Collecting and Analyzing Water Quality Samples From NHTI's Retention Pond

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Background

Retention Pond Basics

Retention ponds are manmade ponds designed with the goal of replicating natural processes that filter water. These ponds are designed to catch storm water runoff from urban sources. The water is then forced to slow down and settle contaminants and sediments before being released[1] (Fig 1).

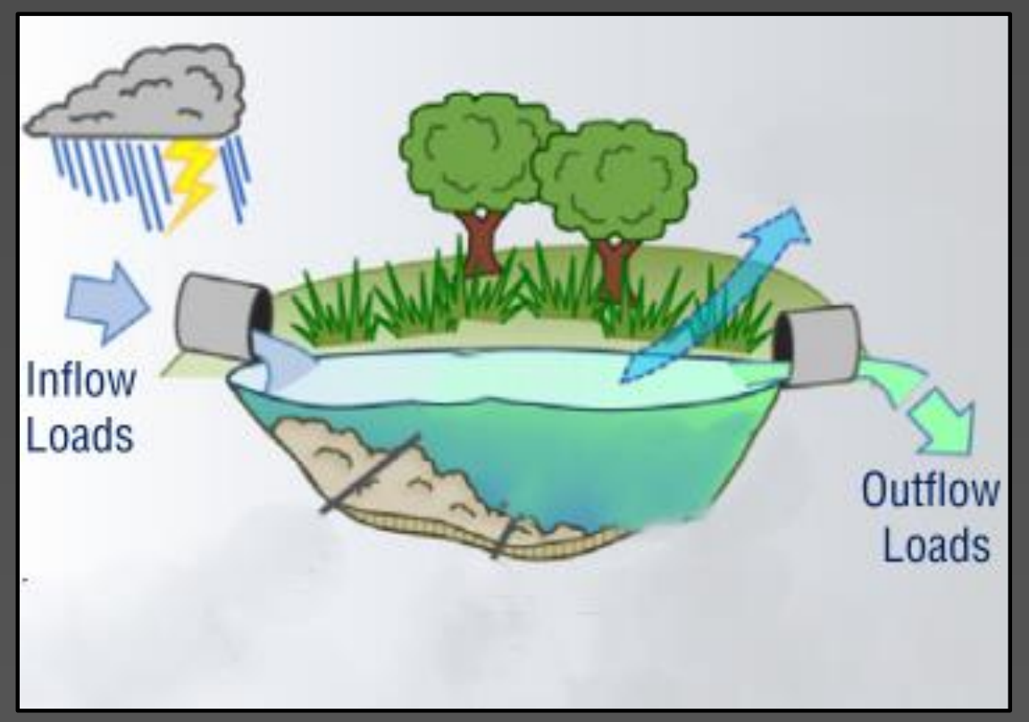


Figure 1. Depicts the general function of a retention pond.

