Department of Biosystems
and Agricultural Engineering
MICHIGAN STATE UNIVERSITY

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Biosystems Design Projects

Prevention of Harmful Algal Blooms in Soldan Dog Park

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INGHAM COUNTY PARKS

Background

Soldan Dog Park in Lansing, Michigan has closed frequently in recent years due to harmful algal bloom (HAB) events. Dog owners have expressed concern about the safety of their dogs due to this. HAB events are caused by excess phosphorus (Janke, 2023). The project aims to prevent HAB events from occurring at Soldan Dog Park by controlling nutrient levels. Figure 1 shows the important focus areas of water testing and the solution implementation area.

Figure 1. Areial view of Soldan Dog Park.

Water samples were taken from the pond across four days, with locations shown in Figure 1. Hach kits were used to test for total phosphorus. Results of testing are shown in Table 1.

Table 1. Total phosphorus levels from three sampling sites, given in mg/L.

Date	Outlet	SE Inlet	NE Inlet
Oct. 24	0.02	0.03	-
	0.04	-	-
Oct. 29	0.02	0.03	-
Nov. 8	0.02	0.01	0.03
	0.05	0.03	0.03
	0.16	0.21	0.29
	0.03	0.04	0.06
Nov. 15	0.11	0.02	0.03
	0.30	0.05	0.72
	-	0.22	0.30
	-	0.02	0.31

Objectives & Constraints

Objectives

- Fully operational by May 2026
- Reduce HAB events by 50% compared to previous two years
- Maintenance four times annually
- Annual maintenance cost of $1,000

Constraints

- Nitrogen concentration of less than 10 mg/L
- Phosphorus concentration of less than 0.1 µg/L
- Surface area less than 1.3 acres

Design Alternatives

Four design solutions were considered:

- Iron Systems
- Bioretention
- Biochar Filtration
- Pump Station Filtration

The chosen solution was Iron Systems:

- Mechanism: Iron adsorbs phosphorus and can be implemented in multiple design solutions
- Effectiveness: Works best with controlled NPS phosphorus.
- Challenges: Potential iron toxicity risks for dogs; careful design needed to mitigate safety concerns.

Water Control Structure

The final design chosen is a water control structure attached to the existing stormwater system. The stormwater will flow into the water control structure and through the phosphorus removal media, Alcan, held in barrels. The structure integrates an overflow outlet to prevent backups in the system.

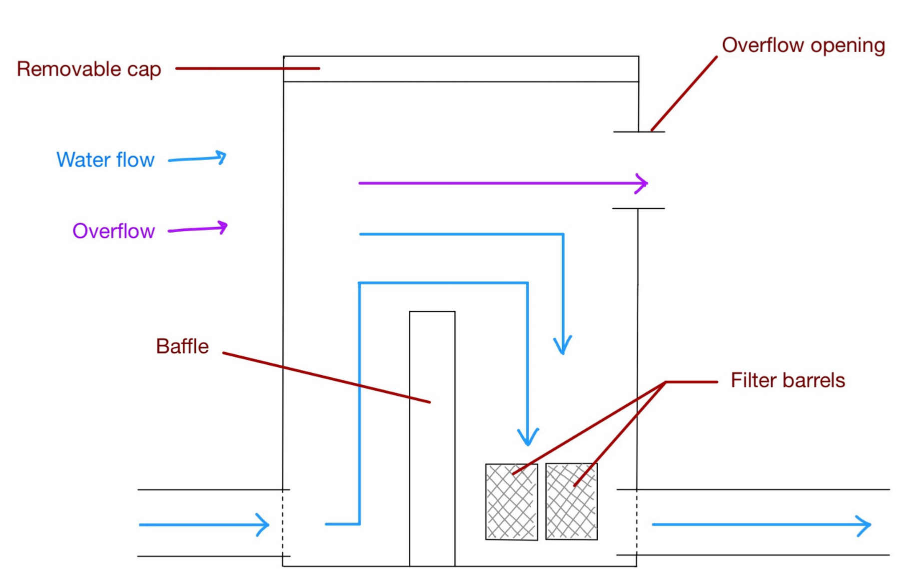

Figure 2. Proposed water control structure with removable filter barrels.

OpenHydroQual Modeling

OpenHydroQual was used to assess the effectiveness of the water control structure at decreasing phosphorus levels in the pond. The whole system included the watershed, filter materials (sand/Alcan), Soldan Dog Park Pond, and Sycamore Creek. Two equations were used to model sorption and desorption that occur.

