Potts Run Passive Treatment System
Operation and Maintenance Plan
October 2018

Background

The Potts Run Passive Treatment System was constructed in 2018-2019 to treat two sources of acid mine drainage—the Oak Twin discharge and the No. 3 discharge. The No. 3 discharge flows from an abandoned deep mine adit while the Oak Twin discharge is the effluent of a rock drain installed as part of a surface mine reclamation project. The treatment system consists of two vertical flow ponds (VFPs) arranged in parallel that discharge to a settling pond which discharges to an unnamed tributary to Potts Run. To ensure that the system provides decades of effective treatment at minimal cost, a regular operation and maintenance (O&M) program should be implemented so that problems are corrected before they impact system performance or become expensive to fix. This O&M plan provides guidance for inspection, operation and maintenance of the passive treatment system.

Treatment System

Figure 1 shows the layout of the treatment system, comprising four primary components:

Intake Structures

The intake structures are designed to capture the mine water so that it can be conveyed to the treatment system for treatment. Additionally, the intakes limit the amount of flow that can enter the system to prevent damage while providing an overflow for excess flow. There are two intake structures. The Oak Twin intake structure captures the mine water beneath the surface in pipes and a rock drain installed in the reclaimed mine backfill. The No. 3 mine intake structure consists of a concrete weir structure with an inclined stainless-steel screen. An in-line water level control structure (WLCS) is installed on the at each intake to regulate the flow into the treatment system. The intake structures are shown in Figure 5.

Water collected by the intake structures is conveyed in a 8” pipe along the south side of Oak Ridge road to a junction where the two pipelines are combined into a single 10” pipe. The combined flow from the two discharges is conveyed under Oak Ridge road to the flow distribution manifold in a 10” pipe.

Vertical Flow Ponds (VFP)

Water is treated by limestone aggregate which is overlain with an alkaline organic substrate. This system contains two primary VFPs (VFP 1 and VFP 2). Each VFP is 6’ deep, and is stratified as follows: 3’ limestone, 1’ alkaline organic substrate, 2’ standing water. Each VFP has 1’ of freeboard to the emergency spillway, and a top-of-berm elevation 1’ higher than the spillway. Figure 2 shows the vertical flow ponds.

Settling Pond

The settling pond is intended to provide metals retention for the VFP effluents during low to normal flow conditions. Under higher flow conditions, the settling pond allows for mixing of the

untreated water bypassed at the flow distribution manifold and treated effluent from both VFPs to mix. During high flows, excess alkalinity created by the VFP's will help the treat raw water that is bypassed into the pond. The settling pond is shown in Figure 3.

Flow Distribution Manifold

Water captured by the intake structures and directed to the treatment system is managed by the flow distribution manifold. Flow to be treated is split evenly between the two VFPs. Flow exceeding the capacity of the VFPs is directed to the settling pond for mixing with the treated effluent of the VFPs. Very high flows that exceed the capacity of the settling pond are bypassed to the unnamed tributary through an overflow pipe. Figure 4 depicts the flow distribution/bypass schematic.

System Inspections

The system should be inspected at least twice per year and following significant rain events. An inspection form is attached to this plan. This form can be used "as-is" or adapted for use by the inspection personnel. Use the "Notes" column to record any other relevant information about the site, such as signs of vandalism, sample numbers if lab samples are taken, or other information.

A system inspection involves visual observations, flow measurements, and simple water sampling. The entire process should require about 1-1.5 hours. The inspector can park at a pull-off on Oak Ridge Road and walk directly into the treatment system area. The settling pond can be accessed by walking to the northern end of the site, down the toe of VFP 2 berm, crossing the UNT to Potts Run, and walking to the northwest along the cleared pipeline route. The intake structures can be accessed directly from the side of Oak Ridge Road.

The inspection forms provide inputs for some key observations. If no problems are apparent, then the inspection is complete. A record of the inspection, even if no problems are found, should be made. If problems exist, then additional investigation should occur as discussed in "Troubleshooting" and in the Narrative.

