Puritan Operation, Maintenance, & Replacement Plan

Project Information

Project Name (coordinates)	**Puritan AMD Full Treatment** (40.367210, -78.646598)
Site Access	Puritan Road, Portage, PA 15946
Hydrologic Order	Trout Run→Little Conemaugh R.→Conemaugh R.→Kiskiminetas R.
Landowners	Neugerbauer, Gerald P.; Cooney Bros. Coal Co., Wenturine Bros. Lumber, Inc., Fisher, Donnal L. & Brunnet, Scott, et al.
Design	BioMost, Inc., Mars, PA, www.biomost.com
Construction	Earth Shapers, LLC, Ebensburg, PA
Project Sponsor	Stream Restoration Incorporated
Responsible Organization	Trout Run Watershed Association, Inc.

Overview

The Puritan AMD Full Treatment Passive Treatment System (System) is located in Portage Township near Portage, PA, Cambria County between Puritan Road and Trout Run. Abandoned mine drainage (AMD) issues from dual 24-inch HDPE Type-S (N-12) pipes that extend from an abandoned underground, above-drainage coal mine. The AMD is directed the System that is comprised of five ponds, two of which that contain high quality limestone to raise the pH, neutralize acidity, and cause both aluminum and iron to precipitate. The metal solids are flushed into two settling ponds prior to the treated water being discharged to Trout Run.

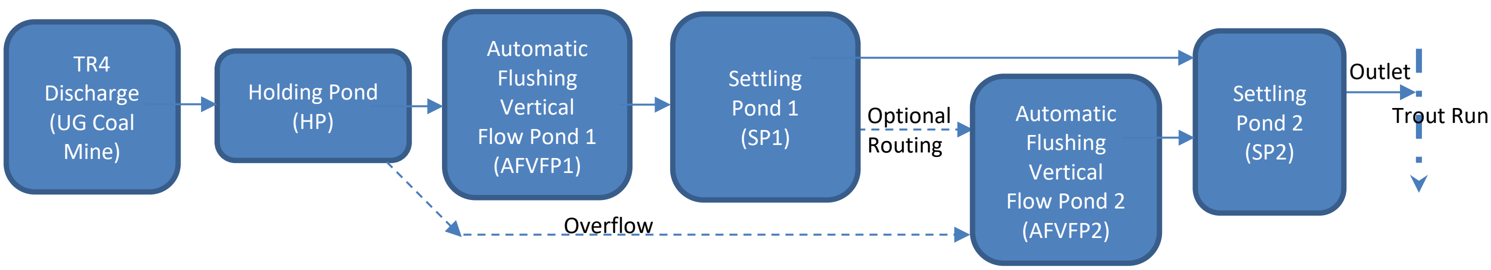

Figure 1. System Flow Diagram

System Design

Treatment Targets

The PA Code Title 25 Chapter 93 protected use for Trout Run is CWF (Cold Water Fishes). Water quality standards typically related to mine drainage are summarized in Table 1.

Table 1. Relevant Stream Water Quality Standards (Title 25 PA Code Chapter 93) ("Treatment Targets")

Parameter	**Standard**	**Source**
Alkalinity	20 mg/L (minimum)	§93.7 Table 3
Iron (total)	1.5 mg/L (30-day average)	§93.7 Table 3
pH	6.0 to 9.0 (inclusive)	§93.7 Table 3
Aluminum (total)	0.75 mg/L (maximum)	§93.8c Table 5
Note: Manganese is included in §93.7 Table 3 as a water quality criterion for potable water supplies at 1.0 mg/L.		

As the Puritan discharge is located in the headwaters of the drainage basin, the water quality standards in Table 1 were used as general treatment targets; However, as the discharge emanates from an abandoned mine, there are no specific applicable effluent standards that must be met.

Discharge Design Characteristics

The Puritan raw water discharge monitored at Point TR4 has been sampled periodically by several organizations over the past two decades. As part of the design effort, Saint Francis University (SFU) in cooperation with BioMost, Inc. (BioMost) conducted a monitoring program that included installing a pressure transducer at a 2.0 foot-wide rectangular weir (Weir) installed below the dual 24" N-12 pipes that extend from the underground mine workings. It should be noted that the weir is situated in a channel that also receives surface runoff during precipitation events. SFU deployed a pressure transducer at the Weir from August 5, 2016 to September 13, 2018 and recorded flow depth at 15-minute intervals. For analysis purposes, the monitoring was broken into two "water years" as described below. Note that the original pre-existing collection system was upgradient of the weir and directed about 100 gpm (73 – 133 gpm) to the original treatment system, therefore, 100 gpm was added to the values measured at the weir for design purposes.

Table 2. TR4 Flow Monitoring Summary

Monitoring Period	n	Minimum	Maximum	Average	Median	95th%tile	99th%tile
9/1/16 – 8/31/17	30,618	110	1599	261	137	558	664
9/1/17 – 8/31/18	28,886	110	1374	242	209	599	724

Flow in gallons per minute (gpm). Values include flow measured at 2.0-foot weir plus assumed 100 gpm directed to system.

