Houston Ball Field

Erosion Study Final Report

Chartiers Creek

Houston, PA

Prepared by the West Virginia Water Research Institute

June 10, 2024

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Background

The Upper Chartiers Creek Watershed Association (UCCWA) has set the goal of pursuing funds for a streambank stabilization project adjacent to the public baseball field in Houston, PA located in Washington County (Figure 1). The reach of interest is approximately 1,035 feet of the left descending bank owned by Houston Borough. Houston Borough has expressed support for the project and was consulted on this study. To gather information to strengthen funding requests, UCCWA applied for assistance through the 3 Rivers QUEST GAPS program. Through this program, the West Virginia Water Research Institute (WVWRI) conducted a small-scale erosion study with the assistance of UCCWA volunteers. WVWRI installed erosion pins, conducted initial measurements, trained volunteers to collect monthly measurements, and compiled results.

Erosion pin methodology was selected due to its ability to monitor relatively small changes through a short-term study, as well as its low cost. Erosion pins are lengths of metal inserted into the streambank with a known length of pin left exposed. When soil is eroded, re-measurement reveals a greater exposed length. Through subsequent measurements, one can estimate the rate of bank retreat based on the difference between the new exposed pin length and the original exposed pin length (Staley et al., 2006). It should be noted that erosion pins do not determine the cause of erosion. The purpose of this study is to provide quantitative measurements of erosion. The methodology for pin spacing, installation, and measurement was adapted from methods described in Staley et al., 2006 and Rando et al., 2017.

Figure 1. Reach of Chartiers Creek targeted for streambank stabilization.

Pin Installation

Pins were installed within 3 subsections representing the bank conditions within the study area (Figure 2).

