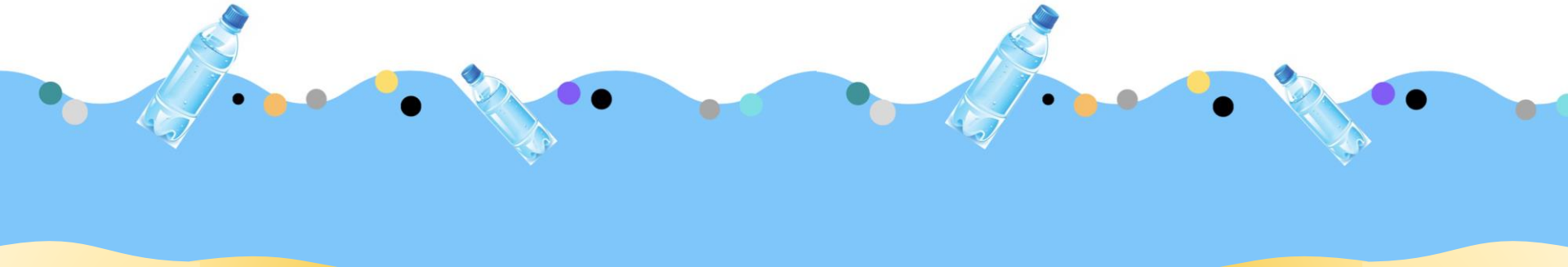
A Pump-Based Method to Sample Midwater Microplastic Pollution



Katie Donovan, Spencer Hoagland, Thomas Lipkin, Eric Stultz

One of the deliverables of our project, was a short animation. The video provides a great background of what our project was all about. Check it out here: https://youtu.be/TFhqwgB98Tw

Our sponsor, the Port Phillip EcoCentre, aims to collect data that will inform policies to reduce microplastic pollution

Our goal was to develop a method to collect microplastics below the surface of the waterways flowing into Port Phillip Bay

Our Objectives

1. To become familiar with microplastic pollution and work being done to address it
2. To identify methods to collect microplastics at depths greater than 20 cm
3. To design and build a suitable portable microplastic sampling method
4. To create instructional materials for the sampling method to be used in the future

Methodology & Results

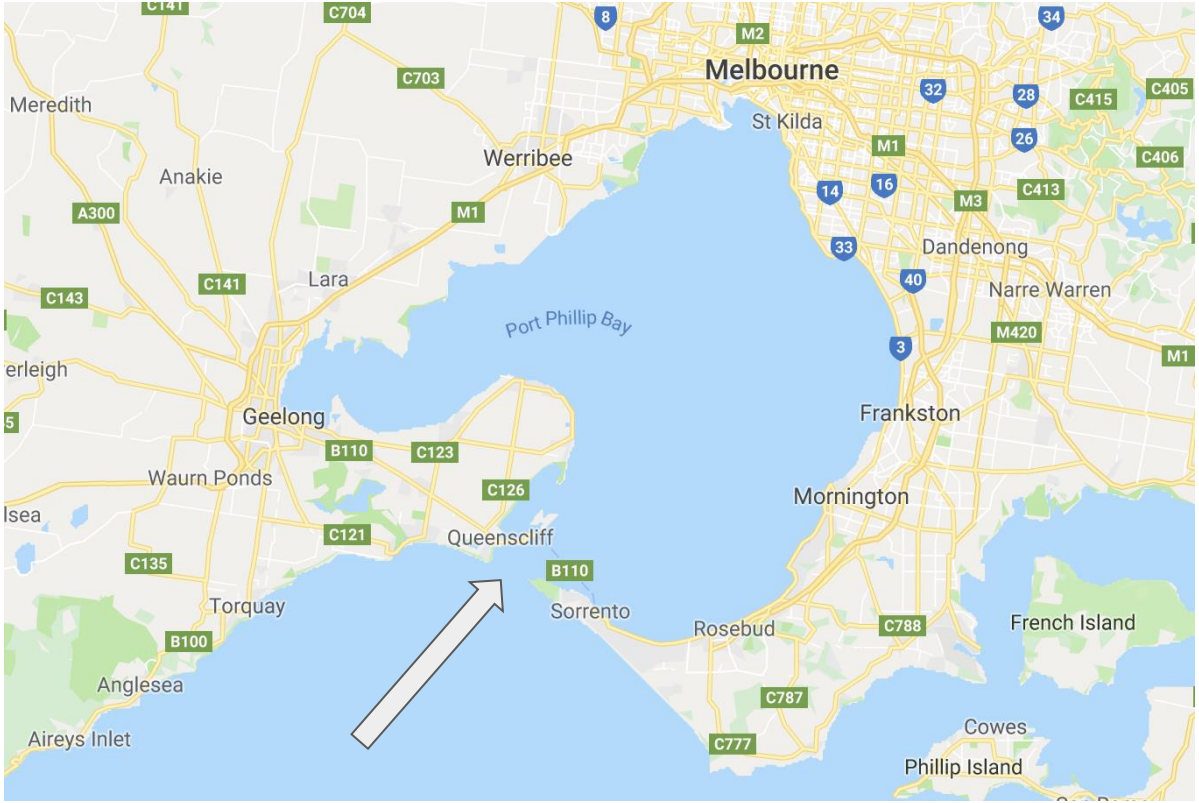
1 Become familiar with microplastic pollution and work being done to address it

