DEPARTMENT OF MECHANICAL ENGINEERING

ENME - B2 - Terrapin Trash Collectors
Waterway Trash Collection System

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Motivation, Goal, Impact

Motivation: Trash accumulation in the Paint Branch leads to degradation of aquatic habitats, threatens wildlife, and reduces usability of waterways for recreation. Additionally, waterway pollution contributes to **economic losses**, **public health risks** associated with contaminants such as **PFAS**, and downstream transport of plastics and microplastics into larger watershed systems.

Goal: To develop an effective solution for intercepting and removing physical trash from small to medium sized waterways like Paint Branch before it propagates downstream.

Impact: By reducing debris accumulation at the source, the proposed system aims to **improve water quality**, **protect wildlife habitats**, **support community engagement** with local waterways, and mitigate long-term environmental and economic impacts associated with aquatic pollution.

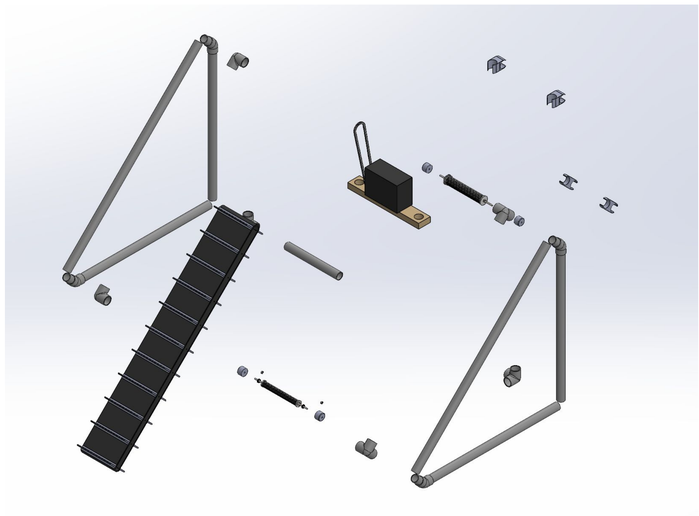
Requirements

1. Must be able to hold up to 18018 in^3 of trash
2. Must not have more than 8 moving components for simpler design
3. Withstand fluctuation in stream flow
4. Container must weigh less than 150 lbs
5. System battery must be able to sustain a 4 hour operation
6. No components should have material that is hazardous when put into water
7. System needs to collect debris more efficiently than an average worker
8. System fits within the dimensions of a standard pickup truck bed (length of 6.5 feet, 54 inches width)

Final Design

Final Design CAD

With an 80% plastic, 20% glass beer bottle composition
- Stores a theoretical total of 88.5 lbs
- Can hold 681 plastic bottles and 171 glass beer bottles



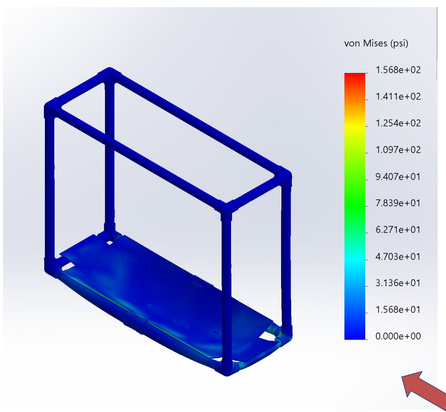
Design Exploded View

Trash collection procedure in water includes:
- Staking to 4 corners to ground of floodplain; 18 inch stakes
- Turning on switch in electronics to continuously keep belt running

Design Calculations & Decisions

Design Decisions:

- 608 series ball bearings
- Contianer width of 49.5 in
- Container Height of 39 in
- StepperOnline 24 V 90 W DC Gear Motor
- DeWalt 20 V battery packs
- PVC pipe
- 100 lb carry load



Container FEA Analysis

Container Optimization:

- 80% plastic, 20% 8 oz beer bottle assumption for trash composition

$$W_{total} = \frac{V_{total}}{(0.8*V_{plastic})+(0.2*V_{glass})} * ((0.8 * W_{plastic}) + (0.2 * W_{glass}))$$

$$Length = V_{total} / Container\ Height / Container\ Width$$

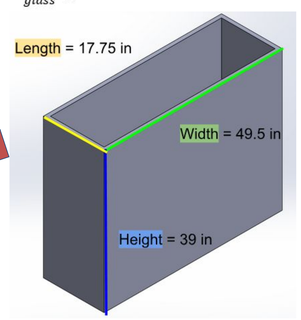
$$W_{plastic} = 0.01984\ lb$$

$$W_{glass} = 0.4375\ lb$$

$$V_{plastic} = 39.85\ in^3$$

$$V_{glass} = 40.78\ in^3$$

$$V_{total} = V_{items} * \#_{of\ items}$$



Optimized Container

Conveyor Belt Design:

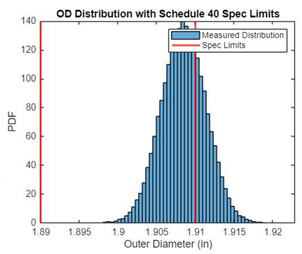
$$W_{belt} \geq W_{obj,max} + 2C$$

$$C = Lateral\ Clearance\ on\ one\ side = 0.5\ in$$

$$W_{obj,max} = Max\ Debris\ Width = 9.5\ in$$

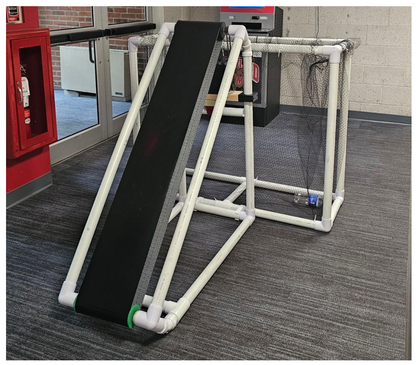
$$W_{belt} = Belt\ width = 10\ in$$

Validation Tests



Monte Carlo Fitting Uncertainty

Prototype & Test Results



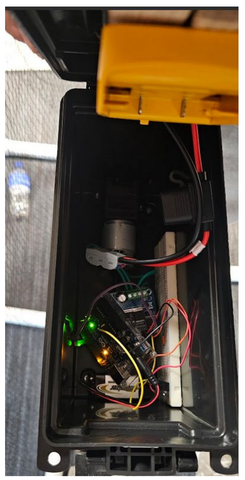
Full Prototype

Measured Size (Done in Real Life)

Tested:
- Belt does not slip on roller
- Roller does not slip on shaft
- All parts are secure
- Can fit in a specified dimension pickup truck
- Container exceeds the minimum required volume

Container has been found to be able to fit in the truckbed with the actual measured dimensions

Container has been found to be able to hold the desired volume of bottles worth in the net



Electronics Layout

Arduino programmed to move motor which drives belt