Sampling and Flow Measurements

During each inspection, the flow rate, pH, and alkalinity should be measured at each sampling station. These data should be recorded on the inspection form so that changes in the system's performance over time can be recognized. Flow can be measured using a bucket and stopwatch at the various piped outfalls of the system. Flows may be too high for measurement by bucket and stopwatch under some conditions. In this case, flows can be estimated by measuring the height of the water in the water level control structures (see the Water Level Control Structures section). Alkalinity is also a valuable field measurement but requires a titrating device. If this is available, measure alkalinity at each sampling location, unless the field pH is less than 4.5.

pH measurements are good indicators of the performance of the system. The system influents (raw) both have pH values between 2 and 4. Both VFP effluent stations should have pH between 6 and 8. If the VFP effluent stations have a pH less than 6, which is verified after checking the

pH meter’s accuracy, then troubleshooting should occur for the poorly functioning treatment unit. The settling pond effluent may intermittently have a pH lower than 6, depending on the relative amount of treated and untreated bypass flow it is receiving.

The collection of water samples for laboratory analysis is recommended. The samples should be analyzed by a qualified laboratory for standard AMD parameters (pH, alkalinity, acidity, iron, manganese, aluminum and sulfate). The laboratory should provide bottles and reagents necessary to properly collect the samples.

Potts Run Passive Treatment System Inspection Form

Inspector _____ Date _____

Recent weather (wet, dry, cold, hot, etc.) _____

Refer to Figures 1-4 for the location of the inspection and sampling points included on this form

General Inspection Activities		
Location	**What to Look For**	**Response and Action**
Intake Structures	*Is the structure overflowing?*	No: OK Yes: if flow is high, OK Yes: flow is not high, troubleshoot
VFPs VFPs	*Discharge over the emergency spillways?* *Is vegetation growing in VFPs?*	No: OK Yes: adjust WLCS (troubleshoot) No: OK Yes: document and monitor
Settling Pond	*Is raw AMD being bypassed into the settling pond?* *Discharge over the emergency spillway?*	No: if total VPF flow <440 gpm, OK Yes: if total VFP flow >440 gpm, OK Yes: if total VFP flow <440 gpm, troubleshoot No: OK Yes: investigate cause and correct
Berms	*Signs of settling, slumping or seepage?*	No: OK Yes: document and monitor
Animal Problems	*Beaver or muskrat activity?*	No: OK Yes: document and monitor

Problems or miscellaneous observations (continue of back of this sheet)

_____
_____
_____
_____
_____
_____
_____
_____
_____

Potts Run Passive Treatment System Sampling Form

Inspector _____ Date _____

Recent weather (wet, dry, cold, hot, etc.) _____

Refer to Figures 1-4 for the location of the inspection and sampling points included on this form

Flow and water sampling information							
	Location	**Flow (gpm)**	**pH**	**Temp**	**Alkalinity**	**Lab Sample?**	**Notes**
Primary Sampling	VFP1 In					Yes	
	VFP2 In					No	
	Combined VFP Out @ Settling Pond					Yes	
	Settling Pond Out					Yes	
Secondary Sampling	Raw AMD Oak Twin					Yes	
	Raw AMD No.3					Yes	
	VFP1 Out @ WLCS					Yes	
	VFP2 Out @ WLCS					Yes	

Additional notes and diagrams below

Troubleshooting

The following table describes how to recognize, diagnose, and fix potential problems with the treatment system.