1 Review of microplastic pollution research

9,790 km² of catchment waterways bring microplastic into Port Phillip Bay

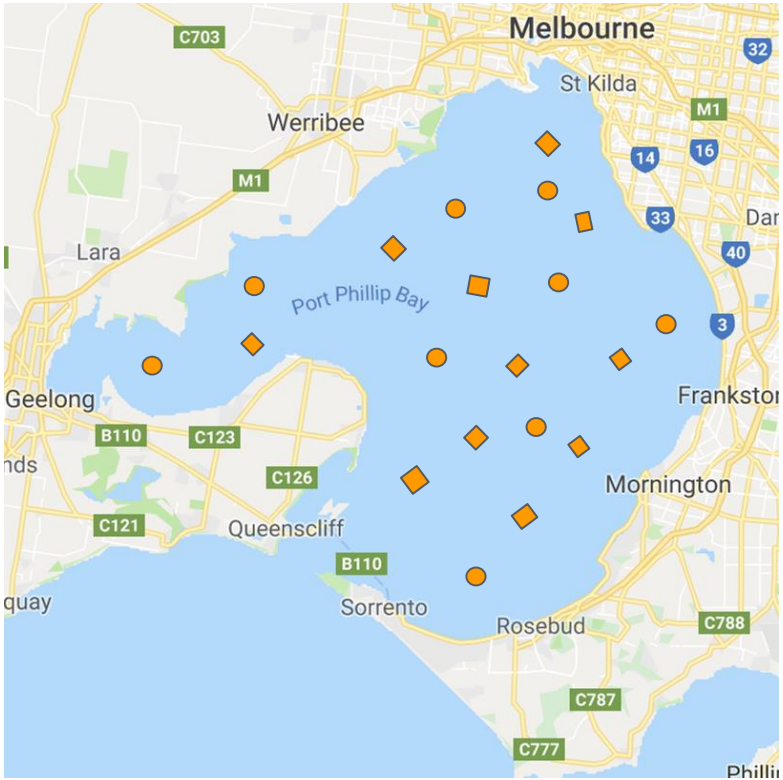
Yarra River Catchment accounts for over 4,000 km²

The Port Phillip Bay traps the vast majority of plastic that enters it



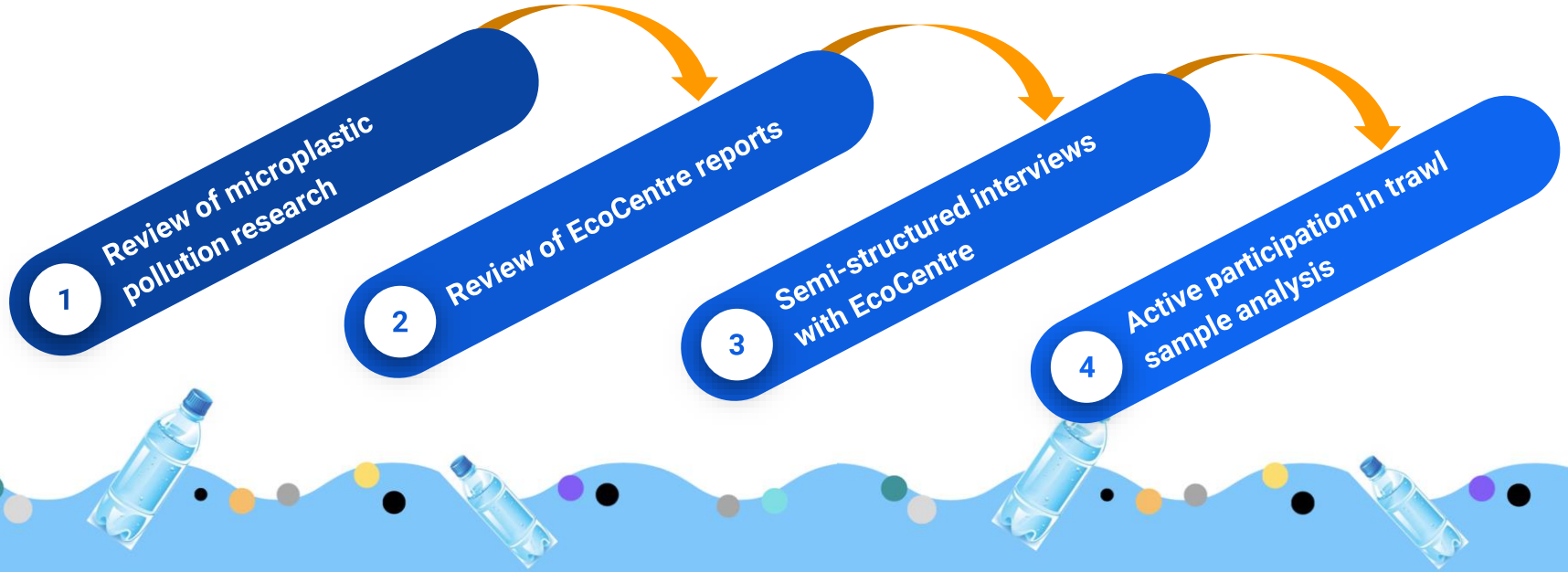
1 Become familiar with microplastic pollution and work being done to address it

