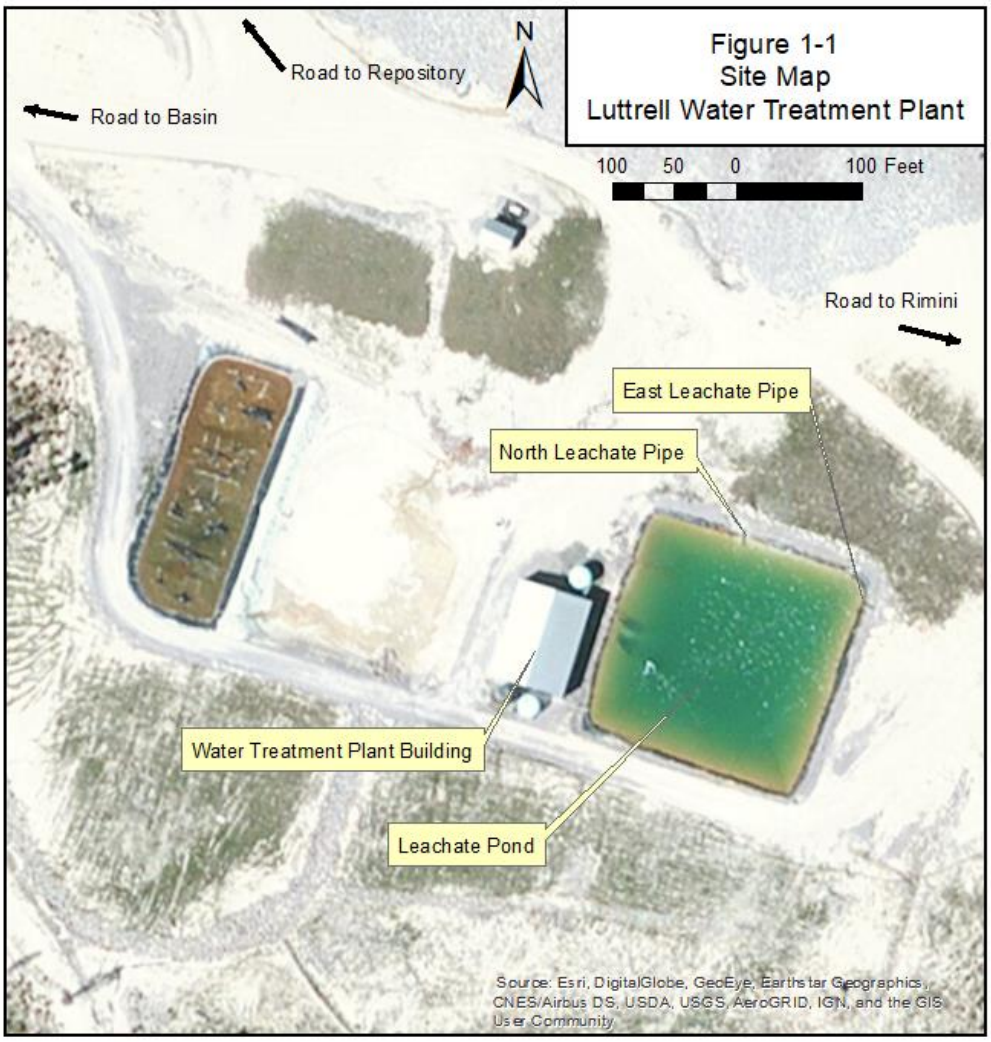
1. Introduction: Luttrell Water Treatment Plant

The Luttrell Water Treatment Plant (WTP) is an interim facility to treat leachate from the Luttrell Repository located at the headwaters of the Tenmile and Basin Creek watersheds. The treatment process and key operating equipment and procedures are provided in this document.

Kemron Environmental Services and URS constructed the WTP to treat the leachate captured by a collection system for the Luttrell Repository under the Environmental Protection Agency Region 8 START 2 contract. Water collected through the leachate has a low pH and high concentrations of arsenic and heavy metals. To meet land disposal requirements (Table 2-1), water collected through the leachate system requires treatment prior to being discharged to the land surface. The WTP treats the leachate to concentrations sufficient for discharge to the land application disposal (LAD) area. Effluent discharge standards are listed in Table 2-1.

Site map is shown in Figure 1-1.

Figure 1-1 Luttrell Water Treatment Plant (WTP) Site Map



2. Treatment Process Overview

Precipitation and snowmelt infiltrating into the Luttrell Repository is captured by the leachate collection system through underground piping and stored in a 750,000 gallon leachate retention pond. Because the WTP is not accessible during winter and spring, leachate is stored in the pond for treatment throughout summer and fall. To ensure pond capacity for storing winter and spring precipitation, the pond has to be fully drained prior to winter. Due to the remote setting, power to the WTP is provided by a diesel generator.

The water from the pond is first pumped into a flash mix tank within the plant where sodium hydroxide ([NaOH] also referred to as caustic) is added to raise the pH level to between 9.5 and 10. At these pH levels, metals form metal hydroxides and precipitate out of solution. The remainder of the treatment process is to settle and retain the metal hydroxide solids generated; lower the pH to near neutral (7.0); and discharge the treated water to the LAD. To aide in precipitation and retention of metal hydroxides, a polymer flocculating agent is added to the water in the flash mix tank. The polymers group together to form chains and nets to attach to and entangle the metal hydroxide solids. As the flocs are formed, particle size increases and settling is promoted. The water from the flash mix tank then overflows into a primary clarifier tank. The primary clarifier tank is large enough to allow time for settling of the waste sludge to occur at the bottom of the tank. This process is called sedimentation. The water then overflows the primary clarifier into a lamella clarifier tank. This secondary clarifier works to promote settling of the remaining solids in the water.

The treated lamella clarifier water then overflows into a pH adjust tank. This pH adjust tank is agitated by a mixer and muriatic acid (hydrochloric acid [HCl]) is added, neutralizing the treated water back to a pH between 6.5 and 7.5. Once the water has been neutralized, it is pumped to two LAD holding tanks. When the LAD holding tanks contain enough water, a pump is turned on, sending the water to the LAD in 10,000-gallon batches.

The average workday at the WTP is 10.5 hours. This includes 7.5 hours of plant operation time, 1 hour for a midday shutdown, and 1 hour of travel time from Helena in each direction (2 hours total). Midday shutdown is necessary to prevent unsettled solids from carrying over from the primary clarifier to the lamella clarifier, which would result in inadequate treatment of the leachate. Runtime of the WTP will be reduced throughout the week as solids accumulate in the primary and lamella clarifiers. Therefore, a weekly flush of both clarifiers is required to keep the system running optimally.

See Section 2.2 for the process flow diagram.