Table 3. TR4 Laboratory Analysis Summary

Parameter	pH s.u.	Conductivity umhos/cm	Acidity mg/L	Iron mg/L	Manganese mg/L	Aluminum mg/L	Sulfate mg/L
Minimum	2.9	1242	77	3.9	1.1	7.7	584
Maximum	3.1	1526	150	9.2	1.6	14.6	709
Average	3.0	1358	114	6.3	1.4	12.0	653
Median	3.1	1328	110	6.0	1.4	12.4	589

Sample dates: 7/6/17, 8/21/17, 11/2/17 (no flow at weir, sample collected at system inlet), 2/10/18, 3/21/18, 4/12/18, 5/29/18, 6/27/18

Automatic Flushing Vertical Flow Pond Sizing

Extensive pre-construction bench-scale (bucket) testing conducted by SFU led to an innovative design approach for automatic flushing vertical flow ponds. The System includes a holding pond that is used to batch treat the AMD with the first AFVFP (AFVFP1) and uses a second, smaller AFVFP (AFVFP2) for overflow during high-flow conditions.

The standard bucket test technique that has been used by BioMost for years to evaluate the required size of AFVFPs adds mine drainage all at once and then monitors changes in chemistry over time. Depending on the raw water chemistry, observations indicate that the majority of acidity can be neutralized very quickly, usually in about four to eight hours in this order: Proton (H^+), ferric iron, and aluminum, with little effect to ferrous or manganese-generated acidity. Typically, limestone-based alkalinity generating passive treatment components are designed to provide a desired retention time (e.g. 12 hours) and the numerous bucket tests conducted as part of this project generally confirmed that this retention time is optimal with significantly less alkalinity generated after 12 hours. The quantity of limestone is usually determined based on a maximum inflow rate and assumed void percentage in the limestone, which works out to be about 10 tons of limestone for every 12 hours of retention time assuming a nominal 50% void space and continuous treatment or plug flow (such as is realized in an anoxic limestone drain or non-flushing-type vertical flow ponds).

Many AFVFPs are designed to flush at a particular interval, such as once per day (i.e. every 24 hours), in order to provide an average retention time of about 12 hours. This is different from the conditions realized in the standard bucket tests and was verified by conducting numerous tests where the water was added to a bucket of limestone gradually over a time interval and compared to buckets where the limestone was saturated all at once. It was found that adding the mine drainage all at once and holding for 12 hours provided similar or better results than when the mine drainage was added gradually over 24 hours. Note that in order to provide an average retention time of 12 hours, about 20 tons of limestone is needed per gallon per minute. In other words, by allowing the AFVFP to fill up gradually and flush periodically, twice as much limestone is needed when compared to adding it all at once, or batch treating the mine drainage.

The available grant funds provided for the construction of two AFVFPs with a total of 6,500 tons of limestone, it became apparent that the standard treatment approach outlined in the grant application would only be able to provide treatment for up to about 325 gpm of mine drainage, with the maximum design flow decreasing over time as the limestone dissolves. Therefore, it was decided to revise the treatment approach to include a holding pond and automated valve system that would allow the AFVFP1 to fill rapidly and utilize float switches and a timer to hold the water for 12 hours. This has two expected advantages: One, it reduces the quantity of limestone by half when compared to the traditional design approach to AFVFPs; Two, using float switches allows for automatic adjustment to ensure a true 12-hour holding period within the limestone as residual solids not flushed into the downstream settling pond gradually reduce the effective void space within the treatment medium.

AFVFP1 was sized to include about 4,600 tons of limestone to allow initial treatment for up to about 460 gpm which is roughly equivalent to the 80^{th} and 92^{nd} percentile flows for the 2016/2017 and 2017/2018 monitoring periods, respectively. Flow in excess of about 460 gpm would be directed to AFVFP2 that contains 2,000 tons of limestone, allowing the two AFVFPs to function in parallel. AFVFP1 includes a timer that will hold the mine drainage for 12 hours and then flush to SP1 and subsequently flow to SP2. The System piping also allows the AFVFPs to function in series if desired. AFVFP2 includes an automatic valve that is programmed to flush once per day regardless of flow rate and provide an initial 12-hour average retention time for up to about 100 gpm.

Combined, the two AFVFPs will provide initial treatment for up to about 560 gpm, which is approximately equivalent to the 95th%tile flow, assuming that 12 hours of retention time is needed. The bucket tests performed by SFU indicate that full acid neutralization can occur in as little as four hours, which would essentially triple the maximum design flow rate for AFVFP1 to about 1,400 gpm, adding the capacity of AVFP2, the maximum potential treatment flow is projected to be about 1,500 gpm, close to maximum measured flow of 1,599 gpm recorded on June 15, 2017. The second highest flow of 1,374 gpm occurred on February 16, 2018. Total flow in excess of 1,000 gpm occurred on only those two dates over the two-year monitoring period. As noted, the limestone will dissolve and the effective maximum treatment flow rate will decrease. The average acid load measured during the 2017-2018 monitoring period was about 263 lb/day (48 ton/year). Assuming a 20-year design life and a 90% calcium carbonate equivalent, about 1,100 tons of limestone will dissolve, effectively reducing the maximum design flow by 6 gpm per year over 20 years for a final maximum design flow of about 500 gpm using a 12-hour retention time. The system is configured so that that limestone can easily be added to AFVFP1 if desired.