Microplastic pollution is prevalent in Port Phillip Bay

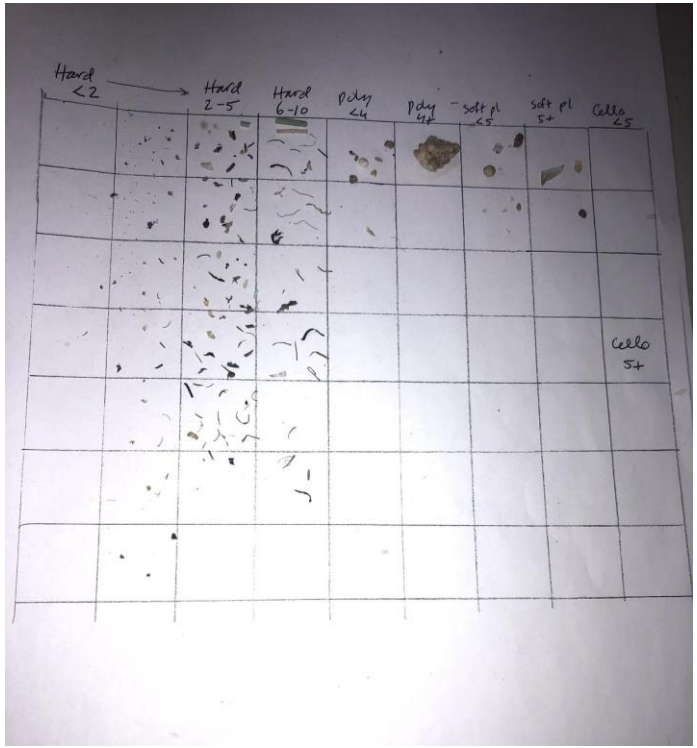


1.4 Billion Litter Items per year

1 Become familiar with microplastic pollution and work being done to address it



Through sample analysis, we were able to work up-close with microplastics

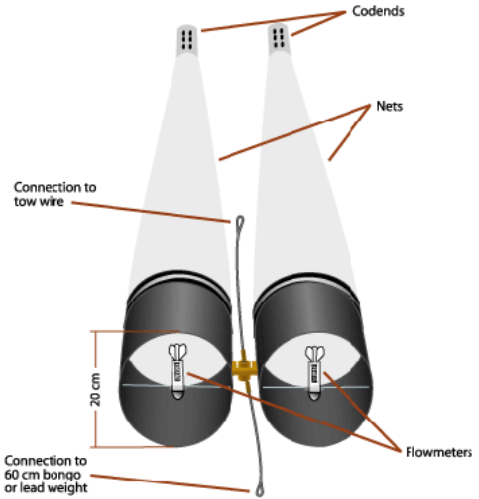


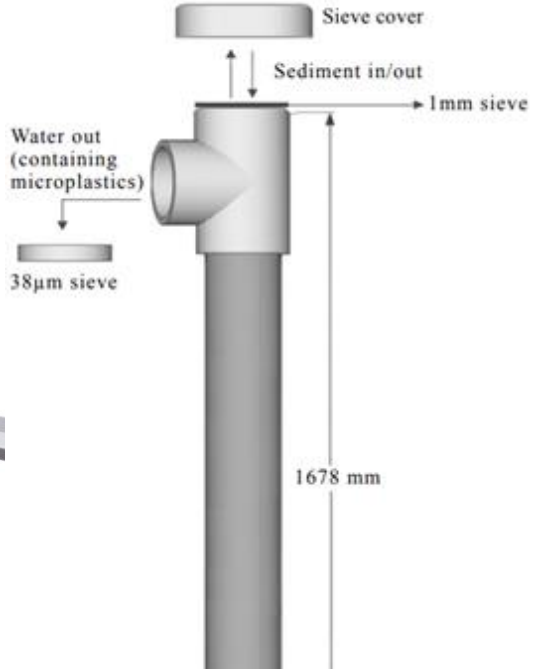
2

Identifying appropriate methods for deep microplastic collection

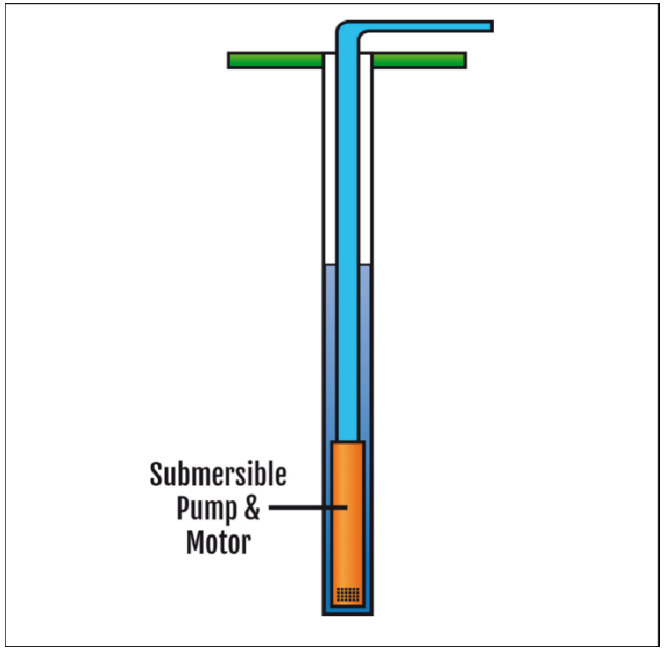
Literature review of existing microplastic collection methods