Table 2-1 Land Application Disposal (LAD) Effluent Discharge Standards

Constituent	Maximum Concentration (mg/L)	
	LAD South	LAD East
Aluminum	8.42	1.42
Arsenic	1.08	1.09
Cadmium	0.34	0.25
Copper	2.25	2.26
Lead	1.45	1.47
Manganese	54.41	57.20
Zinc	47.80	44.83

2.1 Flow Rates

This section summarizes the various untreated and treated water flow rates encountered throughout the treatment system.

- The North Leachate Pipe (NLP) and East Leachate Pipe (ELP) are the sources of contaminated water stored in the leachate pond. As the season progresses, there will be fluctuations in flow rates to both the ELP and NLP due to changing weather conditions and saturation levels of the repository. For the first half of the season, the average NLP and ELP flow rates are approximately 5.0 and 0.4 gallons per minute (gpm), respectively. Once the ELP flow rate is under 0.1 gpm, it is considered negligible. The average NLP flow rate after this occurs is approximately 2 gpm. See Table 2-2 for daily and weekly flow rates for the ELP and NLP.
- During operation time for 1 workday, approximately 13,000 gallons of leachate water enters the plant at 45 gpm. That equates to 91,000 gallons per week (gpw) and 376,000 gallons per month.
- In 1 workday, an average of 11,000 gallons of treated water are sent to the LAD. This amounts to 77,000 gpw and 308,000 gallons per month (gpmo).
- The discrepancy between the volume of treated water and water entering the plant is due to the sludge drainage from the primary clarifier. Approximately 2,000 gallons per day (gpd) are drained out of the primary clarifier, and the clarifier is completely drained on Sundays to clear the system of any accumulated sludge.
- The primary operating season is typically from the first week of June to the second week of October. This varies, depending on weather conditions. The total volume of water treated for the season is approximately 1.13 million gallons, based on the 2018 season. With ~11,000 gallons of leachate treated per day, this results in an approximately 102-day operating season at an influent flow rate of 45 gpm if the plant is run 7-days per week.

Table 2-2 summarizes the flow rates.

Table 2-2 Water Treatment Plant (WTP) Process Flow Rates

Storage Pond Input or Output	Stream	Flow Rate			
		Gallons Per Minute	Gallons Per Day	Gallons per Week	Gallons Per Month (30 days)
Input	North Leachate Pipe -				
	Early Season	5.06	7,286	51,004	218,580
	Late Season	2.07	2,981	20,866	89,430
Input	East Leachate Pipe	0.36	518.4	2,074	15,552
Output	Water Treatment Plant Influent	45	13,000	91,000	390,000
Not Applicable	Land Application Disposal (LAD)	Not Applicable	11,000	77,000	330,000
Input	Primary Clarifier Drain	180	2,000	14,000	60,000

2.2 Process Flow Diagram

Raw Influent

Leachate Pond
(45 gpm)

Caustic Soda
25% NaOH
(200-275 ml/min)

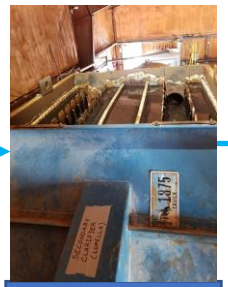
Polymer Flocculant
(26 ml/min)

Chase Water
(0.5 gpm)

Muriatic Acid
30% HCl
(20-30 ml/min)

Flash Mix Tank
(1,050 gallons)

Primary Clarifier
(10,000 gallons)



Lamella Clarifier
(1,215 gallons)

pH Adjust Tank
(1,050 gallons)

LAD Tanks
(2x 10,000 gallons)

KEY

Water

Chemicals

Sludge

Solids

Sludge Reduction
(3x 1,050 gallons)

Sediment Bags

Full Sediment Bags
Taken To Repository

LAD System

Treated Effluent

3. Key Treatment Plant Components and Operating Parameters

An overview of plant components follows. Treatment consumption rates for chemicals utilized by the plant are listed in Table 3-1.

Generator

- Location: Outside and to the west of plant
- Model: Cat XQ35 28-kW (kilowatt)
- Fuel: Diesel
- Tank: 528 gallons (2,000 liters) Trans Cube fuel ll
- Consumption: ~1.2 gph (59 8-hour days between refills)
- Subcontracted fuel truck delivers diesel to plant once per summer

Operation Panel

- Location: Inside WTP building
- Contains switches for:
    - Flash tank mixer
    - pH transfer pump
    - pH adjust tank mixer
    - LAD pump

Leachate Pond

- Location: Outside and to east of plant
- 750,000 gallons of repository leachate collection and storage fed by the NLP and ELP
- Initial settling of suspended solids
- Black plastic lined, enclosed by fencing

Influent Pump

- Model: Xylem Flygt Ready 8 1.1 horsepower (hp), 230 volt (V) submersible pump with 2-inch diameter discharge piping.
- Influent totalizer located in WTP building where water enters flash mix tank
- Flowrate: 30–55 gpm (typically 45 gpm)
- Submersible pump placed in float pulls water off top of leachate pond
- Plug/unplug to turn on/off

Flash Mix Tank

- Location: Inside WTP building
- 1,050-gallon mixing tank where caustic soda is added to raise the pH of the leachate water to form metal hydroxide solids
- Polymer added as a flocculating agent to promote settling of the metal hydroxide solids
- Mixer: Sharpe Model G-033, 0.33 hp motor, 110/220 V, on/off operation (switch on operation panel)
- Outlet: Overflow to primary clarifier; typical residence time approximately 23 minutes
- Secondary drain valve discharges back into the leachate pond via gravity

Caustic

- Location: Inside WTP building
- Concentration: 25% NaOH solution
- Holding tank volume: 350 gallons
- Added to flash mix tank to increase pH to target range of 9.5 to 10.0. Dosage will gradually change as the chemistry in the leachate pond changes (i.e. becomes more concentrated) over the summer.
- Metering pump: Pulsatron Model #LPH6SAVTC3XXX. Typical setting 80% stroke length, 45% frequency (switch on unit)
- Typical dosage: Approximately 200 milliliters per minute (mL/min) early season to approximately 275 mL/min later in season. Dosage changes as water chemistry in leachate pond changes over the summer months. Consumption: Approximately 25 gpd.
- Two 55-gallon drums of caustic are obtained and brought to the WTP every other week from Chemical Montana or a similar vendor via rental truck. The caustic soda is then pumped into the holding tank using a chemical drum pump. Take care when opening the carboys as the decrease in atmospheric pressure experienced when bringing them to the plant causes them to pressurize. Unscrew bung cap slowly with a bung wrench to allow pressure to slowly release. Empty carboys are returned to the vendor.
- Chemical drum pump: Finish Thompson Model PFM 40. Pump tube: 32 inches. Motor: 115 V electric.