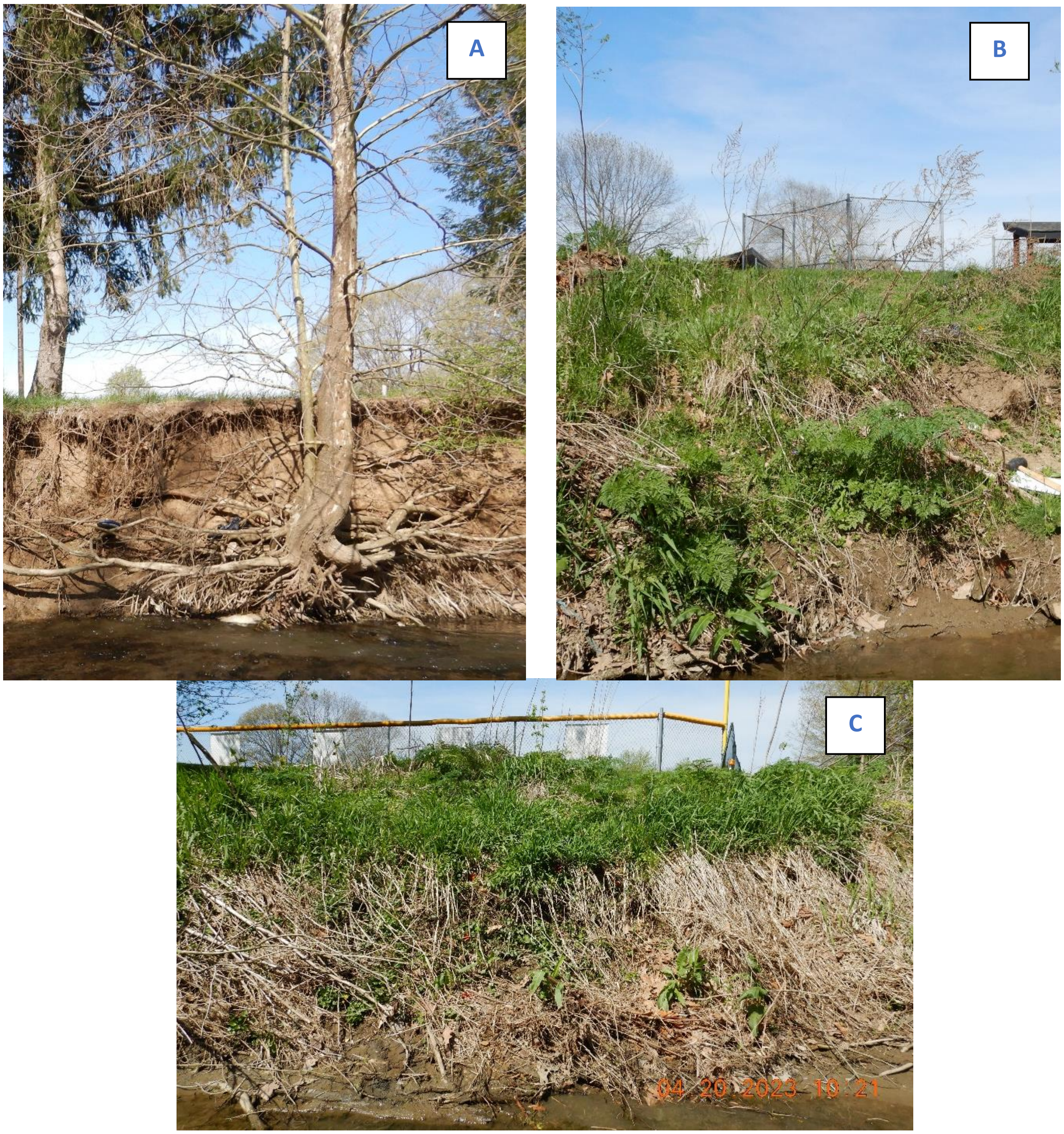

Figure 2. Photos representing the 3 subsections of study, moving downstream from A – C.

One-foot length stainless steel tubing (3/16” diameter) were utilized for the pins. Pins were installed perpendicular to the bank surface with an initial exposed distance of 3 – 6 cm (Figure 3). The exposed distance was greater where vegetation was dense, so that the pins could be found. The initial exposed length for each pin can be found in the field sheet in Appendix A. The exposed portion of all pins was spray painted orange to aid in locating the pins. The first pin in each subsection were located 1 – 3 ft above baseflow water surface elevation. This elevation allowed pin measurement during normal streamflow conditions. Subsequent pins were added every 1 to 3 feet vertically up to floodplain elevation. The distance varied due to variation in bank height. Within each subsection, pins were installed in 2 rows of 3 pins each with horizontal spacing of 2 – 4 feet. A total of 6 pins were installed per each of the 3 subsections, for a grand total of 18 pins. Figure 4 provides an overview of the pin layout and labeling.

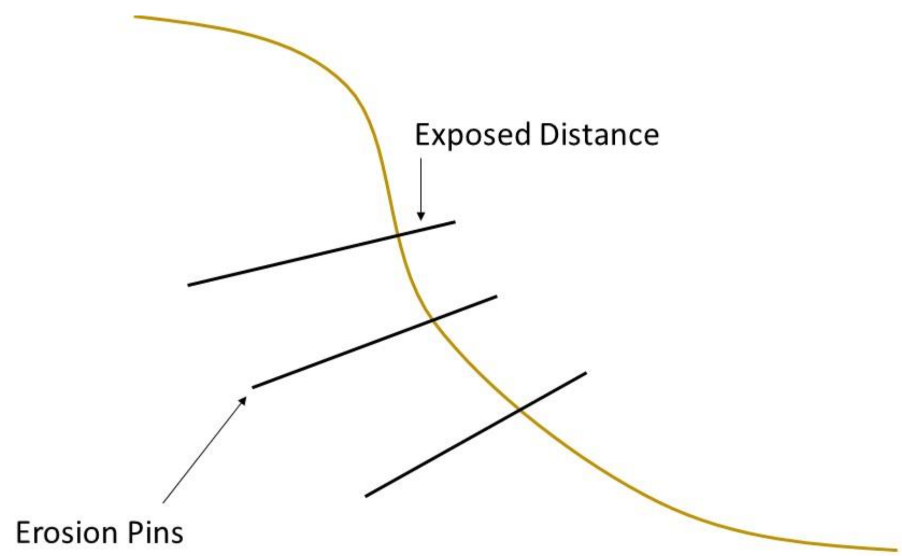

Figure 3. Cross section of streambank demonstrating pin insertion.