Problem	Potential Cause	Solution
Water is not reaching the system	The intake screen or intake flow restriction is clogged	Clean screen or orifice restrictions in inline water level control structure
	Pipeline is clogged	Remove obstruction
VFP performance (pH, alkalinity) declines over time	Organic Substrate is becoming less effective	Mix and add more limestone-amended spent mushroom compost
	Head loss indicated by raising of water level	Remove one or more stoplogs from the WLCS to lower the water level to the design elevation. If problem persists, replace organic substrate.
VFP or Settling Pond integrity (animal activity is affecting system)	Muskrat activity is apparent from the presence of uprooted wetland plants and small huts made of mud and vegetation	Contact the PA Game Commission and request that the animals be removed
	Beaver activity is apparent from dams constructed in channels and sticks wedged in pipes	Contact the PA Game Commission and request that the animals be removed
	-Vandalism	Repair damage, restrict access to site
Flow is not being distributed equally or bypassed correctly	Vandalism	Check orifice restrictions in WLCS 1 & 2 are not obstructed. Verify that stoplog elevations match those shown in as-built plans.
	Accidental stoplog removal?	

Potts Run Passive Treatment System Maintenance Narrative

The following is a description of the system components and instructions for their monitoring and maintenance.

Water Level Control Structures

Description

A water level control structure (WLCS) is a PVC box with inlet and outlet pipes connected to its base and a series of stoplogs that divide the interior of the box in half. Water backs up on one side of the stoplogs in order to flow over and out the other side. Adding or removing stoplogs raises or lowers the water level upstream of the WLCS. These stoplogs are either 5" or 7" in height permitting various combinations of stoplog heights to be used to achieve the desired water level. Each stoplog has attached hooks that can be used to remove the stoplogs. A rod made for removing stoplogs is available on-site.

The WLCS provide five functions for the treatment system. 1) They control how much water is conveyed to the treatment system from the intake structures. 2) They control how much water is bypassed or overflowed 3) They split the water between the two VFP units. 4) They set the water elevation in the treatment systems and allow the treatment units to be drained. 5) They can act as shutoff valves to stop flow for maintenance or assessment.

The treatment system utilizes nine WLCSs. Two are located at the two intake structures, four at the flow distribution location, and one in each VFP and one in the Settling Pond. The Settling Pond WLCS is an inlet water level control structure that sets the water level in the pond and is accessed by a wooden dock. The Oak Twin and No. 3 Mine intake WLCS are installed at the two discharge intake structures and are used to restrict flow to the treatment system. The VFP #1 and VFP #2 WLCS are used to maintain the water elevation in the two treatment units and to allow the VFPs to be drained during major maintenance events. The remaining WLCS's (D-1 through D-4) are used to regulate, direct, and split flows.

When flows into the treatment system and/or settling pond are too high to be adequately measured by the timed volume (bucket/stopwatch) method, flow rates can be estimated by measuring the water depth above the top stoplog in the WLCS and using the table on the following page. Each size column (8" or 10") in the table refers to the size of pipe entering the WLCS. A table showing the pipe sizes of each WLCS is shown on the right.

WLCS Name	Pipe Size
Oak Twin Intake	8"
No. 3 Intake	8"
VFP1 Out	8"
VFP2 Out	8"
D-1	8"
D-2	8"
D-3	10"
D-4	8"

Operation and Maintenance

WLCs installed in the intake structures and flow distribution system should be inspected for blockage, tampering/vandalism. See the intake structure and flow distribution system sections for descriptions of operation and maintenance needs.