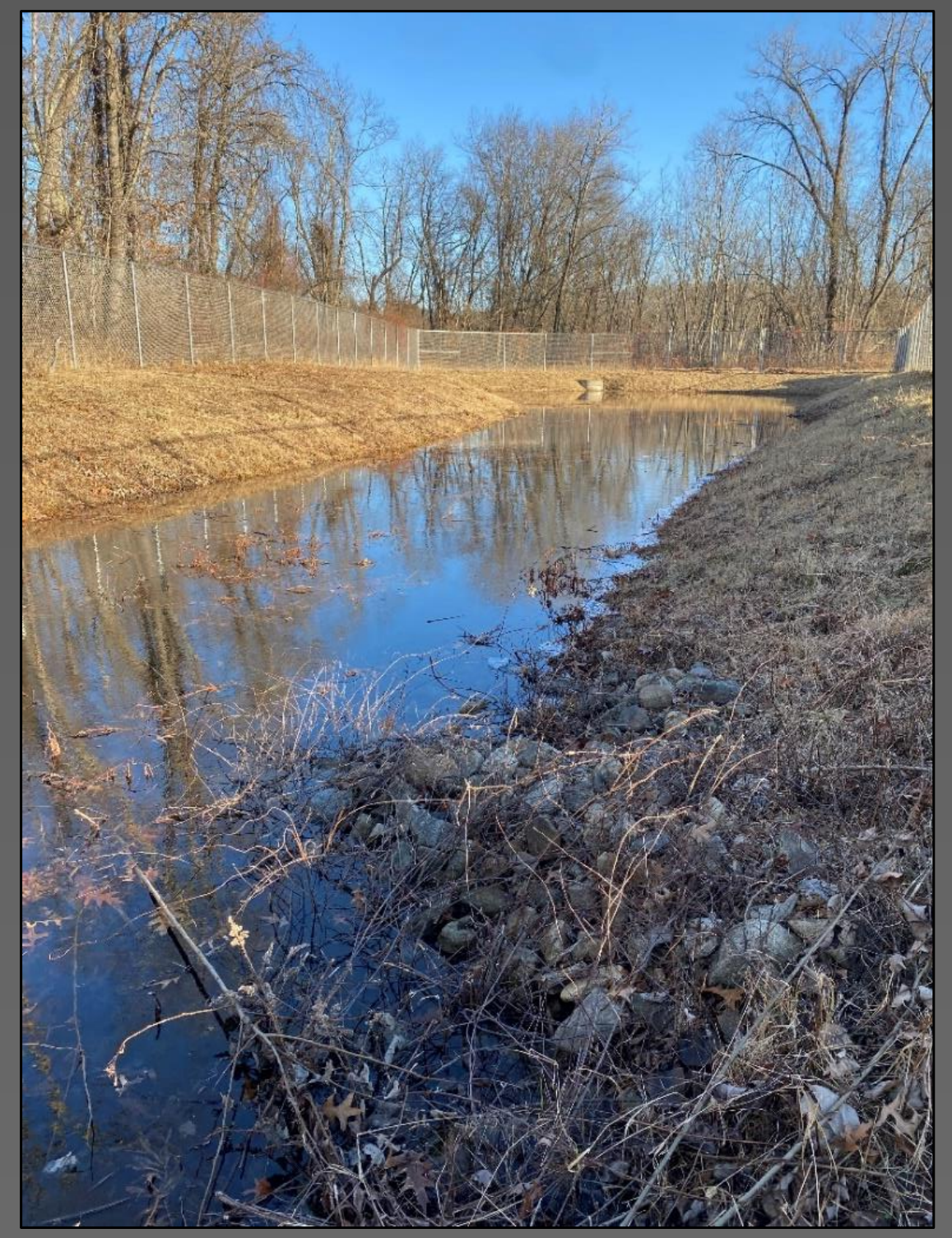


Figure 2. Photo of NHTI's retention pond taken from inlet facing the outlet.

NHTI's Retention Pond

The pond on the NHTI campus (Fig 2) receives stormwater directly from a roughly six-acre parking lot (Fig 4), as well as indirectly from the surrounding areas. This pond should retain the salt used to treat the parking lots in the winter as displayed in (Fig 3), as well as phosphorus that is released from the floodplain soils that the campus is built on[2] (Fig 4).

Figure 3. Heavy salt application on a campus sidewalk.