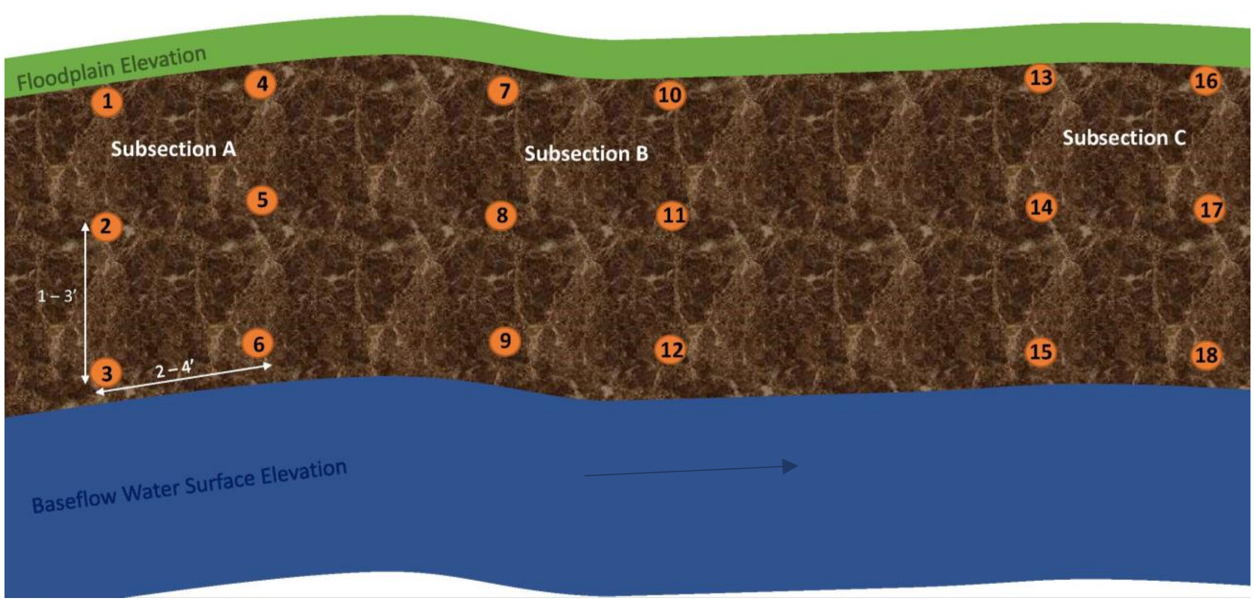

Figure 4. Pin layout overview and labeling from 1 - 18.

Pins are referenced via their assigned number from 1 – 18 following the layout in Figure 4. Pins were installed on April 20th, 2023, and the first measurement was collected approximately 4 weeks later during the volunteer training on May 15th, 2023. Measurements were collected during installation to record bank height and pin spacing. GPS location of the 3 subsections was also recorded and can be found in Table 1.

Table 1. GPS coordinate location for each subsection.

Subsection	Latitude	Longitude
A	40°15’00” N	80°12’21” W
B	40°15’01” N	80°12’21” W
C	40°15’03” N	80°12’21” W

Measurement Protocol

The exposed length of each pin was measured monthly by UCCWA volunteers beginning one month after installation. During each trip, the volunteers completed the field sheet in Appendix A, including general information, weather conditions, pin measurements, and notes regarding any mass failures or disturbances to pins. Past precipitation was found utilizing Weather Underground (https://www.wunderground.com/). Care was taken by volunteers to minimize soil disturbance and to record even very small differences (2 mm) to remain uninfluenced by perception (i.e., if measuring right after a storm).

Volunteers accessed the stream in the area shown in Figure 5, then walked to each pin transect, where they measured each pin’s exposed length. Measurements were taken utilizing a high-precision 15-cm digital caliper (Fisher Scientific), from the pin end to the bank surface at the vertical centerline along the downstream side of the pin (parallel with the stream) until contact was made with the soil surface and slight sediment movement was observed without compaction. If the total distance was greater than 15 cm, a temporary marking was made at 15 cm and a second measurement was collected from that mark to obtain the total distance. After measurements were recorded, pins were reset to their original length indicated in the field data sheet. However, pins with changes of less than 10 mm were not reset to minimize disturbance and error. Those pins were reset in subsequent months once the total change was greater than 10 mm, as compared to the original exposed length. Pins buried due to deposition were noted on the field sheet continuously until they became exposed again. In the event of a mass failure (a section of the bank sliding into the stream) or other cases of pin displacement, photos and notes were taken, and the pin was reset in a location as close to the original location as possible.

Figure 5. Accessible slope to the stream.

Results

UCCWA collected pin measurements monthly from May through October 2023, and repeated measurement again in April of 2024. The April 2024 sample offers results one year after the pin installation. This took place after a winter of high flows, followed by significant flooding in early spring. During this visit, it was observed that 5 pins had been washed out since the measurements taken in October of 2023. The lost pins were not used in calculating the overall study average since their final measurements were unknown. Results from the monthly measurements are summarized in Figure 6 below, where a positive change (brown) indicates erosion, and a negative change (green) indicates deposition. The most widespread erosion occurred in the spring (April – May 2023) and over the winter (October 2023 – April 2024). The average net erosion among the pins was 7.35 mm over the first 6 months and 33.96 mm over the full length of the study. However, one pin showed as much as 101.29 mm (4 inches) of erosion over the year. Taking the net change in the pin lengths over the year concludes that 10 pins experienced net erosion, 3 pins experienced net deposition, and 5 pins were washed out entirely (Figure 7). Data tables and additional figures can be found in Appendices B-C.