Water Level Control Structure (WLCS) Flow estimation table.					
	Flow Rate (gpm)			Flow Rate (gpm)	
WLCS Pipe Size	8”	10”	WLCS Pipe Size	8”	10”
Water Depth (in.)			Water Depth (in.)		
0.00	0.0	0.0	7.09	457.0	545.7
0.20	2.9	3.5	7.28	474.5	566.5
0.39	8.1	9.7	7.48	492.1	587.6
0.59	14.5	17.4	7.68	509.9	608.9
0.79	21.8	26.3	7.87	527.9	630.4
0.98	29.9	36.2	8.07	546.1	652.1
1.18	38.6	46.8	8.27	564.4	674.0
1.38	47.7	58.0	8.46	582.9	696.0
1.57	57.3	69.8	8.66	601.6	718.3
1.77	67.1	82.0	8.86	620.4	740.8
1.97	77.1	94.6	9.06	639.4	763.4
2.17	87.4	107.4	9.25	658.5	786.3
2.36	97.7	120.5	9.45	677.7	809.3
2.56	108.1	133.8	9.65	697.2	832.4
2.76	118.6	147.3	9.84	716.7	855.8
2.95	137.7	160.8	10.04	736.4	879.3
3.15	150.5	174.3	10.24	756.3	903.1
3.35	163.5	195.2	10.43	776.3	926.9
3.54	176.8	211.1	10.63	796.4	951.0
3.74	190.4	227.3	10.83	816.7	975.2
3.94	204.3	243.9	11.02	837.1	999.6
4.13	218.4	260.8	11.22	857.6	1024.1
4.33	232.7	277.9	11.42	878.3	1048.8
4.53	247.4	295.4	11.61	899.1	1073.6
4.72	262.2	313.1	11.81	920.1	1098.6
4.92	277.3	331.1	12.01	941.2	1123.8
5.12	292.6	349.4	12.20	962.4	1149.1
5.31	308.1	367.9	12.40	983.7	1174.6
5.51	323.9	386.7	12.60	1005.1	1200.2
5.71	339.8	405.8	12.80	1026.7	1226.0
5.91	356.0	425.1	12.99	1048.4	1251.9
6.10	372.3	444.6	13.19	1070.2	1277.9
6.30	388.9	464.3	13.39	1092.2	1304.1
6.50	405.6	484.3	13.58	1114.3	1330.5
6.69	422.6	504.6	13.78	1136.4	1357.0
6.89	439.7	525.0			

Intake Structure

Description

Acid mine drainage (AMD) is diverted to the treatment system by an intake structure that both screens debris and restricts flow to the system. This is a specialized device designed for the Potts Run passive treatment system. Details of the intake structure are shown on Sheet 6. A concrete weir is fitted with a specialized wire screen on the downstream side. Beneath the screen is a sump containing am 8-inch-diameter pipe that carries the flow to the pipeline junction. An Agridrain inline water level control structure is installed just downstream of the intake and acts as a flow restriction. The stoplogs are positioned to allow the design flow to pass. If the flow is greater than the maximum design flow, the excess will discharge out the face of the intake screen. Bypassed flow will be visible in the channel downstream of the structure. During base and low flow conditions there should not be more than a few gpm of flow in the bypass channel. During high flow events, water is intentionally bypassed so the channel could contain flow.

Operation and Maintenance

The slanted intake screen is designed to automatically shed debris to minimize clogging. However, metals solids and algae may accumulate on the screen and reduce its flow. The screen may require occasional cleaning. Routine cleaning of the screen can be accomplished with a wire brush, while more intensive cleaning of the screen can be accomplished by removing the screen from the intake weir and using a pressure washer to dislodge accumulated debris; particularly from the back side of the screen. The high pressure sprayers at a manual car wash can be used for this purpose. During the fall months excessive amounts of leaves may accumulate on the screen which can be swept off the face of the screen with a shovel or broom.

Flow Distribution Manifold

Description

The flow into each VFP, settling pond, and overflow pipe are determined by four water level control structures (WLCS D-1 through D-4). WLCS D-1 and D-2 contain a bottom stoplog with an orifice restriction (a hole drilled through the stoplog). Water always passes through the orifices of the D-1 and D-2 WLCS, which are set at the same elevation and split the flows roughly in half. However, when flows are high and the head increases, water begins to flow over the stoplogs of D-4 to the bypass pipeline which carries that flow to the settling pond. The highest flows overtop the stoplogs of D-3 and are discharged to the unnamed tributary via the overflow pipe. Each VFP is designed to receive a maximum of 220 gpm, and the settling pond is designed to receive a total bypass flow of 330 gpm. The board elevations in the four WLCSs are placed so that flows higher than 770 gpm overflow into the UNT to Potts Run.