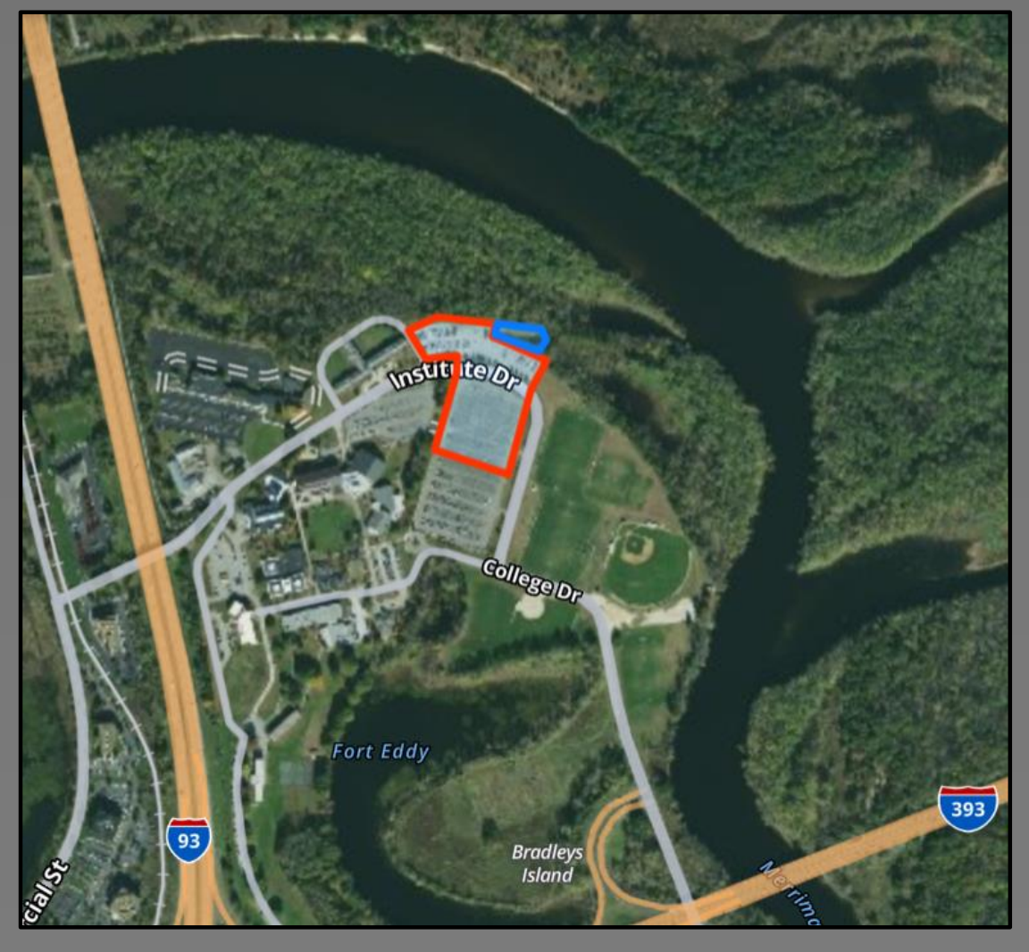


Figure 4. A map of NHTI campus, the orange outline represents the parking lot that drains into the retention pond outlined in blue.

Merrimack River

It is important that the retention pond on campus functions properly, as runoff can directly enter the Merrimack River and affect aquatic life. Historically the river had low chloride levels with a yearly average of 2.9 mg/L in 1900, but levels have increased to 40.2 mg/L today[3]. Total phosphorus concentrations have decreased from 0.13 mg/L in 1967 to 0.029 mg/L today[3]. To protect the river it is important that the pond can retain chloride from salting to prevent further increases. It is also important that the pond can retain phosphorus to continue to keep levels in the river low.

Methods

Sampling Practices

During a storm event and the days following, samples were taken at the inlet and outlet of the pond during the period from 12/20/23- 2/2/24. A handheld probe (Hanna HI9813-6) was used to measure pH and conductivity (Fig 5). Water samples were also taken to later measure chloride and phosphorus concentrations in the lab (Fig 6).

Figure 5. Conductivity being measured in mS/cm at the pond inflow with the handheld probe.

Figure 6. A water sample being collected at the outflow of the pond before it reaches the Merrimack River.

Chloride and Phosphorus Analysis

Total Phosphorus Procedure[4]

- Potassium Persulfate was added to samples
- Samples were then autoclaved to convert phosphorus to orthophosphate
- Samples were cooled and sulfuric acid, ascorbic acid, potassium tartrate and ammonium molybdate was added
- The absorbances of each sample were measured with a Vernier Spectro-Vis and used to assign concentrations to each sample

Chloride Procedure

- Samples were brought to the NHDES Limnology Lab to utilize their chloride probe, a Thermo Orion 4 Star
- A 100mg/L and 1000mg/L chloride standard were measured before the samples to ensure calibration
- The probe was triple rinsed with deionized water and a small amount of the next sample, to prevent contamination before the concentration of each sample was measured

Figure 7. Samples being measured before potassium persulfate is added.