Overall, the design includes a good deal of flexibility as the AFVFPs can be operated in parallel or series, the hold time in AFVFP1 can be adjusted (reducing retention time can increase the maximum flow rate treated as long as treatment goals are met), AFVFP2 will provide at least partial treatment when the total flow rate exceeds 460 gpm as the water will flow through the limestone and over the Agri Drain stop logs (similar to a “traditional” vertical flow pond) and will be able to pass flow in excess of 2000 gpm.

For evaluation and operation and maintenance purposes, the design flow rates of 300 gpm and 600 gpm, average and maximum, respectively have been selected.

System Components

Raw Water Inlet
Mine water emanates from two existing mine entries that have 24” N-12 drainage pipes. A 24” x 12” saddle tee installed on the invert of the upper wet seal captures the AMD that is conveyed by a 12” pipe to a concrete collection box located at the outlet of the lower mine seal. A 12” SCH40 PVC pipe extends from the collection box down to the concrete channel and fiberglass flume at the HP. A 12” Valterra knife gate valve is located along the pipeline near the collection box. When the 12” valve is closed, water will back up in the collection box and lower wet seal and exit via the top of the collection box and flow into an existing drainageway to the Weir, thus bypassing the entire treatment system. The 1.5’ fiberglass H-Flume attached to the outlet side of the concrete channel includes a staff gauge to measure water depth that is used with the H-Flume lookup table in Table 4 to determine flow.

Agri Drain Smart Drainage System (Control Boxes #1 and #2)

System Overview
The System is intended to direct water collected in the Holding Pond to AFVFP1 for treatment. Water is held in the AFVFP1 for a specified period of time (initially set to 12 hours but can be adjusted) and then is flushed into SP1.

Float switches are used to monitor the water level in both the HP and AFVFP1. When sufficient water volume has accumulated in the HP, Float Switch #1 signals the controller. Valve #1 is opened while Valve #2 remains closed, thus filling the AFVFP1. Once the AFVFP1 is filled as indicated by Float Switch #2 Upper, Valve #1 closes and the treatment timer starts. When the treatment timer completes, Valve #2 opens to flush the treated water into SP1 until Float Switch #2 Lower indicates that AFVFP1 is empty and then Valve #2 is shut and the cycle starts over. The Agri Drain Smart Drainage System Operator’s Manual is included as Attachment #1. System details and troubleshooting can be found in the manual, for additional troubleshooting assistance, please contact BioMost.

Holding Pond (HP)
Using a bulk density for limestone of 1.35 tons per cubic yard and the above noted 50% void space, the estimated flush volume for the 4,600 tons of limestone in AVFP1 is about 344,000 gallons. The HP has an approximate volume of 400,000 gallons between an elevation about 0.5’ above the invert of the 12” SCH40 PVC drain pipe near the HP bottom and the invert of the 12” overflow pipe. Bar guards are installed at the inlets of both the drain and overflow pipes to prevent debris from entering the pipes and obstructing flow. The drain pipe bar guard can be removed by pulling the rope tied to the bar guard that extends to a stake situated along the berm near the outlet side of the HP. When flow rates exceed approximately 460 gallon per minute, the water level within the HP is expected to rise to the elevation of the overflow pipe between flush events and the excess water will be directed to AFVFP2. When the raw inflow to the HP is about 460 gallons per minute or less, AFVFP2 will generally remain empty.

Maintenance of the Holding Pond should be minimal and consist of mostly visual checks for erosion and debris occluding effluent pipes. The HP embankments have R-4 riprap armoring throughout the wetted zone. Visual inspection should be done whenever on site and any erosion within this zone should be immediately addressed.

Automatic Flushing Vertical Flow Pond #1 (AFVFP1)
AFVFP1 contains approximately 4,600 tons of high-calcium (~94% $CaCO_3$ equivalent/77% as $CaCO_3$) limestone. When Valve #1 opens, approximately 344,000 gallons of raw AMD will enter the AFVFP1 from the HP and be held for 12 hours per the initial programming of the Smart Drainage System. The hold time may be changed depending on future water quality measurements or changes to System parameters. Ideally, to maximize the volume of AMD that can be treated and to minimize metal accumulation in the limestone, the hold time should be adjusted to the

shortest period that achieves the treatment goals. The pond has an underdrain system comprised of 6” DR17 HDPE perforated lateral pipes connected with non-shear flexible couplers. The underdrain pipes are 25’ long, spaced approximately 20’ apart, and are perpendicular to the longitudinal axis of the pond. A 12” DR26 HDPE perforated header pipe parallels the length of the pond and is joined to the laterals with 6” flexible saddle tees. The 12” DR26 HDPE is connected with non-shear flexible couplers at each joint and as it transitions to SCH40PVC pipe where it extends into the embankment to the Agri Drain structure.