There is a wide variety of microplastic sampling methods





Pump systems have the ability to collect microplastics at various depths

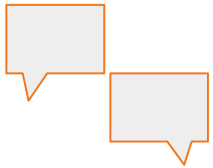


2

Identifying appropriate methods for deep microplastic collection

Literature review of existing microplastic collection methods

Active participation in trawl sample analysis



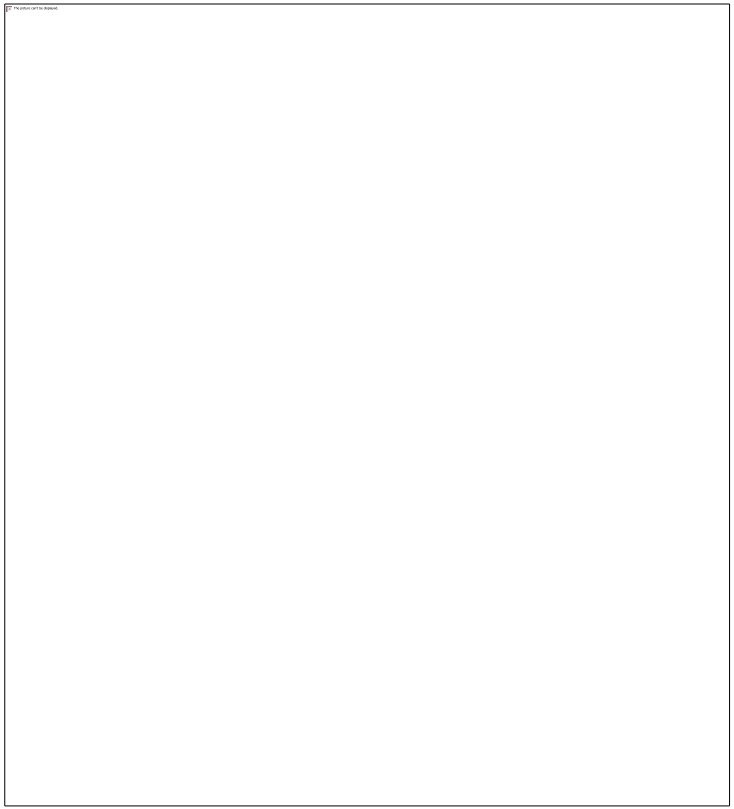
Semi-structured interview with Anthony Despotellis, and Captain Blair Stafford

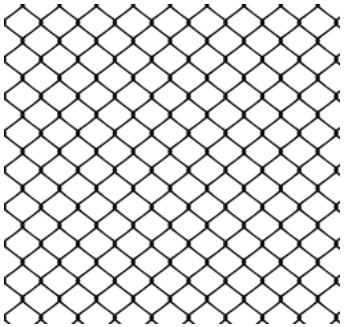
Our interviews identified specifications and sampling sites

Diameter?

Stiffness?

How to secure?



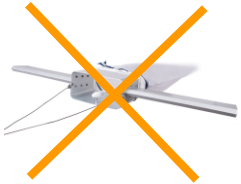


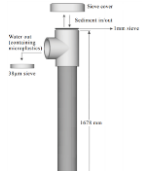
How long until cleaning is required?

