TREATMENT SYSTEM EVALUATION

SL 142-1 – PIGEON CREEK

Carroll Township
Washington County
Pennsylvania

Stream Restoration Incorporated
Passive Treatment Operation & Maintenance Technical Assistance Program
Funded by Pennsylvania Department of Environmental Protection Growing Greener Grant
August 2025

Introduction

The SL 142 – Pigeon Creek Passive Treatment System (System) is significant in that it is over 50 years old and likely one of the oldest known passive treatment systems in Pennsylvania, if not the world. Based on contract documents available on Datashed (datashed.org), the system was designed in 1969 and completed by 1971 with minor repairs completed circa 1974.

System Description

Water is collected by a wet seal installed at a mine entry located on the north side of SR-2023. A 24-inch clay pipe extends from the wet seal to a concrete catch basin (manhole) that has two outlets. The primary outlet directs mine drainage to the system via a 24-inch corrugated metal culvert pipe under SR-2023. Excess flow that may occur during precipitation events overflows an internal weir (concrete stop log) and outlets to a bypass ditch. The bypass ditch flows east along the north side of SR-2023 and drains into a second culvert under SR-2023 that discharges to a ditch that extends to Pigeon Creek along the east sides of the System.

The original design included a perforated stainless steel distribution box that split flow to two stainless steel troughs (drip pans) used to aerate the mine drainage as it entered the system. A nine-foot deep concrete-lined sludge pit was installed at the inlet of the system and the drainage flows from the sludge pit through an open-seamed wooden timber baffle into a five foot-deep settling pond. The floor of the settling pond was paved with eight inches of #4 (AASHTO #1) limestone aggregate. A 100-foot wide, five-foot-high concrete dam with concrete an outlet lip was installed along the left descending bank of Pigeon Creek. The water surface area of the treatment system is about 17,000 square feet (1,600 square meters). The system can be described as a third-acre aerobic wetland-type passive treatment system.

Water Quality, System Performance, and Environmental Impact

The original system configuration clearly demonstrates the designer's understanding of the importance of aeration of alkaline-iron mine drainage. Oftentimes it is thought that aeration is needed to introduce oxygen that is required to react with dissolved iron to form iron solids that can be settled out of the water. Though oxygenation is a critical component of the treatment process, the impact of dissolved carbon dioxide is, in the author's experience, the primary contributor to poor performance of aerobic wetland-type passive treatment systems. This poor performance has been particularly observed in discharges that are very strongly alkaline (negative acidity less 300 mg/L as calcium carbonate). Carbon dioxide can depress pH in alkaline mine drainage, more often in highly alkaline water. Iron oxidizes 100 times slower at six pH than seven pH. The raw mine drainage is highly alkaline with an average lab-measured alkalinity of 510 mg/L and acidity of -477 mg/L, both reported as equivalents of calcium carbonate. The average raw iron is 3.6 mg/L while the system outlet average is 2.3 mg/L. Though the average influent pH is over seven, the system does not affect the amount of iron removal that would be expected.

A common design method for sizing aerobic wetlands is to calculate the surface area needed based on the iron load. Typically accepted removal rates are 10 – 20 grams of iron removed per day per square meter (g/sm/d) of wetland as measured at the water surface area. The System is about 1,600 square meters. Using the more conservative removal rate of 10 g/sm/d, it would be expected that the system be able to remove about 16,000 grams (35 pounds) of iron per day. On March 17, 2022, the influent total iron concentration was 2.5 mg/L at a flow of 190 gallons per minute resulting in an iron load of 2,600 grams per day or 5.8 pounds per day. The effluent iron concentration was 2.4 mg/L, indicating the load removed was 0.4 pounds or 180 grams of iron per day. It is generally understood in passive treatment that the removal rate declines as iron concentrations decrease, but the measured removal rate was less than 0.1 g/sm/d. Channelization and short circuiting certainly contributed to the lack of treatment effectiveness on the day the system was sampled as about half of the system is filled in with sediment (see photos). Even adjusting for a 50% reduced surface area, the removal rate would be no more than 0.2 g/sm/d, two orders of magnitude less than expected. Perhaps if the system aeration devices were working the system would perform better, but that would require the system to be restored to its original configuration to evaluate. This begs the question: is the system needed?

Pigeon Creek has a protected use for aquatic life of Warm Water Fishes (WWF) that requires an in-stream total iron concentration of 1.5 mg/L or less (25 PA Code Chapter 93). Though the two available upstream and downstream samples indicate that the iron concentrations increase from an average of 0.2 to 0.5 mg/L, the downstream concentration is only 30% of the allowable maximum concentration. The raw discharge meets all other in-stream regulatory limits for WWF streams.

A summary of water monitoring data is attached.