Maintenance of the AFVFP1 will include periodic cleaning of limestone. AFVFP1 maintenance will be triggered based on poor water quality in SP1 or when overflow from the HP occurs daily when the total inflow rate as measured at the flume is 300 gpm or less. The pH measured at the outlet of SP1 (8” SCH40 PVC pipe outlet in SP2) should always be above 6.0 with a field alkalinity of at least 20 mg/L. A pH less than 6.0 or an alkalinity less than 20 indicates that the limestone has become passivated and needs to be cleaned. Daily overflow from the HP when inflow rates are 300 or less indicate that the voids within AFVFP1 have become filled with metal precipitates. If daily overflow occurs at or below 300 gpm, the hold time in AFVFP1 should be adjusted to less than 12 hours and the water quality in SP1 be monitored in an effort to achieve treatment goals with a reduced retention time. Timing of the stirring and cleaning of limestone should be based on the above System parameters, but it can be expected that the first stirring of AFVFP1 may be needed within the first 5-10 years and at a similar to lessened intervals thereafter.

Stirring of the limestone should be to a depth as low as possible without compromising the clay liner. Typical stirring would involve lowering the water level in AFVFP1 to about three to four feet, stirring the limestone to wash accumulated solids from the stone surface, temporarily stockpiling the stone, then removing the solids by either draining the pond through the 12” pipe or pumping the solids into SP1. The underdrain piping may be left in-place during washing or temporarily removed if desired. The limestone should be excavated to the bottom of the pipes and the accumulated solids removed so that the clean limestone is placed around the underdrain pipes. AFVFP1 has a compound sloped bottom to help facilitate sludge removal. The pond is approximately 1’ lower on the outlet side than the inlet side and approximately 1’ lower on the northern side compared to the southern side to help sludge flow towards the outlet pipe. The stilling well should be removed and replaced as needed, ensuring that the float switch elevations are reset to pre-maintenance elevations.

Once the limestone is cleaned and the accumulated solids removed from the AFVFP1, replace the underdrain piping if needed and place the cleaned limestone around the pipes, being careful to maintain joint integrity during stone placement. Once all the limestone is in-place, allow the AFVFP to fill with water and grade the stone evenly using the water surface as a level indicator. Remove one or more stoplogs from the Agri Drain structure as needed to set a temporary water level. Once the stone is level, replace the stop logs so that the maximum water surface is just below the top of the limestone when the valve is shut and the AFVFP1 is full (water is flowing over the top of the stoplogs). As it is not uncommon for aggregate to enter the underdrain piping during maintenance, manually open and shut Valve #2 several times to ensure that the valve seat is free from rock fragments or other debris.

If desired, stop logs can be removed from the AFVFP1 Agri Drain structure to prevent water from entering the overflow pipe to AFVFP2 and allow AFVFP1 to operate in flow-through mode between flush events during high flow periods. This is an optional configuration that will and allow the entire TR4 flow to travel through both AFVFPs in series.

Automatic Flushing Vertical Flow Pond #2 (AFVFP2)

AFVFP2 contains approximately 2,000 tons of high-calcium limestone and has a flush volume of about 150,000 gallons based on the aforementioned limestone bulk density and void space. The underdrain is composed of a single 12” perforated DR-26 HDPE pipe connected with non-shear flexible couplings at each joint and to the solid 12” SCH40 PVC outlet pipe that extends through the embankment and an Agri Drain structure to SP2. The Smart Drainage System can be programmed to open for a specified period each day and can be set to open every day or any selected day(s) of the week. Smart Drain #3 was initially programmed to open once every day for 90 minutes, which is intended to allow AFVFP2 to fully drain. Smart Drain #3 is fully independent from Smart Drains #1 & #2, and functions solely on a timer unlike the other drains that incorporate float switches. The schedule can be modified if needed following the Smart Drain programming instructions included within this O&M plan. A solar-powered actuator operates a 12" Valterra valve within the Agri Drain structure in accordance with the program selected. It is recommended to schedule monthly inspections to coincide with the flush events which will allow the inspector to observe the AFVFP2 flush event. If the valves do not open as desired, the Smart Drainage System components should be inspected and repaired as needed.

Agri Drain Smart Drain #3 (Stand Alone – AFVFP2)

The Smart Drain structure serves two functions: 1) It is the primary control system to flush AFVFP2 and 2) It provides a controlled overflow prior to a flush event and during high flow. The flush valve is a 12" knife gate valve (Valterra brand) which is opened and closed by an electric linear actuator (GlideForce Part No. LACT12P-12V-20, 12VDC, 12" stroke, maximum load ~112 lb) operated by a controller housed in an enclosure mounted on the solar panel support pole adjacent to the Smart Drain structure. The controller and actuator are battery powered, and the battery is recharged by a solar panel mounted above the enclosure. The controller is programmable and can be adjusted to flush for shorter or longer periods of time as well as on only specified days of the week. See the Smart Drain Programming Instructions below for further details.