3 Designing and building a suitable, portable microplastic sampling method

Revise device based on trial

Submit design options to the EcoCentre





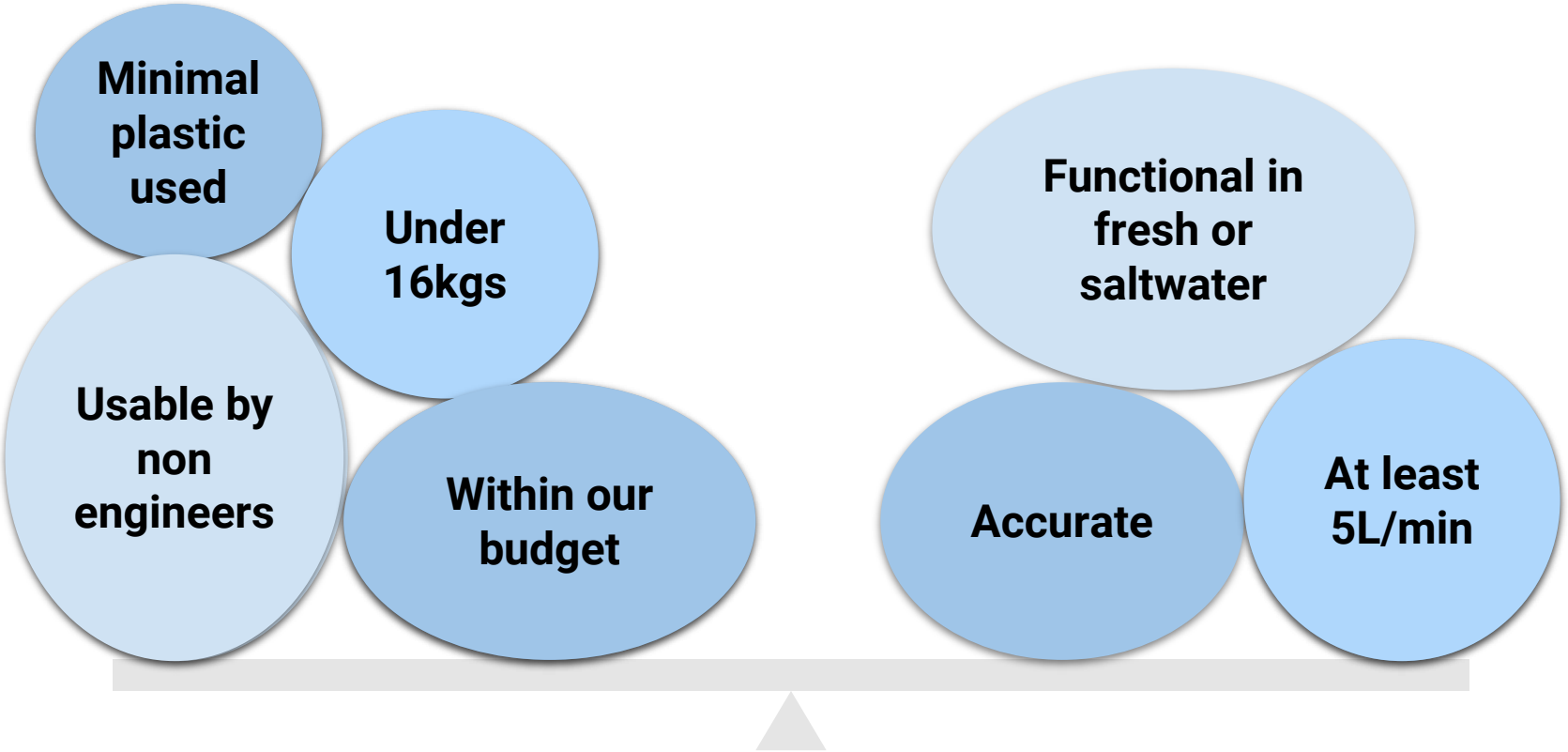
Design process

Build the sampling device and trial

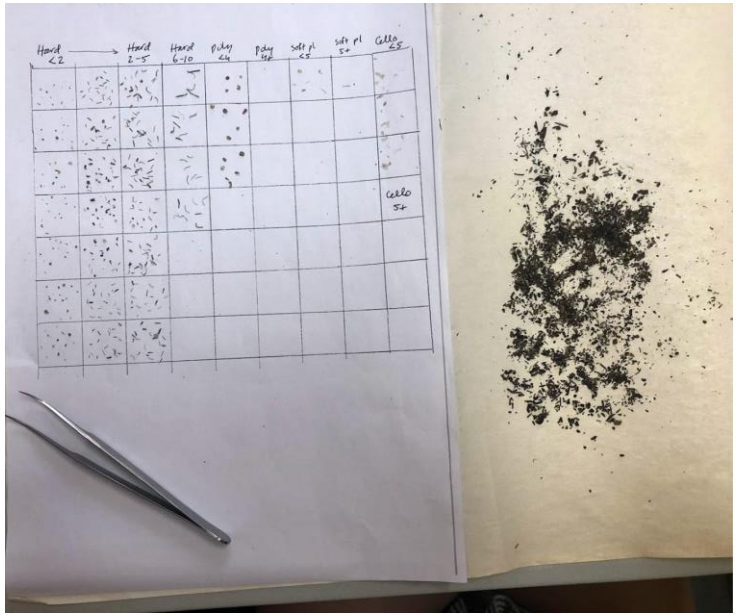