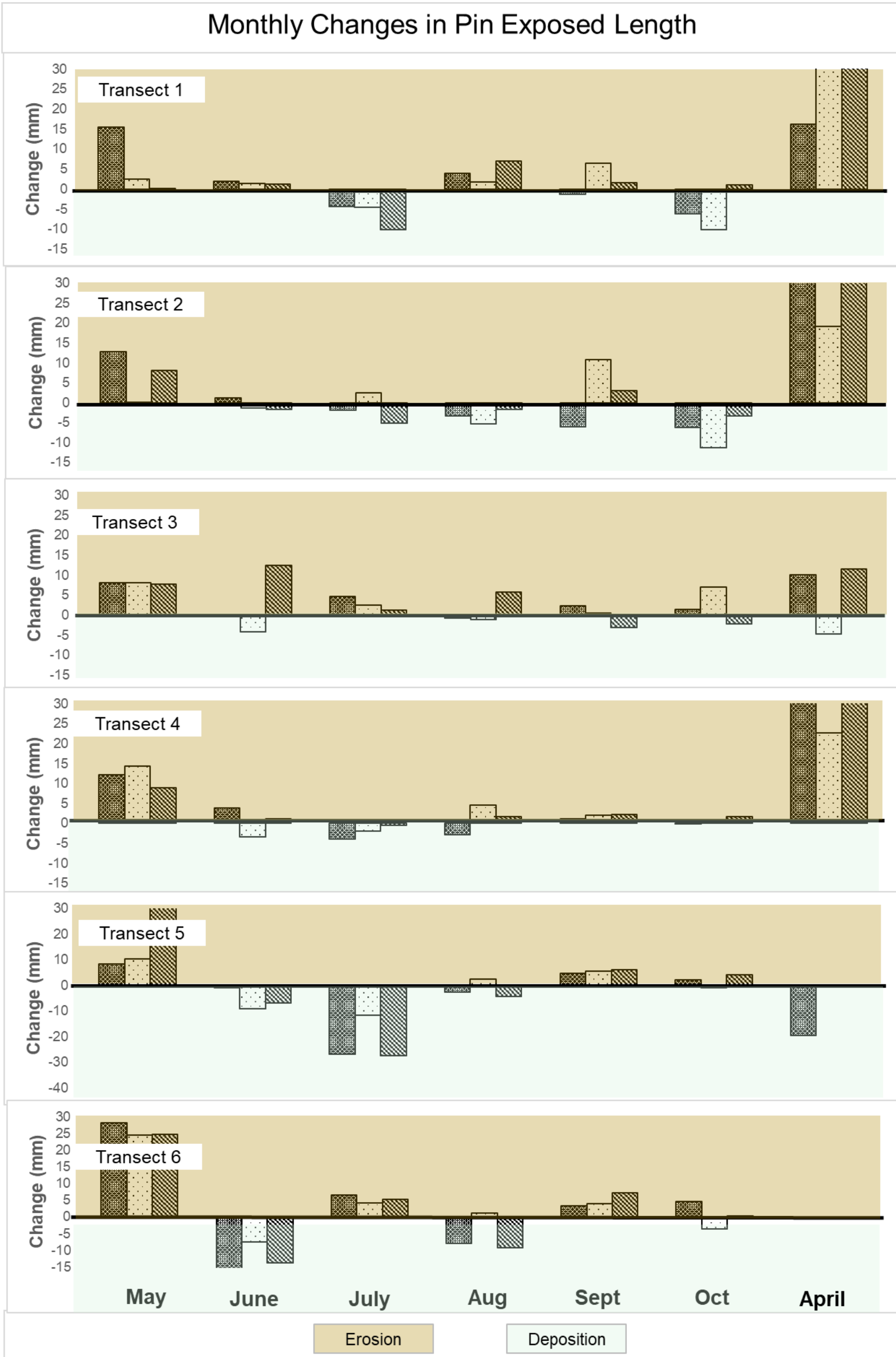

Figure 6. Change in pin exposed length from May 2023 through April 2024 at each of the six transects.