Prior to flush events, during periods of high flow, or if the control system malfunctions, AFVFP2 will fill and overflow the stop logs within the Smart Drain structure, and continuous flow to SP2 will be observed. Note that Valterra valves are known to have minor leaks and small amounts of flow observed at the 12" discharge pipe between flush events is expected.

If AFVFP2 is found not to be flushing as intended, open the Smart Drainage System control box (gray box mounted on solar panel support pole) and check the three fuses in the upper right of the box, replace with 5V 250VAC slo-blo ¼" x 1 ¼" fuses (Littlefuse part #313005P or equivalent); Check the controller (see also Smart Drain Programming Instructions): Use arrow keys to highlight "Registers" and hit enter, ensure that "Manual Mode" is "Off"; Check that each day of the week is set to "On", select each day and verify that the setting each day is "1" for "On"; Verify that the duration is set to "90 min", adjust if needed or as desired; Check the "StartHour" and "StartMinutes" and adjust if needed or as desired; Check battery voltage which should be >12; Check the solar voltage which should be close to 20 on a sunny day; Check if the relay is functional by selecting manual mode to verify that the small green light is illuminated when the controller is set to the "valve open" position, replace the relay if found to be faulty. Contact BioMost if there are any unresolved issues; Alternatively, a qualified electrician should be able to troubleshoot the system if needed. The battery is a 12V absorbed glass mat (AGM) type and should last 5-10 years, replace as needed. The controller should last 10+ year, replace as needed.

Agri Drain Smart Drain – General Maintenance

The stop logs in all three Smart Drain structures should be lubricated every year to allow them to be easily removed or added as needed. Remove all the stoplogs and grease rubber seals with Lubriplate No. 105 Motor Assembly Grease or equivalent. Ensure there is no debris in the tracks or along the bottom of the structure. Replace the stoplogs after greasing, ensuring bottom stoplog is installed first. Set the top stop log at or just below the top of the limestone (there should not be any appreciable water on the surface of the limestone during normal operation). Both the lid to the Agri Drain box and the door to the box of the controller are secured with a numeric-combination Masterlock (Combination: 1-7-7-6).

Settling Ponds 1 & 2 (SP1 & SP2)

SP1 & SP2 pond capacities are calculated from the bottom contours to emergency spillway crest elevations shown on the as-built drawing. SP1 is approximately 98,000 cubic feet and holds at least 733,000 gallons of water. SP2 is approximately 71,500 cubic feet and holds approximately 535,000 gallons of water. Routine inspections should take place to check for erosion of embankments and slopes. Any erosion shall immediately be graded as needed and stabilized utilizing seed and mulch or, in cases of bad erosion due to flooding or vandalism, erosion control fabric may be needed.

While SP1 will only receive water from AFVFP1, SP2 will receive water from both AFVFP1 and AFVFP2.

The primary SP1 outlet is an 8” floating skimmer that is attached to the end of the 8” SCH40 PVC outlet pipe with a flexible coupler. The 8” SCH40 PVC pipe extends to SP2. The skimmer is intended to throttle flowrates and decant flush volumes from AFVFP1 so that SP1 can fully contain the flushes it receives while providing settling to retain metal solids. If desired for additional treatment potential, SP1 can be manipulated (by closing the 8” stainless steel Orbinox gate valve, thereby disabling the floating skimmer) to flow through the rock lined spillway to AFVFP2, which would route the water through both AFVFPs in series. However, normal operation is proposed to be routed from SP1 to SP2 through the floating skimmer and 8”primary outlet pipe. The skimmer should be checked regularly during site visits to ensure that it is functioning properly. Improper function would be indicated by SP1 discharging through its spillway to AFVFP2 when the 8” stainless steel Orbinox gate valve is open. In this case, the skimmer should be detached from the 8” pipe (separated by pulling the corrugated pipe from the flexible coupler with the attached rope). The skimmer device should then be adjusted accordingly and re-deployed when SP1 is drained to the primary outlet pipe elevation.

The primary SP2 outlet is the 6” orifice on the upstream side of the concrete structure near the outlet end of the pond. If the 6” opening is obstructed, water will rise and overflow the top of the concrete structure through the trash rack. If both the 6” opening and trash rack are clogged, or during large storm flow events, water will exit SP2 via the rock-lined emergency spillway. The concrete structure is drained by a 24” N-12 culvert pipe. The outlet of the 24” pipe should be kept clear of vegetation, and any accumulated debris that could restrict flow through the pipe should be removed. The 6” opening and trash rack should be inspected during every site visit and cleaned immediately if needed. A 4” slide gate valve (Valterra brand) is located on the inside of the concrete structure near the bottom elevation of SP2 and can be opened by pulling on the rope affixed to the handle and tied to the trash rack; However, over time solids will accumulate in SP2 and care should be taken to avoid draining sediment to Trout Run.