Sorption Equation:

$$Rate\ Expression = k_f * [AqP]$$

Desorption equation:

$$Rate\ Expression = \frac{\frac{k_f}{K_D}}{[SorbP]}$$

OpenHydroQual Modeling continued

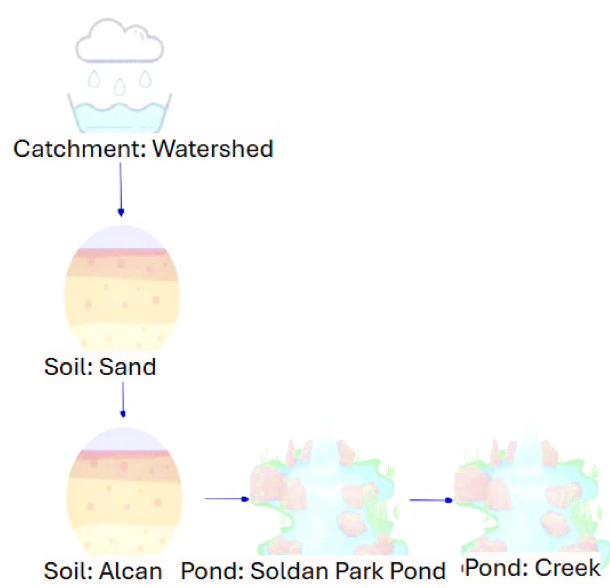

Figure 3. OpenHydroQual graphics showing the blocks used to model the overall stormwater system.

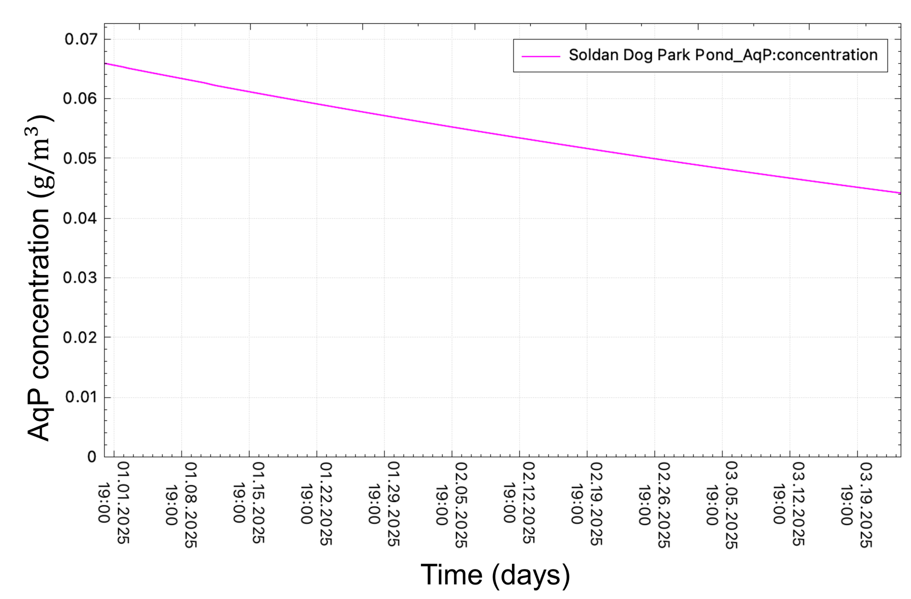

Figure 4. Aqueous phosphorus concentration $(\mathrm{g/m^3})$ in the pond over time.

An equation was derived from this graph of aqueous phosphorus concentration in the dog park pond:

$$AqP = -2.6201e^{-4t+0.066}$$

Using this equation, it would take 176 days to get below the 0.02 $\mathrm{g/m^3}$ threshold for which HAB events are caused by excess phosphorus (Liao et al., 2023).

OpenHydroQual was used to adjust the dimensions of the control structure, shown in Figure 5. This was to minimize the use of the overflow outlet. Increased residence time caused by the filter media barrels also increased the probability of water backing up in the control structure.

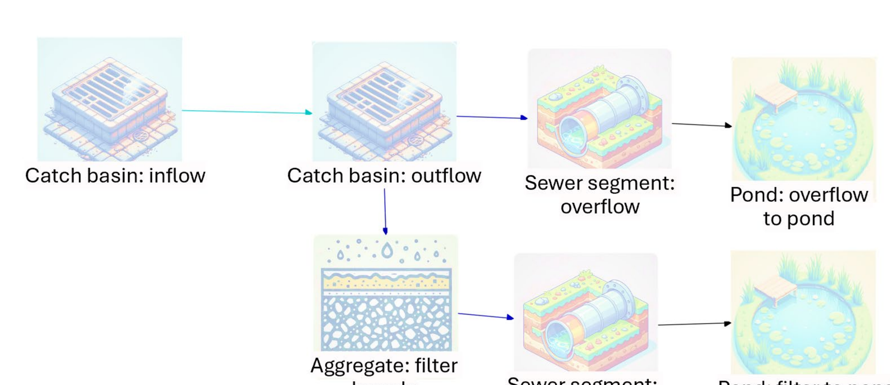

Figure 5. OpenHydroQual graphics showing the blocks used to model the water control structure.