Polymer Flocculant

- Location: Inside WTP building
- Polymer skid: ProMinent Part No. 990106
- Flocculant: Clarifloc CM-2228
- Polymer skid is used to prepare 0.5% “make-down” polymer solution. The 0.5% polymer solution is made with relatively clean chase water. The 0.5% make-down polymer solution production procedure is presented in Section 8. It is important to understand exactly how to operate the polymer skid.
- 0.5% make-down polymer is added to the system with chase water at a 0.5 gpm flowrate via submersible pump to prevent clumping of polymer. A static mixer is present in-line to mix make-down polymer solution with chase water before it enters the flash mix tank. The flowrate of the

chase water added to the system is modulated with an in-line valve. 0.5 gpm is marked on the valve.

- NOTE: Alternatively, polymer can be prepared by hand. See section 8.5.
- NOTE: Never let water mix with “neat” polymer (i.e., undiluted polymer) as it will turn clumpy and unusable.
- Make-down polymer is prepared in 4-gallon batches and stored in 5-gallon buckets. Small batches ensure that the polymer is fresh/active for the entire duration of its intended use.
- Diluted “fresh” polymer is active for 5 to 7 days. Make only the volume needed for 1 week.
- Metering pump: ProMinent Gala10008PVT400UD103000

Chase Water

- Chase water tank volumes (2 tanks): 535 gallons and 200 gallons
- Treated water pumped from LAD influent line to chase water tank as-needed
- This water is used for both 0.5% polymer make-down solution production and as chase water to increase mixing when adding the polymer product.

Primary Clarifier

- Location: Outside, north of plant
- 10,000-gallon tank for primary settling of the metal hydroxide solids (flocs) into sludge
- Dead tank: 12 inches on bottom, 31.6 inches on top
- Secondary drain valve discharges back into the leachate pond via gravity

Lamella Clarifier

- Location: Inside WTP building
- 1,215-gallon secondary clarification tank in series with the primary clarifier tank where further floc settling is promoted until overflow to pH adjust tank occurs.
- Secondary drain valve discharges back into the leachate pond via gravity.
- There should be no visual carryover of solid flocs from the lamella clarifier to the pH adjust tank. If this occurs, treatment will be inadequate.

pH Adjust Tank

- Location: Inside WTP building.
- 1,050-gallon mixing tank where muriatic acid (HCl) is added to neutralize the pH of the treated water back to a value between 6.5 and 7.5.
- Mixer: Sharpe Model G-033, 0.33 hp motor, 110/220 V, on/off operation (switch on operation panel)
- Pump located downstream transfers treated water to LAD tanks. On/off operation. A valve is present downstream to modulate flow so that pH adjust tank level stays consistent. Level must be consistently monitored and pump rate adjusted.
- Secondary drain valve discharges back into the leachate pond via gravity.

pH Transfer Pump

- Location: Inside WTP building
- On/off operation (switch located on operation panel)
- Valve located down line to modulate flow to 45 gpm. If the flowrate is not set at 45 gpm, the pH adjust tank will overtop or empty. A marking is made on this valve so that the flowrate is near 45 gpm. NOTE: This is imprecise; thus, the level of the pH adjust tank must be consistently monitored and the valve position adjusted accordingly. There is a mid-tank marking on the pH adjust tank to use as a reference for modulating flow.

Muriatic Acid

- Concentration: 30% HCL solution
- Carboy: 145 pounds
- Metering pump: ProMinent Gala1005PPE260UD012000
- Typical Dosage: 20 to 30 mL/min. Consumption: approximately 1 gallon per week
- Two carboys brought up at the beginning of WTP operational season from Chemical Montana
- NOTE: Muriatic acid is highly corrosive and volatile. Take care when handling to avoid contact with skin or eyes.

LAD Effluent Tanks

- Location: Outside, south of plant
- Two 10,000-gallon holding tanks that store treated water until ready to be discharged in 10,000-gallon batches to the LAD
- Sight glass on side of tank indicates level when unable to see through tank wall
- Both tanks fill simultaneously for increased treated water storage capacity

LAD Fields

- Location: Outside, east of plant; in two forested locations near the treatment plant where treated effluent is land-applied
- LAD Pump: US Electric Motors 20 hp Model A939A
- The land application disposal system is a series of discharge lines with sprinklers. Typically, only two lines are open.
- Excess arsenic and metals are attenuated by the LAD soils through adsorption.

Sludge Reduction System

- Location: Outside, north of plant; adjacent to primary clarifier
- Three 1,050-gallon holding tanks that store sludge from the primary clarifier.
- One tilt-trailer capable of holding multiple, filled sediment bags. Trailer bed is angled towards the leachate pond allowing sediment bags to drain.
- Reduces re-introduction of solids into leachate pond from primary clarifier flushing.

Table 3-1 Treatment Consumption Rates

Consumable	Consumption Rate
Sodium Hydroxide (NaOH, caustic)	180 to 280 mL/min, ~25 gpd
Neat Polymer	0.3 gph/0.005 gpm during 0.5% make-down polymer production
0.5% Make-Down Polymer	20 to 30 mL/min
Muriatic Acid (HCl)	1 gpw
Flocculant Chase Water	0.5 gpm

4. Daily Plant Operation

The average workday at the WTP is 10.5 hours. This includes 7.5 hours of plant operation time, 1 hour for a midday shutdown, and 1 hour of travel time from Helena in each direction (2 hours total). Midday shutdown is necessary to prevent unsettled solids from carrying over from the primary clarifier to the lamella clarifier. NOTE: It is necessary to ensure the plant gate is locked after entering/leaving the mine site.

4.1 Routine Startup

This section presents a list of standard system conditions and the routine tasks that are needed on a daily basis to start the treatment plant.