A windowed baffle curtain has been installed in each of the two settling ponds to promote distribution of flow and utilization of the entire pond settling volume. Baffle curtains should be visually inspected for debris that could damage the curtains and to ensure the curtains are securely attached to the anchor posts and that the anchor posts remain firmly in place.

During the life of the System, it is possible that the settling ponds will become filled to a level that no longer allows sufficient retention time during flush events for effective retention of the precipitates. When this occurs, the sludge will need to be removed from the ponds. Sludge should be dewatered and disposed of in accordance with applicable laws and regulations.

Baffle Curtains

Windowed baffle curtains are installed within each settling pond approximately half the distance of the pond from the inlet pipe. The baffle curtains extend to a depth of three feet and are anchored to 2” galvanized steel pipes using stainless steel cable at an elevation approximately equal to the crest elevation of the emergency spillway. The curtains in both SP1 and SP2 have 2’ long x 3” high horizontal windows cut within the fabric laterally every 4’ on center and alternate approximately 6” and 18” down from the bottom of the baffle curtain float. The curtain should be kept clear of heavy debris that could restrict flow through the windows of the baffle curtain or from debris that could damage the baffle curtain. Any damage should be immediately repaired, and the baffle curtain should be reset at its original location. Curtains are expected to have a 10+ year lifespan and should be replaced when deterioration is sufficient to inhibit proper function.

Diversion Ditches

Diversion ditches route surface runoff away from the System. Ditches should be inspected annually to ensure drainage is directed as shown on the as-built drawing and there is no excessive erosion. Ditches should also be monitored to ensure vegetation or sediment built-up does not back up the water and cause the flow to leave the drainage ditch. Repair ditch and stabilize with equivalent or better channel lining as needed, and remove vegetation and sediment as needed. A 24" culvert pipe carries drainage from DD2 and PTS DD between SP1 and AFVFP2 and should be regularly inspected and cleaned as needed.

OM&R Schedule

Monthly

- Measure and record flow at the flume
- Visual inspection of all components
- Inspect bar guards and trash racks at HP and SP2, respectively, and clean as needed
- Check pH and alkalinity at SP2 outlet
    - pH should always be >6.0 except when total in flow is in excess of about 600 gpm
    - Alkalinity should be >20 mg/L except when total in flow is in excess of about 600 gpm
- Check pH and alkalinity at SP1 outlet
    - pH should be ≥6.0
    - Alkalinity should be ≥20 mg/L
- Inspect access road and gate, repair as needed.
- Verify that the Smart Drain System is functioning as designed.
  (Adjust inspection frequency as needed based on long-term field observations)

Annually

- Exercise (fully shut and then fully open) 12" RAW pipeline valve and 8" SP2 pipeline valve
- Inspect diversion ditches
- Clean and grease stoplogs in all Agri Drain boxes
- Collect samples for laboratory analysis at Raw, SP1, and SP2 during high flow (Feb, Mar, Apr)
    - Parameters: pH, conductivity, "hot" acidity, alkalinity, iron, aluminum, manganese

As Needed

- Clean stone in AFVFP1 and AFVFP2
- Removal and disposal of sediment from SP1 and SP2
- Remove vegetation from spillways, channels, pipes, embankments, etc. as needed
- General site maintenance of roads/parking areas, diversion ditch, vegetation, etc.
- Replace 90% CCE limestone when above listed maintenance no longer achieves treatment goals
- Replace pipe, Smart Drain components, etc.

AFVFP2 Smart Drainage System Programming Instructions

Note: The #3 Agri Drain Smart Drainage System control box is stand-alone and has separate features compared to control boxes #1 & #2
(The following instructions were provided by Agri Drain, Adair, Iowa)

General

- You can scroll through the options using the UP and DOWN arrows on the front of the controller (a/k/a "radio").
- You can select an option by pressing the ENTER button.
- You can return to the previous screen by pressing the BACK button.
- Whenever you see a GREEN LED light appear on the right side of the controller, that means that the controller is processing information (updating values, checking if it should open/close the valve, etc.).
- The controller only checks for changes once every minute or so. This means that if you change settings in the registers, such as telling the valve to open, it may take up to a minute before you see the valve open.
- All time settings are based on the clock in the upper right-hand corner of the controller's screen. This clock is in Coordinated Universal Time (UTC) and is five hours ahead of eastern standard time (winter) and four hours ahead of eastern daylight time (summer). Please be sure to keep this in mind when dealing with time settings.
- The only useable values are 1 and 0 except for time durations. All other values are invalid and may offer contradicting information between the system and the user. **Check to verify all setting are either a 1 (ON) or 0 (OFF).**