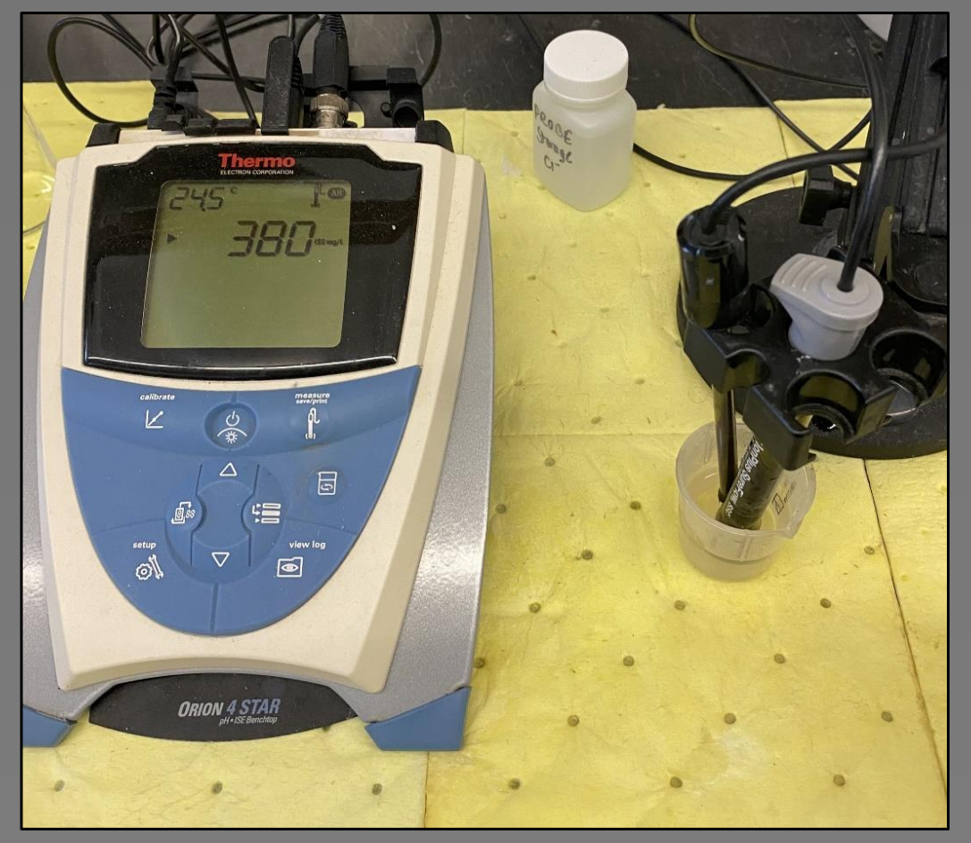


Figure 8. A chloride sample being measured with the desktop probe.

Results

Chloride Concentrations (mg/L) In vs Out

1/9/24 Storm	In	Out
1/10/2024	145	94
1/12/2024	145	156
1/25/24 Storm	**In**	**Out**
1/25/2024	4910	193
1/26/2024	424	199
1/29/24 Storm	**In**	**Out**
1/30/2024	9330	240
1/31/2024	369	261

Table 1. Organized above by storm are the inlet (left), and outlet concentrations (right). Each sampling event except January 12 (in red), supported the effective reduction of chloride concentrations after entering the pond.

Total Phosphorus In vs Out (mg/L)

1/9/24 Storm	In	Out
1/10/2024	0.033	0.031
1/12/2024	0.024	0.057
1/25/24 Storm	**In**	**Out**
1/25/2024	0.037	0.055
1/26/2024	0.052	0.044
1/29/24 Storm	**In**	**Out**
1/30/2024	0.047	0.063
1/31/2024	0.044	0.085

Table 2. Total phosphorus concentrations are organized tracking the same sampling dates as Table 1. Unlike chloride, total phosphorus concentrations increased after entering the pond in four of six measured outlet samples displayed in red.

Figure 9.

When conductivity was converted to µS/cm and plotted against chloride, an R^2 value of .9527 was produced. Any R^2 value >0.85 indicates a strong correlation suggesting chloride is the dominant dissolved ion in NHTI's retention pond[5].