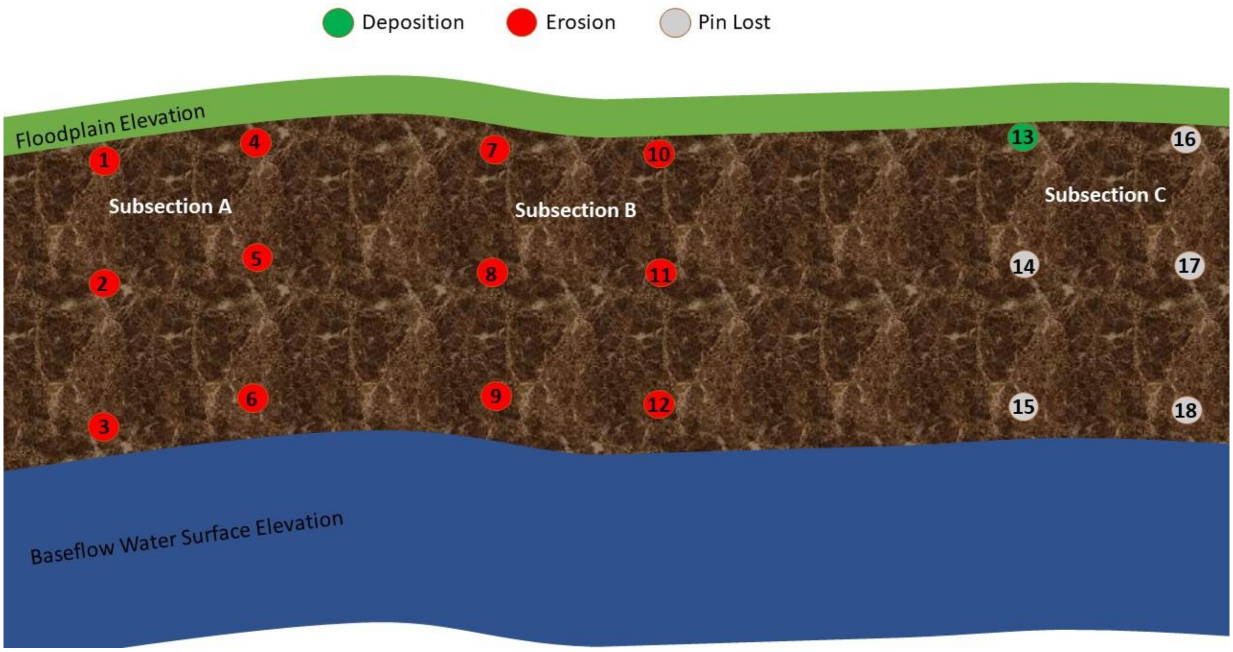

Figure 7. Pin changes one-year post-installation.

Conclusions

During the year of study, erosion was measured at all three subsections. This data backs up visual evidence of erosion, such as exposed roots and crumbling banks, seen throughout the length of the park. Importantly, five of the six pins located in subsection C were washed out during the winter or early spring, indicating that this area experiences the most erosion and should be prioritized for streambank stabilization. Visual evidence of the erosion is shown when comparing the photos from April 2023 (Figure 2) and May 2024 (Figure 8). Significant flooding occurred at the site in early April 2024 (Figure 9). Imaging from the Pennsylvania Flood Risk Map (Figure 10) shows that the Houston Ball Field is a regulatory floodway, which is defined by FEMA as the channel of a river or other watercourse and the adjacent land area that is reserved from encroachment in order to discharge the base flood without cumulatively increasing the water-surface elevation by more than a designated height. Accordingly, FEMA states that communities must regulate development in these floodways to ensure that there are no increases in upstream flood elevations. It is predicted that the severity and frequency of flooding events will be amplified due to climate change (Easterling et al., 2017). Therefore, it is crucial to take proactive steps now to stabilize the already eroding stream bank at the Houston Ball Field.

Figure 8. Erosion at subsection C, shown on May 3rd, 2024.

Figure 9. Flooding of Houston Ball Field in April 2024.