- Solids in the primary clarifier tank will have settled overnight, open drain valve on primary clarifier tank connected to the sludge reduction system line until the discharge runs clear (usually between 1000 and 1500 gallons). This flushes most of the settled sludge in the bottom of the tank back into the leachate pond. Fill sludge tank 1 (located furthest from clarifier tank) first; then fill sludge tank 2 (middle tank) as-needed.
- Check generator oil and coolant levels.
- Turn on generator and open plant building:
    - To turn generator on, open the engine compartment door (left side) and turn the red battery switch to the “on” position. Open the control panel door (back side) and hit the green “on” button. Let the generator warm up for approximately 5 minutes before flipping fuse on the generator (below the control panel) to the “on” position.
    - Inside the WTP, open breaker panel A (center of building) and flip fuses 2, 3, and 4 to the “On” position.
- In the following order:
    - Turn on caustic metering pump (switch located on unit);
    - flocculent chase water pump (turn on surge protector);
    - flocculent metering pump (turn on surge protector); and
    - the flash mix tank mixer.
    - Confirm caustic/polymer are pumping into system by observing the caustic/polymer lines in the flash mix tank.
- Record totalizer volume, time, and date in the Excel spreadsheet. The influent totalizer is located inside the WTP building on the inlet line for the flash mix tank. Plug in plant feed pump located next to the muriatic acid tank. The plant feed pump is set at 45 gpm.
- Wait for overflow from lamella to pH adjust tank. Record totalizer volume, time, and date at time of overflow to lamella. Depending on how many gallons were drained back into the pond from the primary clarifier, this usually takes between 15 and 45 minutes. During this time, check Hanna probe in calibration solutions to verify proper pH readings. When overflow occurs, turn on acid metering pump (switch located on unit). The plant consumes acid at approximately 1 gpw.
- Wait for water level in pH adjust tank to rise to the mixer line. Turn on mixer (operator panel).
- Wait for water level to rise to transfer line. Turn on pH transfer pump (operator panel) and adjust valve to 45 gpm marking.

4.2 Operation

The plant is operated and controlled manually, requiring frequent operator attention. The following list describes daily operation protocol for running the WTP and discharging treated effluent to the LAD system.

- Check pH coming out of flash mix tank with Hanna probe in port located on overflow line, controller is located on wooden frame of flash mix tank. ph levels should be between 9.5 and 10. Check hourly.
- Check pH in lamella clarifier directly with Bluelab pH probe or Horiba multi-meter. ph levels should be between 9.5 and 10. Check hourly.
- Check pH of pH adjust tank with Hanna probe located inside pH adjust tank, controller located on wall near east-facing window. ph levels should be between 6.5 and 7.5. Check hourly.
    - Overnight, pH in the clarifier tanks will decrease; therefore, adjust acid accordingly. Throughout the day, pH will increase; therefore, acid must be increased. Set the stroke length to 28% in the morning and adjust to a 32% stroke length midday.
    - Leachate water quality gradually changes throughout the summer (becomes more concentrated). Adjust acid and caustic consumption accordingly.
- Run plant until LAD tanks read 6,000 gallons.
- Turn off pH transfer pump and turn on LAD pump (operator panel). Then turn on pH transfer pump again to reduce the load on the generator.
- In the event field parameter measurements indicate a potential treatment issue (indicated by low or extremely high pH in the WTP), zinc concentrations in the WTP effluent should be tested to determine whether or not the treatment processes are functioning properly. Zinc concentrations should be measured using a Hach field colorimeter and verified via the samples sent to the laboratory. It is recommended to perform a zinc test on every effluent sample early in the operating season to verify metals reduction because lab sample results will not be immediately available.
- Run 10,000 gallons (batch size) to the LAD (usually takes about 65 minutes for laterals 3 and 4 and 75 minutes for laterals 1 and 2). Switch LAD laterals 3 to 4 times per operating season so that plant effluent is dispersed evenly in LAD field. Record time, date, batch number, drain field, lateral numbers, and totalizer readings in the Excel spreadsheet. Typically, 1.5 batches are sent per day. The LAD pump is set to run between 125 and 150 gpm and at 40 pounds per square inch. Shut down LAD pump.
- After 3.5 to 4.5 hours of run time, or if flocculant carryover is observed in the lamella clarifier sooner, shut the plant down to let additional settling occur in the primary clarifier and lamella clarifier.
- Let sludge settle for approximately 45 min.
- Open drain on primary clarifier tank for approximately 10 minutes or until the water runs clear, following sludge reduction system protocol outlined in Section 8.5.
- Restart plant using protocol above.
- At the end of the day, shut down the plant and generator per Sections 4.1 and 4.3. Record time and totalizer readings in the Excel spreadsheet. Water treated after the midday shutdown can remain in the LAD tanks.

- On Sundays, following the AM treatment run: shutdown the plant, drain the primary and lamella clarifiers completely to remove weekly sludge buildup, and refill the primary and lamella clarifiers over the afternoon.
- See Table 3-1 for approximate consumption rates.

4.3 Shutdown

This section presents a list of the routine tasks that are needed on a daily basis to shut down the treatment plant.

- To shut down, perform in the following order: unplug plant feed pump, turn off flocculent metering pump, unplug flocculent chase water pump, and turn off caustic metering pump.
- Wait until flow from the lamella to pH adjust tank is about half and turn off acid metering pump.
- Once acid is turned off, open valve between pH adjust tank and LAD tanks all the way.
- Turn off mixer once water level is below marked mixer line.
- Turn off pH transfer pump
- Make sure gate to mine site is locked after leaving

4.4 Instrumentation

Hach Colorimeter

- Model: Hach DR 300
- Chemicals: Cyclohexanone**,** Zincon Reagent Pouch (contains cyanide)
- Zinc content is used as an indicator to gauge overall metals content of the sample. Performing a zinc test on the WTP effluent gives the operator insight into metals reduction and performance of the plant.

Hanna pH Controller/Probe

- pH probes located in two locations:
    - In-line between flash mix tank and primary clarifier, controller mounted on wooden frame of flash mix tank.
    - Inside pH adjust tank, controller mounted next to east-facing window above acid metering pump.
- Used to measure water pH of WTP flash mix tank and pH adjust tank.
- A calibration check should be performed on the Hanna probe daily with buffer solutions. Calibration should only occur when consistent drift is observed (increasing or decreasing trend, 3 days in a row, by 10% of the measurement or greater).

Horiba U-52 Water Quality Multimeter

- Handheld multimeter used to measure water quality parameters of WTP influent and LAD tanks.
- Measures pH, temperature, oxidation reduction potential, specific conductivity, and turbidity.

Bluelab pH Probe

- Handheld pH probe for measuring pH of lamella clarifier and as a backup instrument.

Influent Totalizer

- Located on influent line entering pH adjust tank
- Digital
- Flowmeter/totalizer functions
- Check regularly for 45 gpm influent flowrate
- Record totalizer at beginning/end of operating day and when primary clarifier overflows to the lamella clarifier.

Effluent Totalizer

- Located on effluent line between LAD tanks
- Analog
- Flowmeter/totalizer functions
- Record totalizer readings before and after each batch is sent out to LAD

5. Seasonal Schedule

Due to a high altitude and heavy snowfall, the Luttrell WTP season of operation begins when the access road can be cleared and made passable in late April or May. The process units and lines must be checked and repaired as necessary. Maintenance on the LAD lines begins when not prohibited by snow cover. Once the plant is in working order, LAD lines are cleared, and all required chemicals are present, treatment of the leachate pond water can commence. The pond has a capacity of 750,000 gallons, and with the incoming water from the NLP, the ELP, and rainfall, the treatment season goes until late September or early October. Once the pond is drained, the plant is put into hibernation until the next season. It is the operator's responsibility to determine if the plant is ready to operate and to treat the leachate water before the treatment season ends, leaving a nearly empty pond for leachate collection over the winter. If the plant lines or pond freeze, it is too early/late for treatment and equipment and plumbing will be damaged.