Registers

- ManualMode (ON/OFF)
  - While ON, the user can open/close the valve by setting the ValveStatus to 1/0 respectively
  - While ON, the controller will ignore any scheduled open/close times
  - While ON, a RED LED light will appear on the right side of the controller
  - While OFF, the RED LED will not be visible
  - 1 = ON, 0 = OFF
- ValveStatus
  - Displays the current status of the valve
  - While ManualMode is enabled, changing the valve status between 1/0 will open/close the valve, respectively
  - While OPEN, an ORANGE LED light will appear on the right side of the controller
  - While CLOSED, the ORANGE LED will not be visible
  - 1 = OPEN, 0 = CLOSED
- Days of the Week (ON/OFF)
  - Set which days of the week the valve should open on
  - When set to ON, the valve will open at the specified StartHour and StartMinute and remain open for the specified Duration
  - When set to OFF, the valve will not open on that specific day of the week
  - 1 = ON, 0 = OFF
- Duration (minutes): The amount of time the valve will stay open for
- StartHour: The hour portion of the time you wish the valve to open
  - NOTE: This is based on the time displayed in the upper right-hand corner of the radio
- StartMinutes: The minute portion of the time you wish the valve to open
  - NOTE: This is based on the time displayed in the upper right-hand corner of the radio
- Battery: The current battery voltage
- Solar: The current voltage from the solar panel

Examples

I want to open the valve right now.

1. Set ManualMode = 1 (ON)
2. Set ValveStatus = 1

I want the valve to be open every Monday, Wednesday, and Friday at 5:30pm for 2 hours.

1. Make sure ManualMode = (0) OFF
2. Set Sunday = (0) OFF, Tuesday = (0) OFF, Thursday = (0) OFF, Saturday = (0) OFF
3. Set Monday = (1) ON, Wednesday = (1) ON, Friday = (1) ON
4. Set Duration = 120
5. Set StartHour = 17
6. Set StartMinutes = 30

Table 4. 1.5' H-Flume Lookup Table

(Staff gauge marked in tenths – yellow outline; flow typically reported in gpm)

Approximate average design flow shown in green (~0.63'=300 gpm). Approximate maximum design flow shown in red (~0.82'=600 gpm).

TRACOM INC.

770.664.6513 (V) 770.664.6565 (F)

Discharge Table For 1.5' H Flume

Document: H15-D-T Rev.: 0 Date: 3-26-00 By: Matt Kazmier

LEVEL		FLOW		
FEET	INCHES	CFS	GPM	MGD
0.01	0.12			
0.02	0.24	0.0011	0.4937	0.0007
0.03	0.36	0.0023	1.032	0.0015
0.04	0.48	0.0039	1.750	0.0025
0.05	0.60	0.0057	2.558	0.0037
0.06	0.72	0.0078	3.501	0.0050
0.07	0.84	0.0103	4.623	0.0067
0.08	0.96	0.0131	5.879	0.0085
0.09	1.08	0.0164	7.360	0.0106
0.10	1.20	0.0200	8.976	0.0129
0.11	1.32	0.0237	10.64	0.0153
0.12	1.44	0.0276	12.39	0.0178
0.13	1.56	0.0319	14.32	0.0206
0.14	1.68	0.0365	16.38	0.0236
0.15	1.80	0.0414	18.58	0.0268
0.16	1.92	0.0467	20.96	0.0302
0.17	2.04	0.0523	23.47	0.0338
0.18	2.16	0.0582	26.12	0.0376
0.19	2.28	0.0645	28.95	0.0417
0.20	2.40	0.0711	31.91	0.0460
0.21	2.52	0.0780	35.01	0.0504
0.22	2.64	0.0854	38.33	0.0552
0.23	2.76	0.0931	41.78	0.0602
0.24	2.88	0.1011	45.37	0.0653
0.25	3.00	0.1095	49.14	0.0708
0.26	3.12	0.1183	53.09	0.0765
0.27	3.24	0.1275	57.22	0.0824
0.28	3.36	0.1371	61.53	0.0886
0.29	3.48	0.1470	65.97	0.0950
0.30	3.60	0.1570	70.46	0.1015
0.31	3.72	0.1680	75.40	0.1086
0.32	3.84	0.1790	80.34	0.1157
0.33	3.96	0.1910	85.72	0.1234
0.34	4.08	0.2030	91.11	0.1312
0.35	4.20	0.2150	96.49	0.1390
0.36	4.32	0.2280	102.3	0.1474
0.37	4.44	0.2410	108.2	0.1558
0.38	4.56	0.2550	114.4	0.1648
0.39	4.68	0.2690	120.7	0.1739
0.40	4.80	0.2830	127.0	0.1829
0.41	4.92	0.2980	133.7	0.1926
0.42	5.04	0.3140	140.9	0.2029
0.43	5.16	0.3300	148.1	0.2133
0.44	5.28	0.3460	155.3	0.2236
0.45	5.40	0.3630	162.9	0.2346
0.46	5.52	0.3800	170.5	0.2456
0.47	5.64	0.3980	178.6	0.2572
0.48	5.76	0.4160	186.7	0.2689
0.49	5.88	0.4350	195.2	0.2811
0.50	6.00	0.4540	203.8	0.2934
0.51	6.12	0.4730	212.3	0.306
0.52	6.24	0.4930	221.3	0.319
0.53	6.36	0.5140	230.7	0.332
0.54	6.48	0.5350	240.1	0.346
0.55	6.60	0.5570	250.0	0.360
0.56	6.72	0.5790	259.9	0.374
0.57	6.84	0.6010	269.7	0.388
0.58	6.96	0.6240	280.1	0.403
0.59	7.08	0.6480	290.8	0.419
0.60	7.20	0.6720	301.6	0.434
0.61	7.32	0.6970	312.8	0.450
0.62	7.44	0.7220	324.0	0.467
0.63	7.56	0.7470	335.3	0.483
0.64	7.68	0.7730	346.9	0.500
0.65	7.80	0.8000	359.0	0.517
0.66	7.92	0.8270	371.2	0.534
0.67	8.04	0.8550	383.7	0.553
0.68	8.16	0.8830	396.3	0.571
0.69	8.28	0.9120	409.3	0.589
0.70	8.40	0.9420	422.8	0.609
0.71	8.52	0.9720	436.2	0.628
0.72	8.64	1.002	449.7	0.648
0.73	8.76	1.033	463.6	0.668
0.74	8.88	1.065	478.0	0.688
0.75	9.00	1.097	492.3	0.709
0.76	9.12	1.130	507.1	0.730
0.77	9.24	1.163	522.0	0.752
0.78	9.36	1.197	537.2	0.774
0.79	9.48	1.231	552.5	0.796
0.80	9.60	1.270	570.0	0.821
0.81	9.72	1.300	583.4	0.840
0.82	9.84	1.340	601.4	0.866
0.83	9.96	1.380	619.3	0.892
0.84	10.08	1.410	632.8	0.911
0.85	10.20	1.450	650.8	0.937
0.86	10.32	1.490	668.7	0.963
0.87	10.44	1.530	686.7	0.989
0.88	10.56	1.570	704.6	1.015
0.89	10.68	1.610	722.6	1.041
0.90	10.80	1.650	740.5	1.066
0.91	10.92	1.690	758.5	1.092
0.92	11.04	1.730	776.4	1.118
0.93	11.16	1.780	798.9	1.150
0.94	11.28	1.820	816.8	1.176
0.95	11.40	1.860	834.8	1.202
0.96	11.52	1.910	857.2	1.234
0.97	11.64	1.950	875.2	1.260
0.98	11.76	2.000	897.6	1.293
0.99	11.88	2.050	920.0	1.325
1.00	12.00	2.090	938.0	1.351