<u>Preliminary Rehabilitation Evaluation</u>

Assuming that the system is filled with five feet of sediment it would require the removal of about 3,000 cubic yards of material that would likely need to be hauled to a landfill. Using a bulk density of 1.5 tons per cubic yard, about 4,500 tons of material would need to be removed off-site. Using an estimated disposal cost of $100/ton for hauling and landfill fees, the disposal cost to rehabilitate the treatment system would be over $500,000, plus other site work, design, permitting, and project management costs which would likely add an additional 50% to overall cost. Even if the system was restored to original condition, passive aeration will likely not be sufficient to achieve meaningful iron removal without powered aeration (e.g., Maelstrom oxidizer) or chemical addition (peroxide). Spending $750,000 to restore a third-acre wetland of questionable effectiveness that is not needed to protect the aquatic resource of Pigeon Creek seems unwarranted.

<u>Recommendations</u>

Due to the age of the system, celebrating the historical significance of this passive treatment system is recommended. Sites over 50 years old are eligible to be registered as historical. A historical marker and interpretive signage are recommended. Vegetation should be removed and the fence repaired as needed. A small walking path may also add to the site aesthetic. Though there is no parking on site, the American Legion is located immediately to the west of the site on the same side of SR-2023.

Photos

Top Left: The mine discharge is piped from a wet seal (left of photo) and into the steel grate-covered catch basin along the north side of SR-2023 (3/17/22).
Top Right: A 24-inch corrugated metal pipe extends form the catch basin, under SR-2023 and outlets into a perforated stainless steel box (3/17/22).
Bottom: Discharge of the system over the five-foot-high concrete dam into Pigeon Creek (right). Note that the people shown are standing on sediment that has been deposited in the settling pond, likely by Pigeon Creek during high flow events, and is above the crest elevation of the outlet dam (3/17/22).

SL 142-1 Pigeon Creek Water Monitoring Data

Sample Point	Date	Flow (gpm)	pH Field	pH Lab	ORP Field (mvolts)	DO Field (mg/L)	Temp (C)	Cond (umhos/cm)	Alk Field (mg/L)	Alk Lab (mg/L)	Acid Lab (mg/L)	T. Fe (mg/L)	D. Fe (mg/L)	T. Mn (mg/L)	D. Mn (mg/L)	T. Al (mg/L)	D. Al (mg/L)	SO4 (mg/L)	TSS (mg/L)
IN	08/26/10	202	6.8	7.5	2		12.7	2140		559	-511	5.8	5.5	0.2	0.2	0.0	0.0	342	8
IN	08/31/10	214	7.0	7.7	-56		12.5	2170		565	-530	6.0	5.4	0.2	0.2	0.0	0.0	333	14
IN	01/28/11	221	7.8	7.9	-51		9.3	2080		525	-477	6.0	1.8	~~227~~	~~211~~	0.0	0.0	342	24
IN	05/24/11	418	7.0	7.0	-30		12.9	1599		458	-443	3.2	2.8	0.2	0.2	0.0	0.0	256	0
IN	03/17/22	190	7.5	7.2	185	3.9	12.5	1506	462	441	-426	2.5	2.3	0.1	0.1	0.0	0.0	189	11
	Average:	**249**	**7.2**	**7.5**	**10**	**3.9**	**12.0**	**1899**	**462**	**510**	**-477**	**4.7**	**3.6**	**0.2**	**0.2**	**0.0**	**0.0**	**292**	**11**
OUT	08/31/10	214	7.2	8.0	-26		12.5	2220		556	-519	2.1	1.1	0.2	0.2	0.0	0.0	354	12
OUT	01/28/11	221	7.4	7.6	-44		10.8	2070		529	-511	5.4	5.1	0.2	0.2	0.2	0.0	517	20
OUT	05/24/11	418	7.4	7.3	-34		13.4	1386		422	-412	5.0	1.1	~~173~~	~~152~~	0.0	0.0	223	20
OUT	03/17/22	190	7.6	7.4	210	7.3	12.6	1494	373	441	-428	2.4	1.7	0.1	0.1	0.0	0.0	186	13
	Average:	**261**	**7.4**	**7.6**	**26.5**	**7.3**	**12.3**	**1793**	**373**	**487**	**-468**	**3.7**	**2.3**	**0.2**	**0.2**	**0.1**	**0.0**	**320**	**16**
UPSTREAM	08/31/10		7.4	8.2	24		18.6	3250		245	-222	0.0	0.0	0.1	0.1	0.0	0.0		6
UPSTREAM	05/24/11	35,740	8.7	8.4	114		17.7	955		198	-184	0.3	0.0	0.0	0.0	0.0	0.0	275	6
	Average:	**35,740**	**8.1**	**8.3**	**69**		**18.2**	**2103**		**222**	**-203**	**0.2**	**0.0**	**0.1**	**0.1**	**0.0**	**0.0**	**275**	**6**
DNSTREAM	08/31/10		7.3	8.6	-41		18.1	2620		760	-748	0.8	0.0	0.1	0.1	0.4	0.0	291	18
DNSTREAM	05/24/11		8.7	8.4	117		18.1	966		197	-184	0.3	0.0	0.0	0.0	0.0	0.0	272	5
	Average:		**8.0**	**8.5**	**38**		**18.1**	**1793**		**479**	**-466**	**0.5**	**0.0**	**0.1**	**0.0**	**0.2**	**0.0**	**282**	**12**

Spurious data noted in red and not included in statistical calculations.