Revise design based on feedback

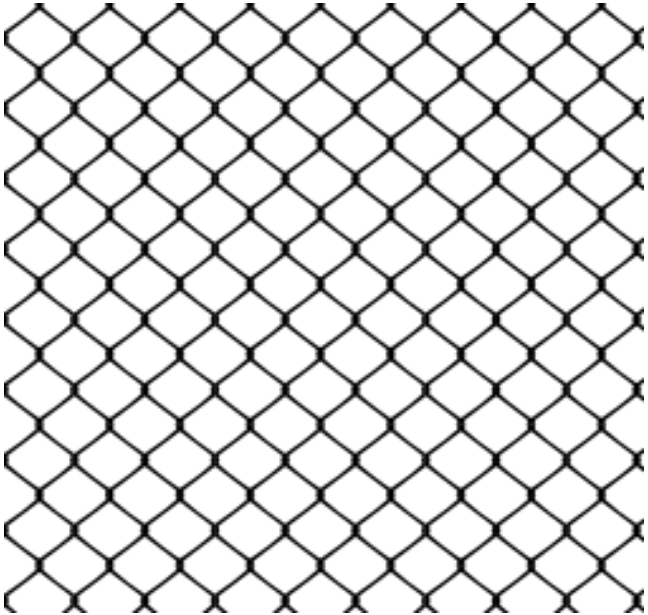
Identify required materials and costs

We aimed to achieve balance in our design

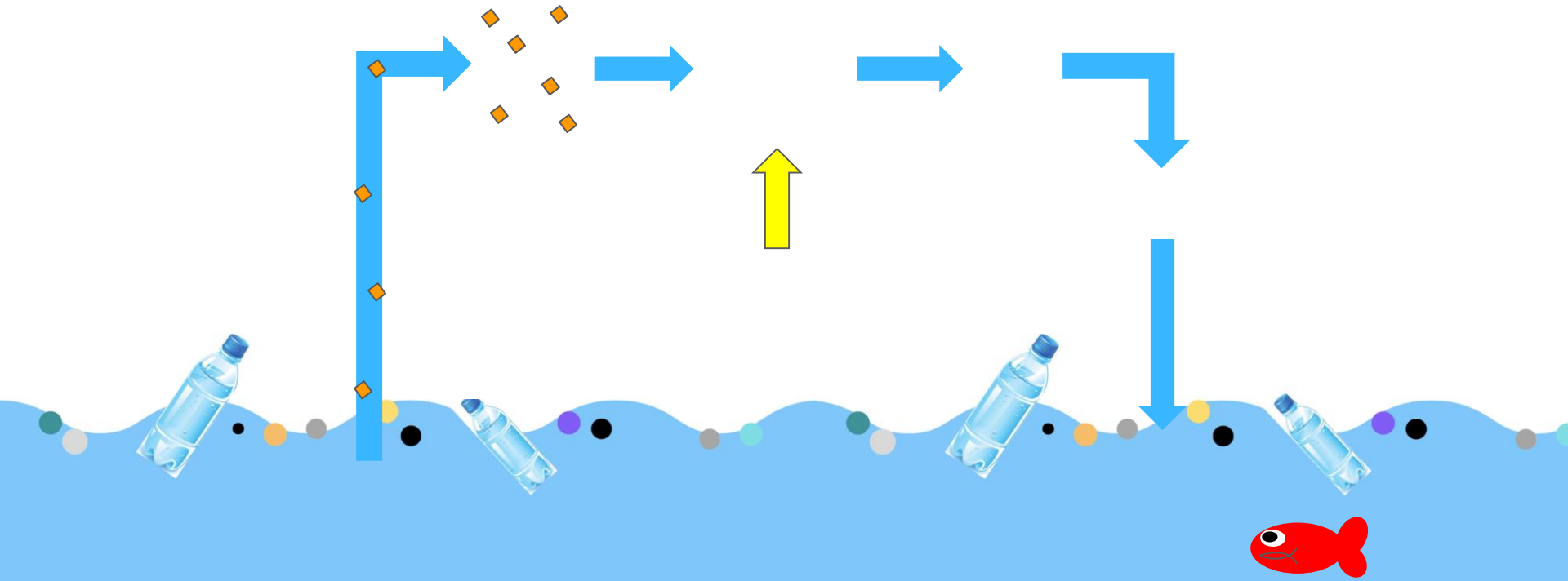


In order to collect meaningful data, we planned to include several design features