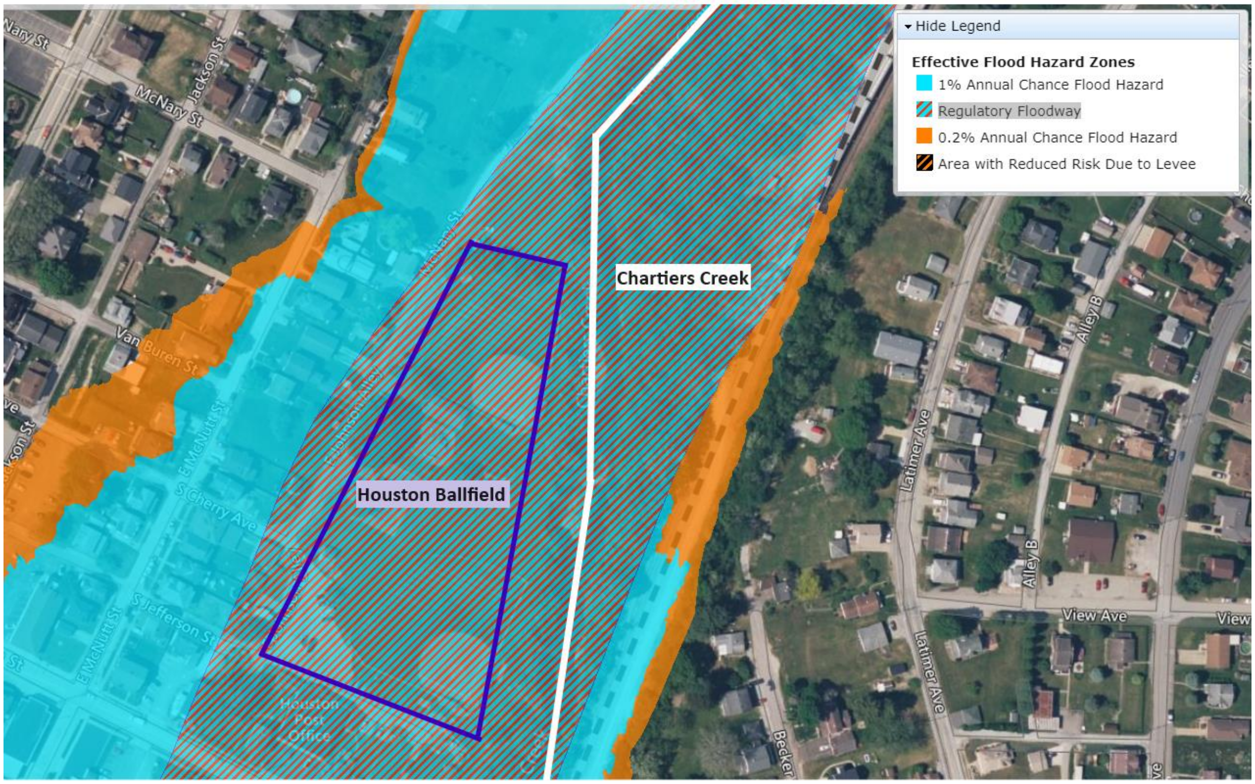

Figure 10. PA Flood Risk of the Houston Ball Field and surrounding communities.

References

Easterling, D.R., Arnold, J.R., Knutson, T., Kunkel, K.E., LeGrande, A.N., Leung, L.R, Vose, R.S., Waliser, D.E., Wehner, M.F. 2017. *Ch. 7: Precipitation Change in the United States. Climate Science Special Report: Fourth National Climate Assessment, Volume I*. U.S. Global Change Research Program, https://doi.org/10.7930/J0H993CC.

"PA Flood Risk." *Pennsylvania Emergency Management Agency*, https://pafloodrisk.psu.edu/home/index.html. Accessed 5 June 2024.

Rando, Carolina, Leslie Hopkinson, Melissa O'Neal, and Jason Fillhart. 2017. "A Method for Assessing Shoreline Stability of Alpine Lake, West Virginia." *Journal of Contemporary Water Research & Education* 160 (1): 85–99. https://doi.org/10.1111/j.1936-704X.2017.03242.x.

Staley, Nathan Andrew, Theresa Wynn, Brian Benham, and Gene Yagow. 2006. "Modeling Channel Erosion at the Watershed Scale: Model Review and Case Study."

Appendix A: Field Data Sheet

Houston Ball Field Erosion Pin Study
Field Data Sheet

Name: **Date:** **Time:**

Current weather:

Notes on previous weather/precipitation:

Trip Photo Numbers: **Representative subsection photos taken?** ☐ Yes

Any signs of damage or disturbance to pins?

Any perceptible changes in the site?