5.1 Spring Startup

The beginning of operation season usually starts around the beginning of June. A bulldozer is subcontracted to open the road from Basin, typically in the beginning or middle of May. Preparation for WTP operation usually occurs from mid-May to June. Spring startup duties include the following:

- Connect lines from the LAD pump to the LAD tanks (camlock fittings).
- LAD pump maintenance (usually seized):
    - To unseize LAD pump, housing is removed where pump shaft can be rotated with a large wrench. Be sure to put grease in the appropriate ports before housing is put back on.
- Hire subcontractor to deliver a plant generator. Subcontractor will connect fuel lines to on-site diesel storage tank and hook up electrical lines to power the plant.
- Sprinkler maintenance is performed on the LAD to ensure sprinklers spray properly:
    - Check sprinkler heads for material buildup. Either clear or replace if unable to spray properly.
- Verify influent pump is functioning properly and connect influent line from pump to plant.
- Open valves on the effluent discharge line and on the end of LAD lines to release water that may have settled in over the winter.

Once the plant has been properly prepared and water treatment begins, the valves on the LAD lines must be closed. The LAD pump is started, and the operator walks along the effluent lines, closing all open valves. The valves for lines 1 and 2, 3 and 4, and 4 and 5 are then opened two at a time while all others are closed, depending on the last set of lines used for discharge. Only two adjacent lines are opened at a time.

Once the snow has melted, a subcontracted grader is used to open up the road from Rimini. This route provides the fastest access to the plant from Helena.

5.2 Winterization

The end of the operation season usually ranges from October 1 to 15, depending on the weather. At the end of every operating season, the plant must be winterized. The first step in this process is to drain the following tanks:

- Primary clarifier via sludge discharge line
- Lamella clarifier via sludge discharge line
- Flash mix tank via sludge discharge line
- pH adjust tank via drain valve on bottom (most of water should be drained to LAD tanks)
- LAD tanks via LAD method
- The make-down polymer should be managed so that most of it is used for treatment. The remaining solution can be drained into a 5-gallon bucket and dumped in the pond.
- The chase water tank must be drained into the pond using hosing and a 0.5 hp submersible pump located on-site.

The influent pump must be disconnected and stored in the plant. All outside plumbing that can be removed should be stored inside the plant. This includes the plant influent line and lines connecting the LAD tanks to the pH adjust tank and LAD pump. The caustic and acid in the plant can be left on-site over the winter. The unused neat polymer must be removed and taken to the warehouse.

The generator must be arranged to be removed by the subcontracted rental company.

6. Sampling

It is necessary to collect routine samples to monitor plant effluent and overall plant efficiency. A weekly sample of treated effluent from the sampling port leading to the LAD tanks is taken every Monday. Additionally, monthly samples from the NLP, ELP, and plant influent are taken (along with the weekly LAD sampling). All samples are to be collected in two aliquots, one is preserved with nitric acid for total metals analysis and the other is unpreserved for sulfate analysis. Field parameters, including: pH, temperature, oxidation reduction potential (ORP), specific conductivity (SC), turbidity, and dissolved oxygen (DO) are to be taken and recorded for each sample with a water quality multimeter. Field parameters should also be taken and recorded for the NLP, ELP, and plant influent on weeks where samples are not taken. Samples should be stored in a cooler for transportation and refrigerated for storage if not immediately transported/shipped to the lab.

6.1 Sampling Procedures

This section presents the procedures for collecting weekly analytical samples from the treatment plant.

- Each Monday, plant effluent is sampled from the sampling port on the eastern LAD tank.
- Two aliquots of the sample are taken in separate containers, one for total metals analysis and one for sulfate analysis. The aliquot collected for total metals analysis is to be acidified with nitric acid. The aliquot collected for sulfate analysis is left as-is.
- Water quality parameters, including: pH, temperature, conductivity, ORP, turbidity, and DO will be collected from all water treatment locations using a Horiba U-52 or similar water quality multimeter. In the event field parameter measurements indicate a potential treatment issue, indicated by low or extremely high pH in the WTP, zinc concentrations in the WTP effluent will be tested to determine whether or not the treatment process is functioning properly. Zinc concentrations will be measured using a Hach field colorimeter and verified via the samples sent to the laboratory.
- Ensure all sample bottle lids are tightened.
- Samples are to be stored in a cooler on ice and delivered to the lab as soon as possible, with 48-hour (rush) processing requested. If samples do not make it to the lab the day they are taken, they are to be stored in the sample refrigerator overnight.

7. Operator Intensive Duties

This section presents a list of the tasks to be performed by the water treatment plant operator for whom there are specific manual duties required and/or special hazards involved.

- Always wear the proper personal protective equipment (PPE)and be aware of possible hazards when: handling chemicals, taking samples, working near the ponds, and changing and/or performing maintenance on the LAD system.
- Always wear gloves and eye protection when handling the nitric acid used to preserve the 1-liter sample bottles.
- The zinc tests require reagent packets containing cyanide. At a minimum, wear gloves, safety glasses, and an N95 respirator when handling these packets.
- Take precautions when walking near ponds and avoid scenarios where slips, trips, and falls could occur.
- Maintain an accurate and updated daily logbook and, at a minimum, update the Luttrell WTP data Excel spreadsheets weekly.
- Ensure caustic is being pumped into the flash mix tank when turning on the caustic metering pump by visually checking the discharge end of the line (inside the flash mix tank) for liquid flow.
- Ensure plant influent flowrate is set at 45 gpm and check throughout the day. If the flowrate is low and the valve is unadjusted, check influent line for pinching and make sure influent pump has not been pushed onto the leachate pond bank.
- Ensure there is ample chase water and make-down polymer solution for operation. If more chase water is needed, water can be pumped from the effluent line into the chase water tank. The plant typically consumes chase water at 0.5 gpm.
- Make sure the acid metering pump is turned on once overflow occurs from the lamella clarifier to the pH adjust tank. Check the pH periodically throughout the day in the lamella clarifier and pH adjust tank. The pH should read between 9.5 and 10 in the lamella clarifier and between 6.5 and 7.5 in the pH adjust tank. Adjust acid and caustic consumption accordingly.
- When the pH transfer pump is in operation, make sure that the valve between the pH adjust tank and LAD holding tanks is set to the 45 gpm mark.
- Periodically clean the pH probes. The probes should also be calibrated using the calibration standard solutions to ensure accuracy of readings such as pH and conductivity.
- Check oil and coolant levels in the generator prior to plant startup and add fluids when necessary.