Source: Field Manual for Research in Agricultural Hydrology, Handbook No. 224, United States Department of Agriculture, February, 1979, pp. 92.

Table 4. 1.5' H-Flume Lookup Table (continued)

LEVEL		FLOW		
FEET	INCHES	CFS	GPM	MGD
1.01	12.12	2.140	960.4	1.383
1.02	12.24	2.190	982.9	1.415
1.03	12.36	2.240	1005	1.448
1.04	12.48	2.300	1032	1.486
1.05	12.60	2.350	1055	1.519
1.06	12.72	2.400	1077	1.551
1.07	12.84	2.450	1100	1.583
1.08	12.96	2.500	1122	1.616
1.09	13.08	2.560	1149	1.655
1.10	13.20	2.610	1171	1.687
1.11	13.32	2.670	1198	1.726
1.12	13.44	2.730	1225	1.764
1.13	13.56	2.780	1248	1.797
1.14	13.68	2.840	1275	1.835
1.15	13.80	2.900	1302	1.874
1.16	13.92	2.960	1328	1.913
1.17	14.04	3.020	1355	1.952
1.18	14.16	3.080	1382	1.991
1.19	14.28	3.140	1409	2.029
1.20	14.40	3.200	1436	2.068
1.21	14.52	3.270	1468	2.113
1.22	14.64	3.330	1495	2.152
1.23	14.76	3.390	1521	2.191
1.24	14.88	3.460	1553	2.236
1.25	15.00	3.520	1580	2.275
1.26	15.12	3.590	1611	2.320
1.27	15.24	3.660	1643	2.365
1.28	15.36	3.730	1674	2.411
1.29	15.48	3.800	1705	2.456
1.30	15.60	3.870	1737	2.501
1.31	15.72	3.940	1768	2.546
1.32	15.84	4.010	1800	2.592
1.33	15.96	4.080	1831	2.637
1.34	16.08	4.150	1863	2.682
1.35	16.20	4.220	1894	2.727
1.36	16.32	4.300	1930	2.779
1.37	16.44	4.370	1961	2.824
1.38	16.56	4.450	1997	2.876
1.39	16.68	4.520	2029	2.921
1.40	16.80	4.600	2064	2.973
1.41	16.92	4.680	2100	3.025
1.42	17.04	4.760	2136	3.076
1.43	17.16	4.840	2172	3.128
1.44	17.28	4.920	2208	3.180
1.45	17.40	5.000	2244	3.232
1.46	17.52	5.080	2280	3.283
1.47	17.64	5.160	2316	3.335
1.48	17.76	5.240	2352	3.387
1.49	17.88	5.330	2392	3.445