Pin Measurements

Using the caliper, measure from the top of the pin to the bank surface ***along the downstream side of the pin*** *(parallel to the stream) until light contact is made with the soil surface. Record to the highest level of precision. Reset pins to Original Exposed Length after photos and measurements are taken.*

Make a note of pins with changes of less than 10 mm; ***do not reset pins with changes of less than 10 mm.*** *Make a note of pins buried due to sediment deposition;* ***do not reset buried pins.*** *Mark the Reset Length as N/A in tables below for pins that are not reset.*

Pin Subsection A

Pin #	**Original exposed length (mm)**	**Measurement (mm)**	**Reset length (mm)**	**Notes** (pin buried, changed <10 cm, etc.)
1	40			
2	40			
3	30			
4	40			
5	40			
6	30			

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Houston Ball Field Erosion Pin Study
Field Data Sheet

Name: **Date:** **Time:**

Pin Subsection B

Pin #	Original exposed length (mm)	Measurement (mm)	Reset length (mm)	Notes (pin buried, changed <10 cm, etc.)
7	50			
8	50			
9	50			
10	50			
11	50			
12	50			

Pin Subsection C

Pin #	Original exposed length (mm)	Measurement (mm)	Reset length (mm)	Notes (pin buried, changed <10 cm, etc.)
13	50			
14	50			
15	50			
16	60			
17	50			
18	50			

Mass Failures

Take pictures of significant mass failures (landslides) within the area of interest and describe below.

Additional notes:

Appendix B: Exposed Pin Lengths Over Course of Study

Table A1. Exposed pin length measurements.

	Length (mm)							
Pin #	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Apr-24
1	40	55.47	41.9	37.56	41.44	40.15	34.04	50.2
2	40	42.42	43.8	39.33	41.11	47.65	37.53	84.54
3	30	30.03	31.3	21.16	28.18	29.77	30.85	75.5
4	40	52.85	41.17	39.36	36	29.92	34.19	69.92
5	40	40.15	38.81	41.3	36.01	46.8	35.43	54.56
6	30	38.15	36.42	31.26	29.59	32.61	29.19	88.37
7	50	58.03	57.65	62.26	49.25	51.63	53.04	63.24
8	50	58.19	53.95	56.48	55.38	55.86	62.89	45.23
9	50	57.68	70.16	51.25	56.97	53.93	51.66	63.27
10	50	62.11	53.93	50	47.24	48.43	48.37	139.19
11	50	64.32	46.67	44.81	49.35	51.38	51.45	74.1
12	50	58.89	60.09	49.58	51.21	53.49	55.12	87.76
13	50	58.37	57.6	30.94	47.46	52.26	54.57	34.99
14	50	60.39	41.01	29.53	52.39	58.05	57.23	
15	50	80.28	43.07	15.65	45.68	51.77	56.04	
16	60	88.24	44.53	66.64	58.8	62.16	66.77	
17	50	74.41	42.6	46.89	48.11	52.18	48.58	
18	50	74.74	36.25	55.29	46.06	53.27	53.63	