Prototype

Mesh densities were tested at 250 µm, 110 µm, and 35 µm. Alcan dosage was set at 3 g/L (Kumari & Dong, 2024). After testing for water retention, media containment, and durability, the optimal liner was found to be 250 µm mesh. BayFilter cartridges will be customized with the media and mesh.

Figure 6. BayFilter™ 545 cartridges supplied by Advanced Drainage Systems Inc.

Overall Schematic

Final design drawings were done by Advanced Concrete Products Co. The 8'x8'x9' structure will be precast concrete. There is a grate on top that allows for removal of barrels for switching out media.

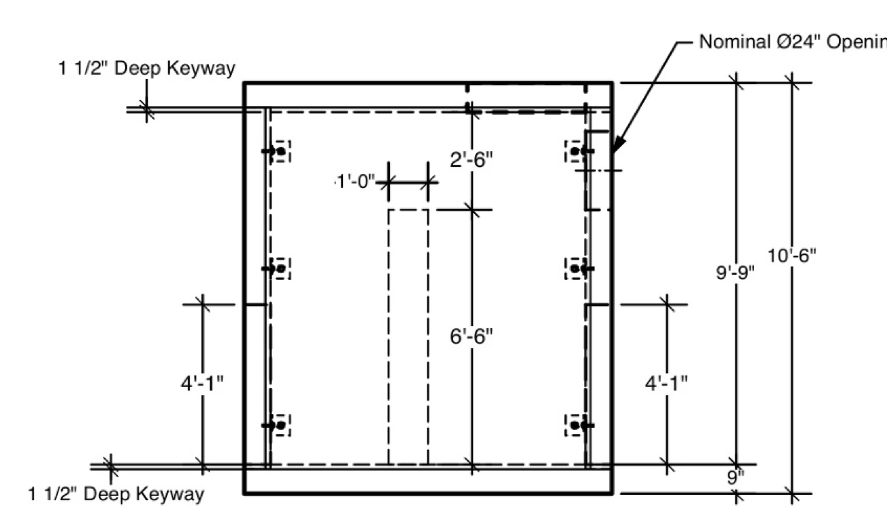

Figure 7. Design drawing showing side view of control structure.

Excavation is required to replace existing pipe with 36" concrete pipes. Riprap along the shore will allow for a waterfall effect as water exits control structure. This serves as an extra preventative measure against HAB's by creating aeration and turbulence that hinders bacterial growth.

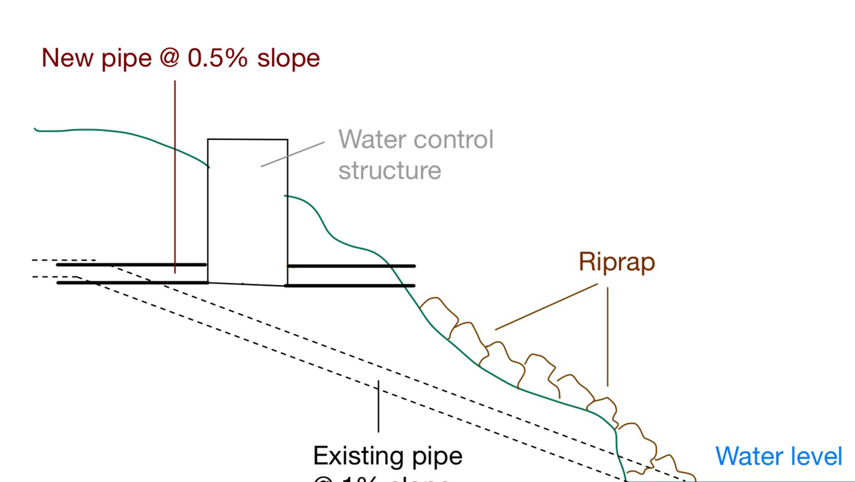

Figure 8. Overall design schematic sketch, showing required excavation and recommended additions.

Economics

One objective that was not achieved in this project is the maintenance cost of the project being less than $1,000 annually. As shown in Table 2, the filter media costs $1,500 to replace annually, which is slightly over budget. The park brings in $150,000 in revenue over the same period, which could be used to offset the cost of the project.

Table 2. The first 10-years cost of implementing the design.

Item	Cost	Frequency	Total cost
Concrete control structure	$22,100	Once (up front)	$22,100
New concrete pipe	$10,000	Once (up front)	$10,000
Filter cartridges	$1,000	Once (up front)	$1,000
Filter media	$1,500	Annual	$15,000
Excavation	$48,000	Once (up front)	$48,000
Park revenue	-$15,000	Annual	-$150,000
Sum of project expenses			**-$53,900**

Acknowledgements

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Select References

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