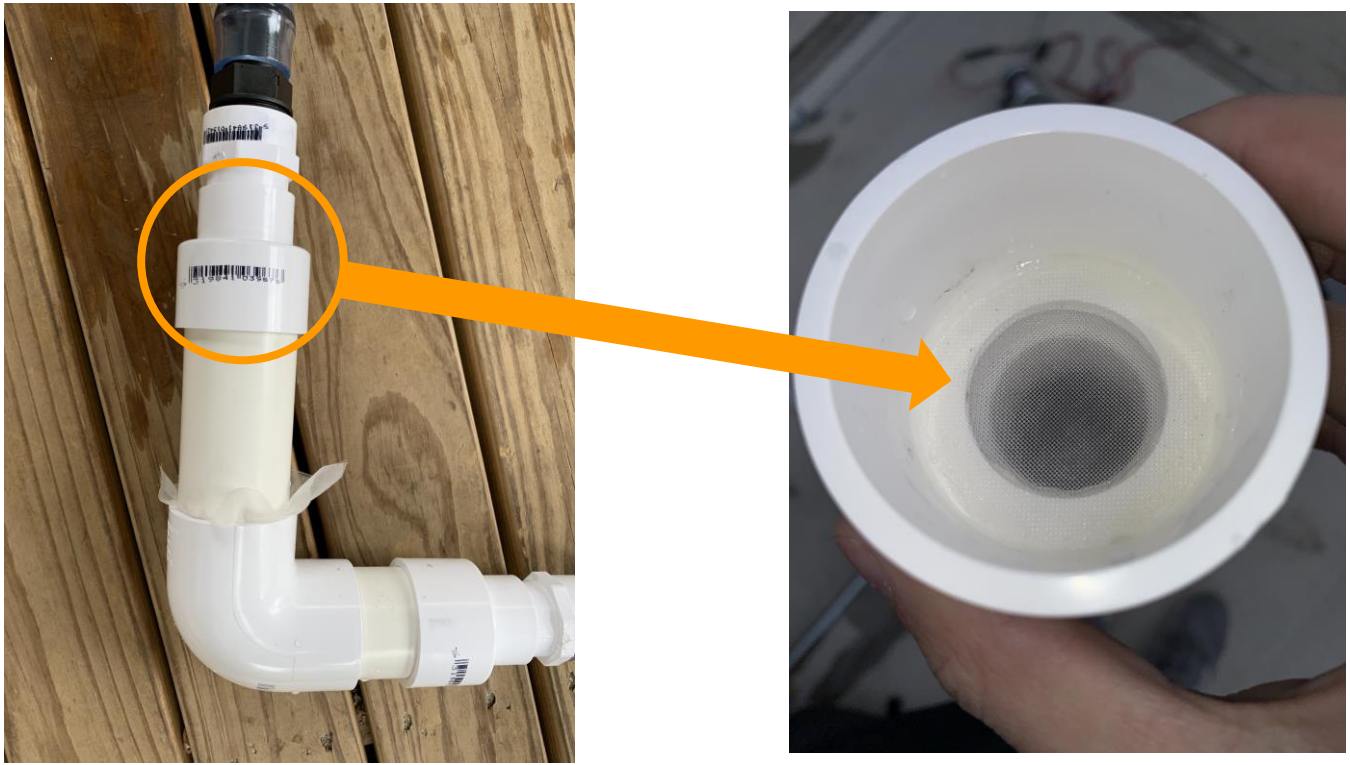
Our design included 6 key components



Interfacing the system proved challenging

We identified a suitable pump that can be powered or charge by a solar panel

We had difficulty attaching the filter



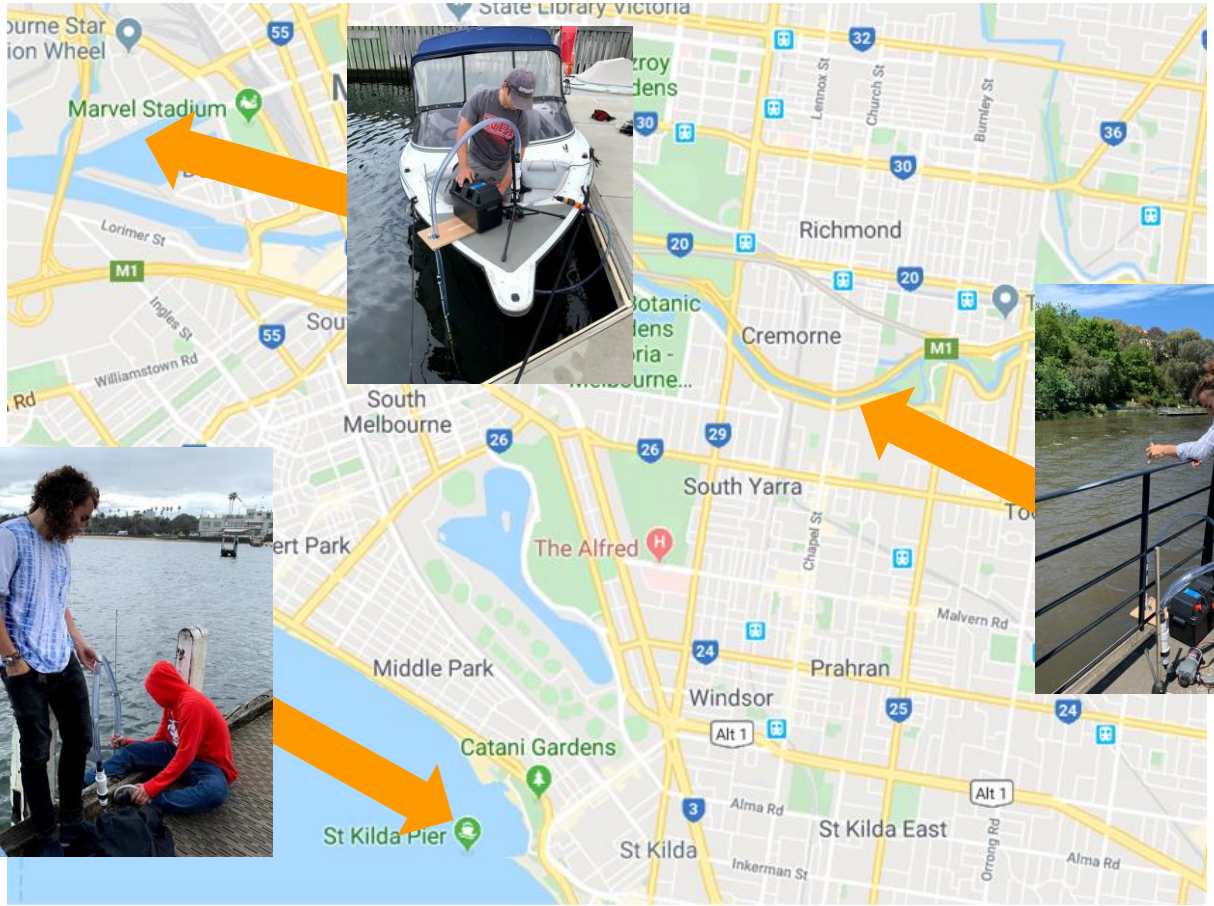
After testing for functionality, we added additional features for stability

The McWap (Microplastic Collector with a Pump)

The McWap meets our design specifications

1	Able to collect microplastics at various depths	**Samples at depths of 0.2m to 2m**
2	Inexpensive	**Total: AU$561.35**
3	Portable	**Able to fit in backpack and is light enough for one person**
4	Compatible with fresh or saltwater	
5	Easy to use	**Was assembled and used by non-engineers**
6	Eco-friendly	**Reusable parts and minimal plastic use**
7	Not time-consuming	**Can pump a 250 liter sample in 50 minutes**