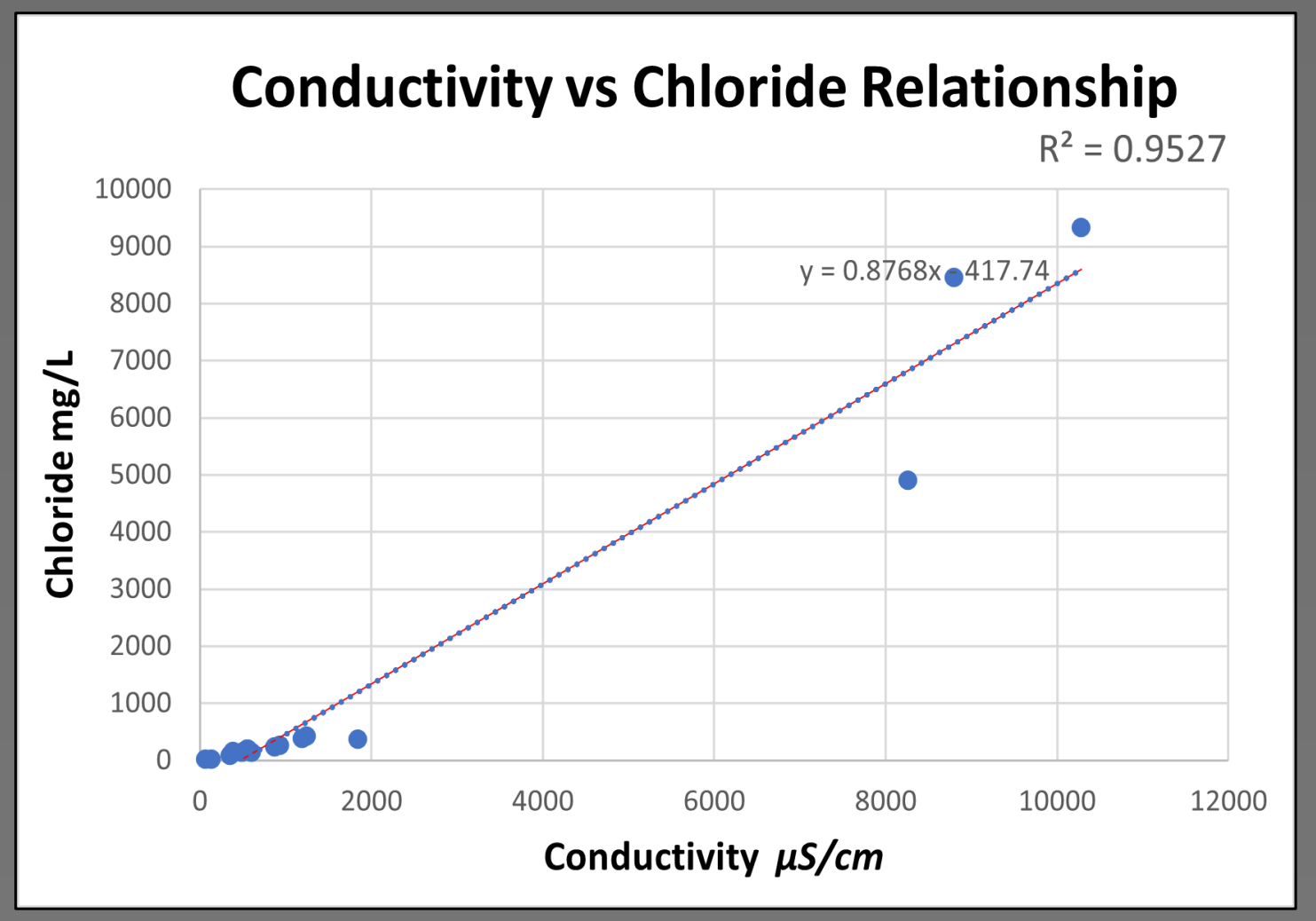
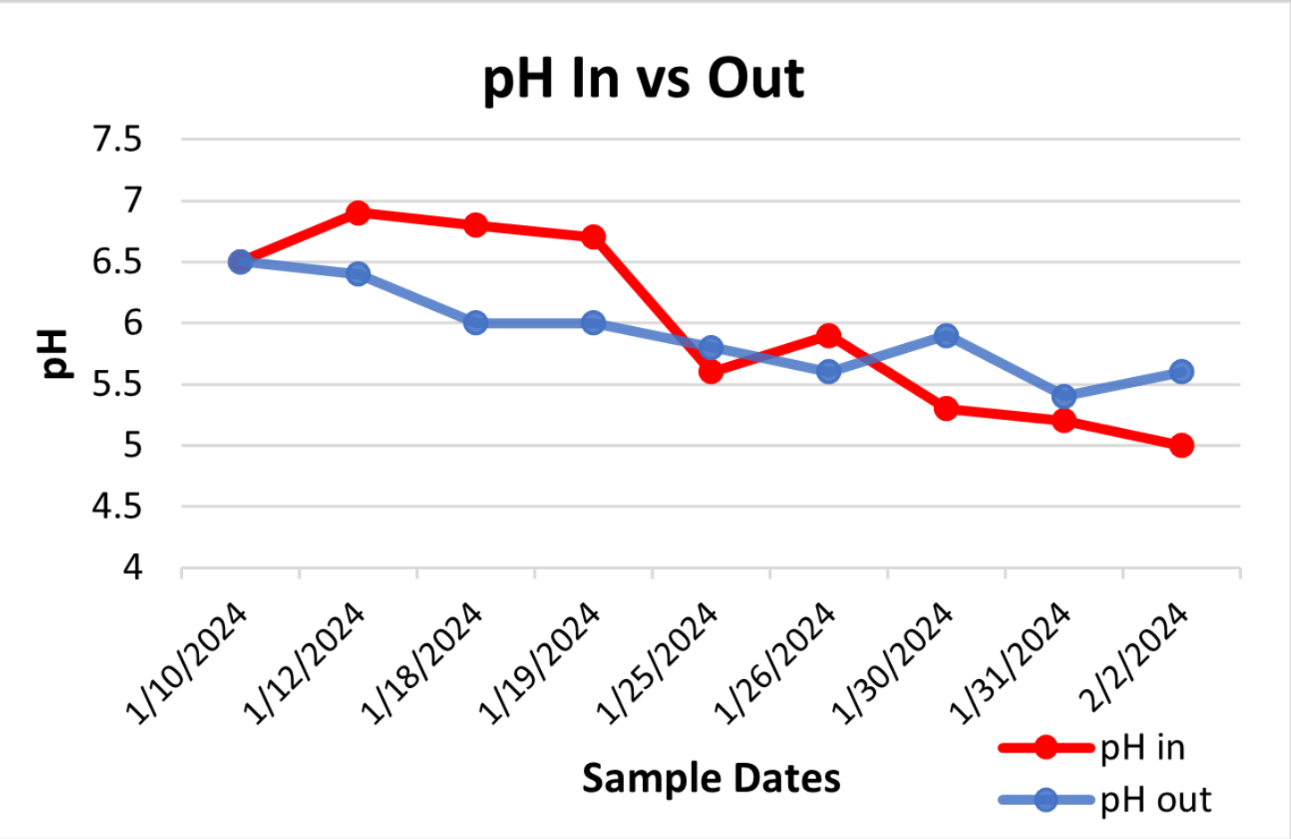