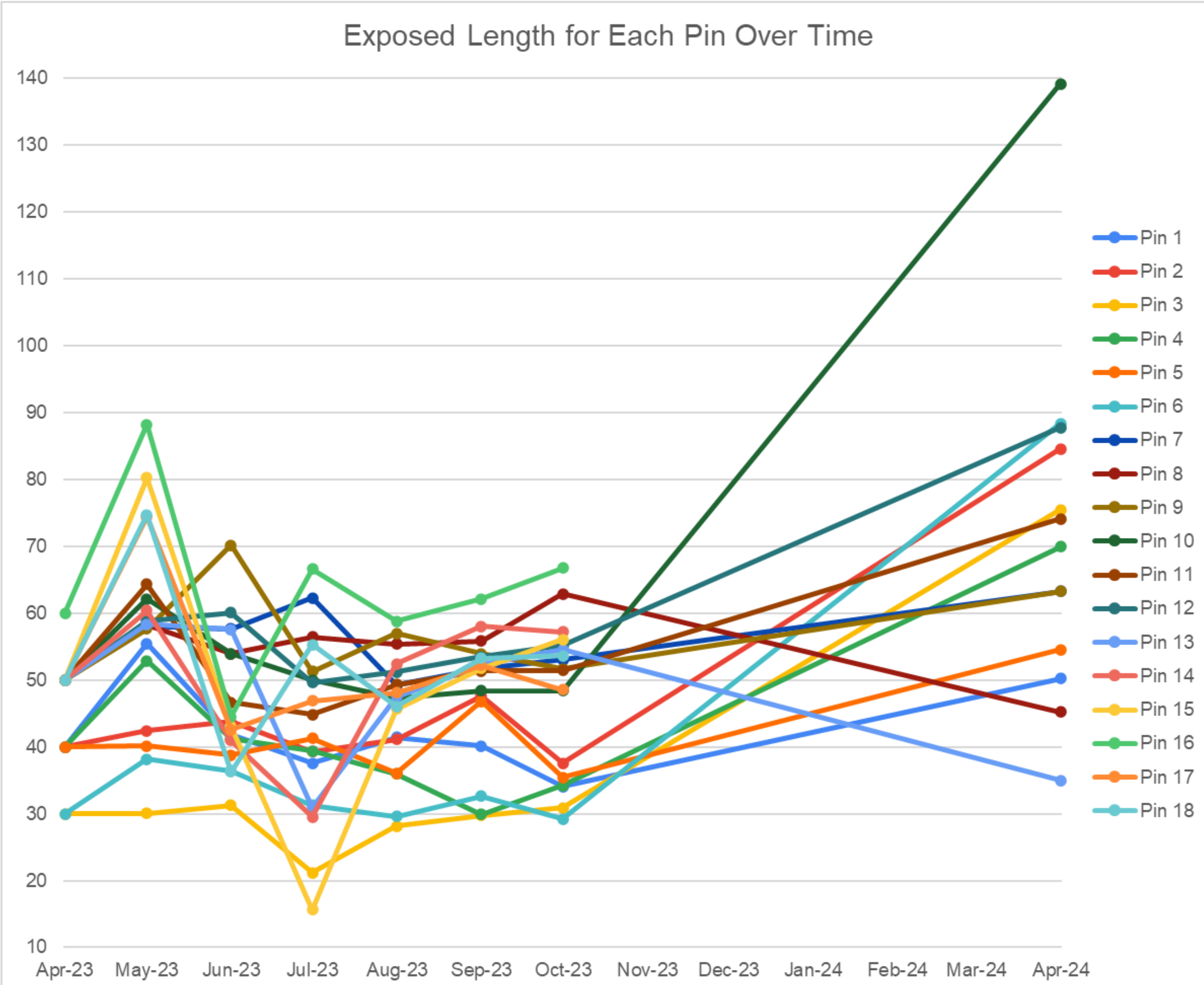

Figure A1. Graph of individual exposed pin lengths over time. An increase in exposed pin length indicates that erosion occurred.

Appendix C: Net Changes in Pin Length

Table A2. Changes in pin lengths over time, including individual net changes and average overall net change. Green values represent areas of net erosion while red values represent areas of net deposition. Note that pins 14-18 were not used to calculate the average net change.

Pin	Change #1 (mm) May	Change #2 (mm) June	Change #3 (mm) July	Change #4 (mm) August	Change #5 (mm) September	Change #6 (mm) October	Change #7 (mm) April	Net Change During Study Period (mm)
1	15.47	1.89	-4.34	3.88	-1.29	-6.11	16.16	25.66
2	2.42	1.38	-4.47	1.78	6.54	-10.12	47.01	44.54
3	0.03	1.27	-10.14	7.02	1.59	1.08	44.65	45.5
4	12.85	1.16	-1.81	-3.36	-6.08	-6.2	35.73	32.29
5	0.15	-1.34	2.49	-5.29	10.79	-11.37	19.13	14.56
6	8.15	-1.73	-5.16	-1.67	3.02	-3.42	59.18	58.37
7	8.03	-0.38	4.61	-0.76	2.38	1.41	10.2	25.49
8	8.19	-4.24	2.53	-1.1	0.48	7.03	-4.77	8.12
9	7.68	12.48	1.25	5.72	-3.04	-2.27	11.61	33.43
10	12.11	3.92	-3.93	-2.76	1.19	-0.06	90.82	101.29
11	14.32	-3.34	-1.86	4.54	2.03	0.07	22.65	38.41
12	8.89	1.2	-0.42	1.63	2.28	1.63	32.64	47.85
13	8.37	-0.77	-26.66	-2.55	4.8	2.31	-19.58	-34.08
14	10.39	-9	-11.48	2.38	5.66	-0.82	-	-2.87
15	30.28	-6.94	-27.42	-4.33	6.09	4.27	-	1.95
16	28.24	-15.47	6.64	-7.84	3.36	4.61	-	19.54
17	24.41	-7.41	4.29	1.22	4.07	-3.6	-	22.98
18	24.74	-13.75	5.29	-9.23	7.21	0.36	-	14.62
							Average Net Change	**33.96**