Operation and Maintenance

The function of the Flow Distribution Manifold is determined by the setup of the WLCS and should not change over time. Changes to the setup should only be necessary if observed treatment performance warrants an adjustment. Adjustments should only be made with carful consideration to avoid overloading the VFPs.

Liners

Description

Due to the treatment system's construction in highly permeable coal refuse, it was determined that both VFP's required a plastic liner. A textured 60mil HDPE geosynthetic liner was installed.

Operation and Maintenance

Both VFPs should be full of water at all times. The flow into each VFP can be measured with a bucket and stop watch at the influent end. The flow out of each VFP can be estimated by measuring the height of the water above the top stoplog and using the Agridrain weir equations. The combined effluent flow can be measured at the settling pond. If any of them are not filled with water or effluent rates are lower than influent rates, the WLCS should be inspected to see if leaks developed between the stoplogs. If no obvious leaks are visible, the rock underdrain should be inspected for alkaline, sulfate rich water.

Vertical Flow Ponds (VFP)

Description

The VFPs contain a three-foot thick layer of limestone aggregate covered with one foot of alkaline organic substrate. The cross-section for design of the VFPs is shown on Sheet 4. Water flows downward through the organic substrate and limestone to a network of 4-inch perforated lateral pipes connected to a manifold and outlet pipe, which is connected to a WLCS.

Operation and Maintenance

If the water level in the VFP is near or above the elevation of the emergency spillway during normal flow conditions and the stoplogs in the WLCS are at or below the design elevation, then the permeability of the organic substrate is decreasing. Remove a stoplog from the WLCS to lower the water level in the VFP.

Over time the organic substrate is consumed and will require maintenance and replacement. After five to seven years of operation, or if monitoring data indicate a decline in the VFP's performance, the VFPs should be drained to permit inspection of the organic substrate layer. The organic substrate inspection process should proceed as follows:

Maintenance can often be performed without stopping flow into the VFP. Remove stoplogs from the VFP WLCS to drain the VFP below the level of the compost. It will take at least a day to drain so plan to begin draining the VFP the day before the inspection.

Using a shovel, dig several holes in the organic substrate to expose profiles of the full thickness of the substrate. The organic substrate will be light brown to gray where it has been exhausted. Viable organic substrate will be dark brown to black. The relative thickness of the exhausted versus viable layers can be used to estimate how much time is remaining until the organic substrate is completely exhausted. The substrate should be replaced or rehabilitated when the viable thickness is less than 6 inches. Document the condition of the organic substrate with photos. Be sure to include a tape measure for scale.

Fill in the inspection hole carefully to avoid creating an easy path for water to flow through the organic substrate into the limestone below.

Repeat above steps for the other VFP.

VFP Minor Maintenance

Generally, minor maintenance is required after five to ten years of operation. The organic substrate will not be consumed uniformly across the VFP due to variations in flow rate through the organic substrate. As a result, the full column of organic substrate may be completely exhausted in one portion of the VFP while another portion is only partially exhausted. If inspections of the organic substrate indicate that this is the case, the organic substrate should be mixed to redistribute the viable organic substrate. Mixing can be accomplished with either an excavator or small dozer. Regardless of the equipment used, the organic substrate should be piled then redistributed uniformly.

VFP Major Maintenance

Major maintenance will likely be required after ten to fifteen years of operation. Before the organic substrate is completely exhausted, new compost should be added (the time to add compost should be determined using the inspection instructions above). Prior to adding new organic substrate, the existing organic substrate should be mixed following the "VFP Minor Maintenance" procedure. The amount of organic substrate required will depend on the amount of room in the VFP that is available to accept additional material. If permeability problems are encountered with the existing organic substrate even after it has been mixed it may require removal and disposal.