8. Operator Intensive Duties: Make-Down Polymer (0.5%) Production Protocol

This process utilizes a polymer emulsion system to flocculate suspended metals in leachate water. The polymer begins as a concentrated solution and is "made-down" by a ProMinent chemical skid into a 0.5% make-down solution. The chase water is used for this dilution. The polymer solution can be produced at 1 gpm and is consumed at 26 mL/min, which equates to approximately 12.5 gpw. The polymer product stays active for 5 to 7 days; thus, polymer production should be done in 15-gallon batches, which is approximately 15 minutes of production time. An alternate by-hand make-down production process is included in section 8.5.

8.1 Notes

- One gpm production of 0.5% make-down polymer solution uses 0.3 gph of neat polymer.
- Do not put water in the calibration column, only mineral oil.
- Polymer product stays active for 5 to 7 days.
- Check needle valve often for 1 gpm reading. Adjust accordingly. No flow sensor on skid.

8.2 Startup

- Connect the black hose to the product valve (Valve 5A) and place the discharge end in the make-down polymer tank.
- There is a T in the line leaving the chase water submersible pump that connects the outlet of the make-down metering pump to the flash mix tank and the inlet of the polymer skid. There is a valve that when opened allows the chase water to feed into the pH adjust tank with the make-down polymer solution. Close this valve so that full flow will be available for the polymer skid.
- Plug in submersible flocculent chase water pump and open valve to chemical skid. Close valve to flash mix tank.
- Open water valve on back side of skid (Valve 1).
- Open neat polymer inlet on skid (Valve 2).
- Make sure calibration column (Valve 3) is closed.
- Open product discharge valve (Valve 4).
- Open discharge to waste valve (Valve 5B) and close product valve (Valve 5A).
- Turn skid switch to hand mode.
- Let static mixer (sight glass) fill and then flush it until the sight glass shows polymer solution moving (usually twice).
    - To flush the static mixer, scroll through menu (down arrow) until mixer screen is up and press enter to flush. The mixer screen is one down from the run screen.
- If the chemical skid is producing solution, milky white liquid can be seen in the sight glass; if not, prime the metering pump.
- Confirm water flow is 1 gpm on the needle valve, indicating chase water flow into the polymer skid.
- Once polymer solution can be seen flowing through the static mixer (sight glass), open Valve 5A and close Valve 5B. Make-down polymer solution is now being produced and sent to the make-down polymer tank.

- Produce polymer for approximately 15 minutes. The plant consumes make-down polymer at approximately 26 mL/min.

8.3 Priming

- If polymer solution cannot be seen moving through the static mixer after flushing it multiple times, hold up and down arrows on frequency display to temporarily set the pump to max speed.
- If nothing can be seen after 1 or 2 minutes, open the calibration column (Valve 3) to purge air and fill the system. Make sure Valve 5B is open and Valve 5A is closed.
- Add mineral oil to calibration column as needed.
- Once pump is primed, close Valve 3.

8.4 Shutdown

- Turn Valve 5B on and Valve 5A off.
- Scroll through menu using down arrow until mixer screen is displayed.
- Press enter to flush when prompted.
- Flush four to five times until water going through static mixer (sight glass) is completely clear.
- Unplug water pump. Close valve to chemical skid and open valve to flash tank as marked.

8.5 Alternative By-Hand Make-Down (0.5%) Production Protocol

- Prepare solution 1 day in advance of use to ensure polymer is adequately mixed.
- Add 4 gallons of water (from chase water tank) to a 5-gallon bucket
- Measure 6 mL of Flopam AN 923 VHM polymer (powder) into measuring glass
- **Slowly** add polymer to the filled bucket a couple grains at time while **gently** stirring the solution with a wooden stirring rod. It should take 10-15 minutes of adding polymer and stirring to incorporate all 6 mL of polymer to the bucket.
- Continue to **gently** stir the solution for several minutes every hour for the next 3 hours.
- The following day, prior to using the prepared solution, gently stir for several minutes. The make-down solution should have a viscosity similar to corn syrup.

9. Operator Intensive Duties: Sludge Reduction System

This process pumps sludge build-up in the bottom of the primary clarifier to one of three sludge reduction tanks, reducing the amount of solids directly re-entering the leachate pond and increasing overall plant efficiency. The start-up flush will occur each morning before the initial treatment run. The mid-day flush will occur in the afternoon before the second treatment run, or any subsequent treatment runs where flushing is necessary.

9.1 Start-Up Flush

- Open influent valve on sludge tank 1 (furthest from primary clarifier), other sludge tank valves closed.
- Open primary clarifier sludge discharge valve.
- Allow 1000-1500 gallons (or until water runs clear) to flush into sludge tanks. When tank 1 is full, switch to tank 2.
- Close primary clarifier sludge discharge valve.

9.2 Mid-Day Flush

- Open influent valve on sludge tank 3 (closest to primary clarifier), other sludge tank valves closed.
- Open primary clarifier sludge discharge valve.
- Allow 400-800 gallons (or until water runs clear) to flush into sludge tank.
- Close primary clarifier sludge discharge valve.
- Sludge from mid-day flush will usually settle quickly. Clear water above the sludge layer is pumped back to the flash mix tank with a small submersible pump.

9.3 Sediment Removal

- Once a sludge tank is full, ensure that an empty sediment bag is loaded into the tilt-trailer and attached to the end of the discharge hose. Use a hose clamp and the lines on the sediment bag to ensure a strong connection between the bag and the hose.
- Ensure that the trash pump is connected in-line.
- Open sludge discharge valve on the tank being drained.
- Turn on trash pump to begin pumping sludge into sediment bag.
- Sediment bags will inflate with sludge. When bag sits about 3 feet off the bed of the trailer and is firm with sludge, turn off pump and allow the bag to drain.
- Repeat process until tank is empty.
- Pumping 1 full sludge tank through a sediment bag takes 30-45 minutes.
- Sediment bags should be changed at a minimum of every 2 days.
- Full sediment bags are transported and recycled back to the repository.

10. Safety

The Luttrell WTP is a hazardous environment in a remote location. The following is a list of safety concerns that the operator is exposed to daily. See site Health and Safety Plan (HASP) for full review of the health and safety concerns.

10.1 Hazards of Concern

Remote Location

Cell phone service is available on the mine site but not on the roads from Rimini and Basin. Flat tires, tree fall road blockages, and road washouts can strand the operator without cell phone service. Due to the hazards involved with working in this remote location, personnel working on-site should be working in pairs with an appropriate check-in/check-out procedure with a third staff member at the main office. Adequate planning and accountability will ensure the operator(s) make it back down the mountain safely when work is done for the day.