Figure 10.

When pH is plotted both inlet (red) and outlet (blue) concentrations had a downward slope. When the storm events in the above tables are averaged, pH also decreased with each successive event.



Conclusion

Discussion

The results of this study support that salting at the NHTI campus increases chloride concentrations in runoff, as seen by the elevated pond inputs. The results also suggest that NHTI's retention pond is able to effectively reduce chloride levels before they enter the Merrimack River. This was displayed by the decrease between inlet and outlet concentrations, with the exception of the sample on 1/12/24. Other studies on retention ponds indicate similar reductions from input to output concentrations supporting these results. The results also indicate that winter storm events are not a major source of phosphorus, as outputs exceeded inputs in most cases. In other studies retention ponds have been found to retain up to 80% of phosphorus inputs, which indicates NHTI's pond as an outlier[6]. In studies that did find increased outputs, phosphorus was being released from pond sediment when conditions supported decreasing pH, low dissolved oxygen (DO) and salinization[7]. The elevated outputs also could have been caused by back feeding through the pond outlet seen during flooding as flood plain soils have been found to be high in phosphorus[2]. If further studies are conducted the potential source of phosphorus should be investigated and conductivity used as a proxy to reduce measured variables.

Next Steps

To limit increased phosphorus outputs, planting aquatic plants has been shown to be effective[8] (Fig 11). During photosynthesis, aquatic plants release oxygen through their roots, increasing DO in the water. Installing an iron enhanced sand filter is another popular option which increases phosphorus retention in sediments (Fig 12). This is achieved as the filters are only underwater during storm events and as water levels drop, the filter contacts the air allowing the iron to rust and trap phosphorus[9].

Figure 11. A retention pond with various aquatic plants

Figure 12. An iron enhanced sand filter is shown between the water and grass

References

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