Weather

The Luttrell WTP is located at high elevation where weather is unpredictable. Extreme temperatures, heavy rainfall, hale, sleet, snow, and high winds can occur at any time throughout the year.

Noise

The plant operates pumps, mixers, and other large pieces of equipment that cause loud noises.

Chemicals

- Muriatic Acid
- Nitric acid preservative
- Caustic Soda
- Zincon reagent pouch which contains cyanide
- Acid mine drainage with heavy metal content
- Diesel fuel
- Polymer flocculant

Forested Areas

The LAD lines are in a forested area. The forests around the Luttrell WTP have a large number of dead trees that are susceptible to falling. Other associated hazards are forest fires, wildlife, uneven terrain, and tripping hazards.

Ponds

The leachate and biochemical reactor ponds are lined with a steep slope. This liner is slippery when wet. There is a graveled ramp next to the northern gate if the operator falls in and cannot get out of the pond. There is also a life ring present.

Wildlife

The Luttrell WTP is in a remote area where wildlife, including elk, bear, and wolves, are present. Wild animals are unpredictable, and personnel should use caution when encountering wildlife.

11. Process Equipment Photolog

Date: 7/9/2021

Component: Generator

Location: Outside WTP, along west wall

Description: CAT Diesel Generator

Date: 7/9/2021

Component: Fuel Tank

Location: Location

Description: 528-gallon Trans Cube fuel tank (diesel)

Date: 7/9/2021

Component: Operation Panel

Location: Inside WTP, on west wall

Description: Right side of operation panel. Buttons (left to right): pH Tank Mixer, Flash Mixer, North Barium Pump (not functional), South Barium Pump (not functional), pH Tank Transfer Pump

Date: 7/9/2021

Component: Operation Panel

Location: Inside WTP, on west wall

Description: Left side of Operation Panel

Date: 7/9/2021

Component: Leachate Pond

Location: Outside WTP, east side

Description: Leachate Pond, view facing E.

Date: 7/9/2021

Component: North Leachate Pipe

Location: Outside WTP, north side of leachate pond

Description: North Leachate Pipe draining mine-affected water into leachate pond, view facing E.

Date: 7/9/2021

Component: East Leachate Pipe

Location: Outside WTP, east side of leachate pond

Description: East Leachate Pipe draining mine-affected water into leachate pond, view facing SE.

Date: 7/9/2021

Component: Influent Pump

Location: Outside WTP, in leachate pond

Description: Pumps water from leachate pond into flash mix tank, view facing NE.

Date: 7/9/2021

Component: Influent Totalizer

Location: Inside WTP, on wooden frame below flash mix tank

Description: Displays current flow rate and total flow volume of influent**.**

Date: 7/9/2021

Component: Influent Sample Port

Location: Inside WTP, on frame below flash mix tank

Description: Port for taking influent samples**.**

Date: 7/9/2021

Component: Flash Mix Tank

Location: Inside WTP, northeast corner

Description: Tank where caustic soda and polymer flocculant are added to influent water.

Date: 7/9/2021

Component: Flash Mixer

Location: Inside flash mix tank

Description: Mixes caustic soda and polymer flocculant with influent water.

Date: 7/9/2021

Component: Caustic Holding Tank

Location: Inside WTP, northeast corner

Description: Caustic Soda (25% NaOH solution) holding tank.

Date: 7/9/2021

Component: Caustic Metering Pump

Location: Inside WTP, on top of caustic holding tank

Description: Pumps caustic soda into flash mix tank.

Date: 7/9/2021

Component: Polymer Production Skid

Location: Inside WTP, center

Description: Produces make-down polymer flocculant.

Date: 7/9/2021

Component: Polymer Type

Location: Inside WTP, center

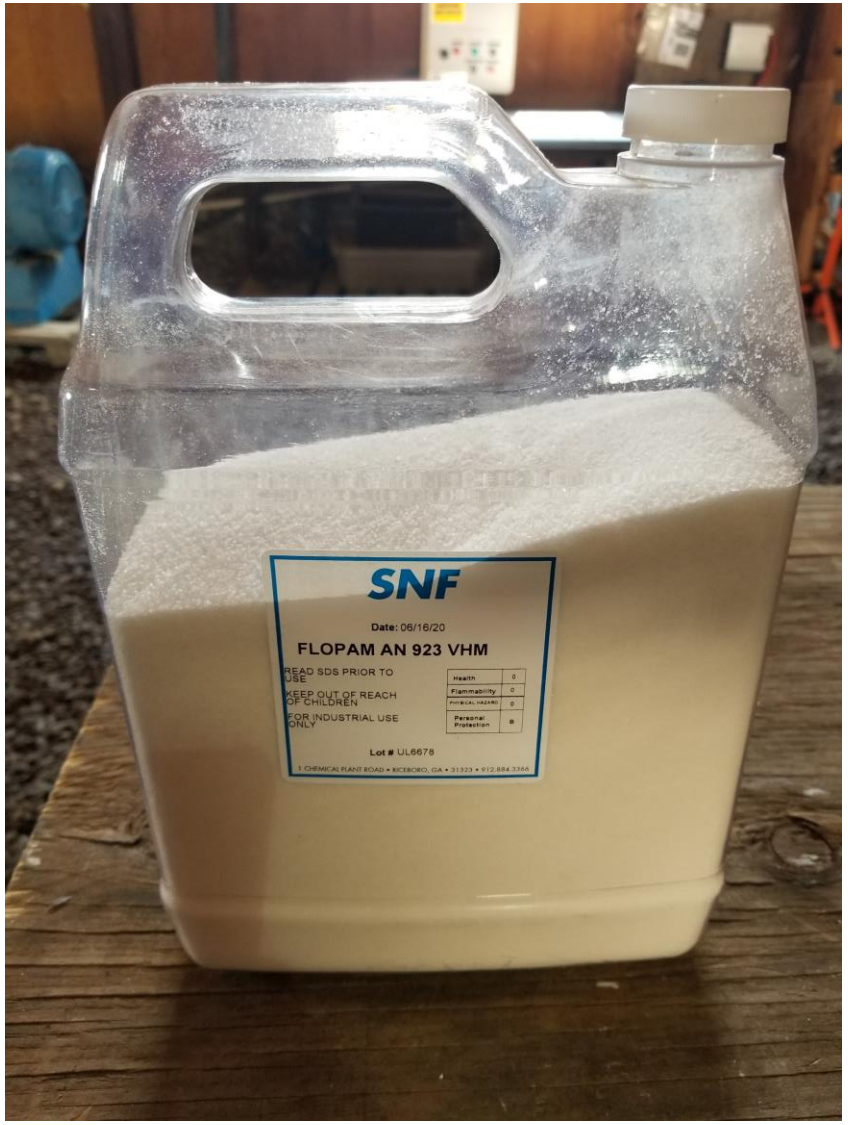
Description: CMC-2228 “Clarifloc” polymer for polymer production skid.

Date: 7/9/2021

Component: Polymer Type

Location: Inside WTP, center

Description: Flopam AN 923 VHM polymer for mixing by-hand.



Date: 7/9/2021

Component: Polymer Metering Pump

Location: Inside WTP, center

Description: Pumps polymer flocculant into flash mix tank

Date: 7/9/2021

Component: Chase Water Tank

Location: Inside WTP, center

Description: Chase water for polymer flocculant

Date: 7/9/2021

Component: Primary Clarifier

Location: Outside WTP, north side

Description: Settles out solid floc.

Date: 7/9/2021

Component: Primary Clarifier Discharge Valve

Location: Side of Primary Clarifier

Description: Sludge discharge valve to drain primary clarifier.

Date: 7/9/2021

Component: Sludge Reduction System

Location: Outside WTP, north side

Description: Reduces reintroduction of solids into leachate pond.

Date: 7/9/2021

Component: Lamella Discharge Valve

Location: Inside WTP, below Lamella clarifier

Description: Sludge discharge valve to drain Lamella clarifier.

Date: 7/9/2021

Component: pH Adjust Mixer

Location: On pH Adjust Tank

Description: Mixes Muriatic acid in pH Adjust Tank.

Date: 7/9/2021

Component: Transfer Pump

Location: Adjacent to pH Adjust Tank

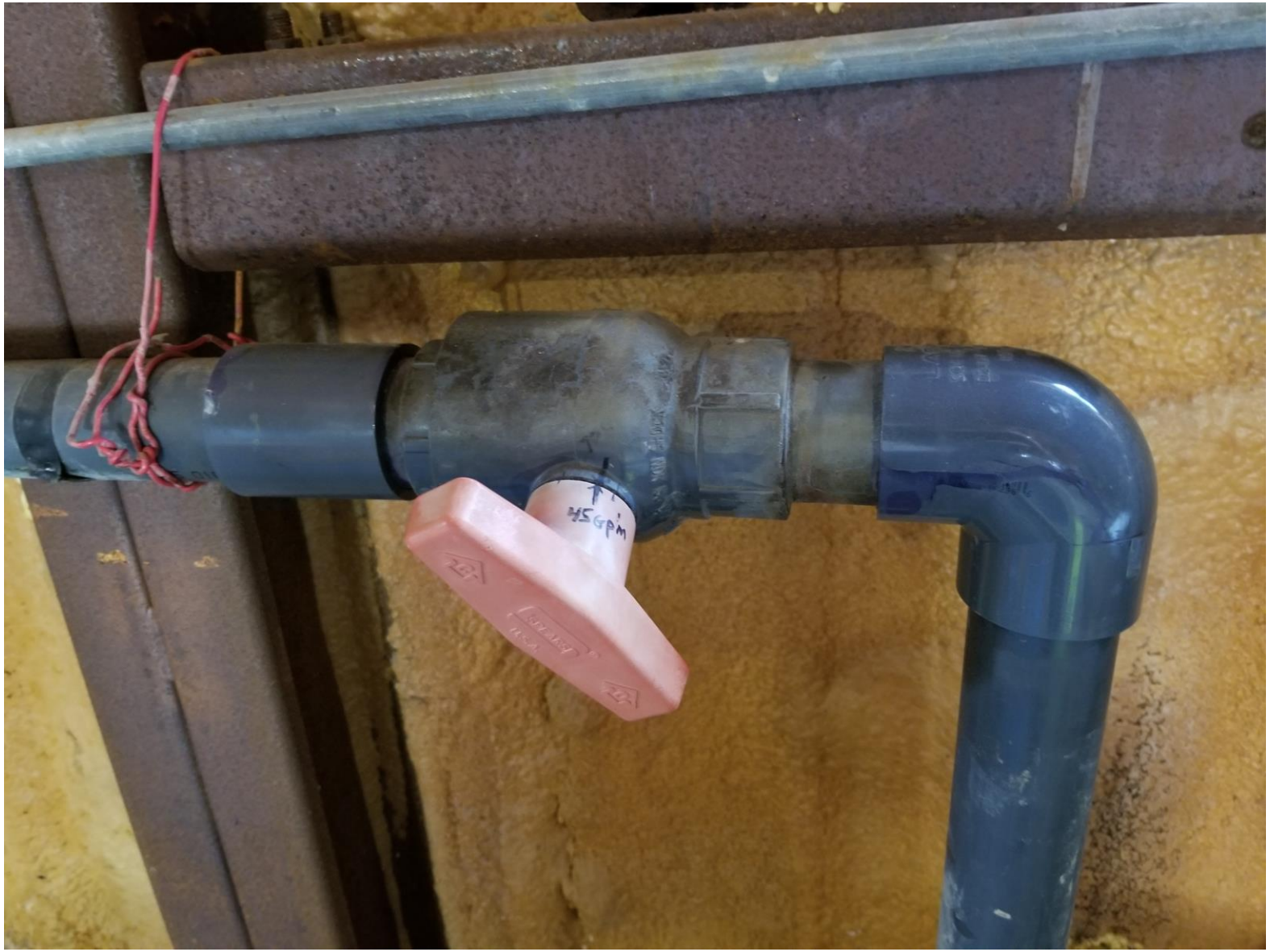
Description: Pumps water from pH adjust tank to LAD tanks.

Date: 7/9/2021

Component: Transfer Valve

Location: Inside WTP, south wall

Description: Controls flow from pH Adjust Tank to LAD Tanks.



Date: 7/9/2021

Component: Acid Metering Pump

Location: Inside WTP, southeast corner

Description: Pumps muriatic acid in-line above pH adjust tank.

Date: 7/9/2021

Component: East LAD Tank

Location: Outside WTP, south side

Description: Holds treated effluent to be released in LAD system.

Date: 7/9/2021

Component: West LAD Tank

Location: Outside WTP, south side

Description: Holds treated effluent to be released in LAD system.

Date: 7/9/2021

Component: East LAD sight glass

Location: Side of East LAD tank

Description: Displays current water level.

Date: 7/9/2021

Component: LAD Pump

Location: Inside WTP, along south wall

Description: Pumps water from LAD tanks to LAD system.

Date: 7/9/2021

Component: LAD Totalizer

Location: Outside WTP, south side

Description: Displays current flow rate and total flow volume to LAD system.

Date: 7/9/2021

Component: First Aid and Eyewash Station

Location: Inside WTP, west wall

Description: First aid kit and eyewash station.

Date: 7/9/2021

Component: Eyewash Station

Location: Inside WTP, on handrail next to Lamella clarifier

Description: Eyewash Station.