We collected samples from several sites

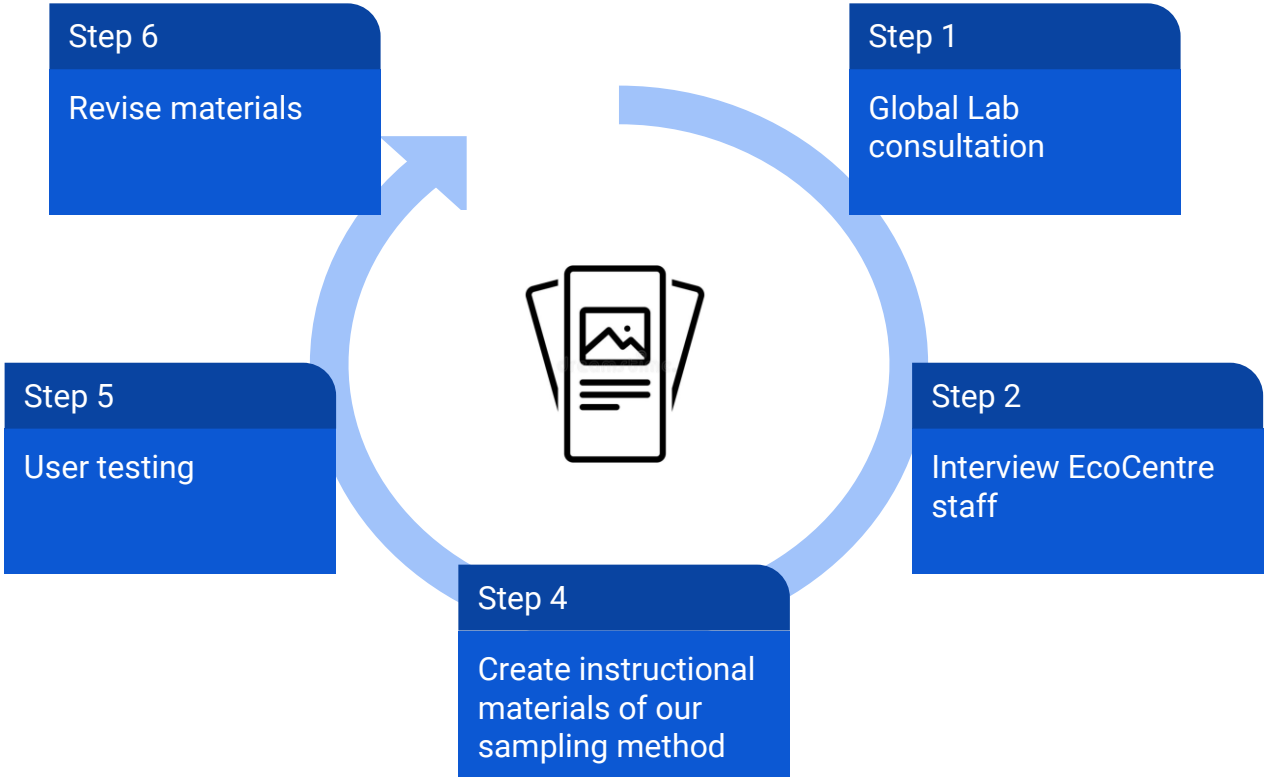


We found microplastics at these sites

Location	Depth (meters)	Microplastics	Categories	Concentration (microplastics per m^3)
St. Kilda Pier (extends into Port Phillip Bay)	1.0	2	hard plastic <2mm and cellophane <5mm	8.26
The Main Yarra Trail near the McConchie Reserve	1.0	4	hard plastic <2mm	16
The Main Yarra Trail near the McConchie Reserve	1.75	4	hard plastic <2mm soft plastic <5mm cellophane <5mm	16
Docklands	2.0	3	hard plastic <2mm hard plastic 2-5mm cellophane <5mm	12

4

Creating instructional materials for the sampling to be used in the future



We decided to pursue 3 types of materials

1. How-to video teaching users to operate the McWap
2. Written manual of device parts, assembly, usage, and troubleshooting
3. Animation depicting the problem of microplastic pollution and why microplastic sampling is important

Instructional Video For McWAP

Port Phillip EcoCentre

Materials You Will Need:

1	330-Micron Mesh in 40mm dia Circle	1	Black Electrical Tape
2	40mm to 25mm PVC Coupling	1	Teflon Tape
1	40mm x 11cm PVC Pipe	2	Threaded 25mm dia Male Quick Disconnect
2	25mm PVC Threaded Fitting	1	Female to Female Quick Disconnect
2	25mm x 3m Tube	1	Holman Flow Meter
1	13mm x .13m Tube	1	Ozito 12V Pressure Pump
1	13mm x .25m Tube	2	Battery Terminal Adapters
1	Pipe Saddle Bracket	1	Projecta 12V Automatic Battery Charger
2	25mm Barbed Threaded Fitting	1	12V Power Battery Station
2	13mm Barbed Threaded Fitting	1	12V Exide Endurance 40 CMF Battery
4	11mm-16mm dia Hose Clamps (STEEL 316)	1	Tripod
4	17mm-32mm dia Hose Clamps (STEEL 316)	1	Solar Panel Apparatus (optional power source)
4	22mm-32mm dia Easy Hose Clamps	1	Wood Plywood with 7cm Hole
4	16mm-27mm dia Easy Hose Clamps	1	Gorilla Clear Epoxy
8	7.9375mm x 2.3cm Nuts	2	Elastic Bands
3+	91.44 cm x 7.9375 mm dia Zinc Plated Threaded Steel Rod		

Take Off The Protective Caps & Keep Track of Positive & Negative

DO NOT TOUCH BOTH TERMINALS AT THE SAME TIME

THANK YOU FOR WATCHING

STARRING: TOM LIPKIN & KATIE DONOVAN

DIRECTED BY: ERIC STULTZ

EDITED BY: SPENCER HOAGLAND

BROUGHT TO YOU BY THE PORT PHILLIP ECOCENTRE

The McWap Manual

The McWap

(Microplastic Collector with a Pump)

Instruction Manual

Worcester Polytechnic Institute
Interactive Qualifying Project
Prepared by: Kathleen Donovan, Spencer Hoagland, Thomas Lipkin, and Eric Stultz
Advisors: Professor Lorraine Higgins and Lindsay Davis
Sponsor: The Port Phillip EcoCentre
13 December 2019

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ASSEMBLY

Step 1: Creating the Filter

Parts needed: 40mm to 25mm PVC Coupling, 330 µm mesh, and Gorilla 25mL Clear Epoxy Glue

1. Cut a circular piece of 330 µm mesh to the size of the coupling's bigger inner diameter (in this case 40mm)
   a. When cutting it is better to use slightly more fabric than you need, rather than less
   b. Be sure to trim the mesh in order for it to lay flat on the inner lip of the coupling
2. Clean the inside of the 40mm to 25mm PVC Coupling with a wet towel or napkin, then let dry
3. Dispense a small amount (approx. 1 tbsp) of Gorilla 25mL Clear Epoxy Glue onto a piece of paper, or any disposable surface to mix
4. Once mixed well, spread the epoxy along the inner lip of the coupling, then lay mesh on top being sure to push the mesh firmly onto the edges with epoxy
5. Add a little more epoxy onto the net above the lip
6. Let dry overnight or for at least 8 hours
7. Add tape to the outside of the coupling to help differentiate it from the coupling that does not have a filter inside
   a. Any sort of marking that will not rub off of the coupling works

Recommendations & Conclusions

Sampling with the McWap regularly will produce valuable data

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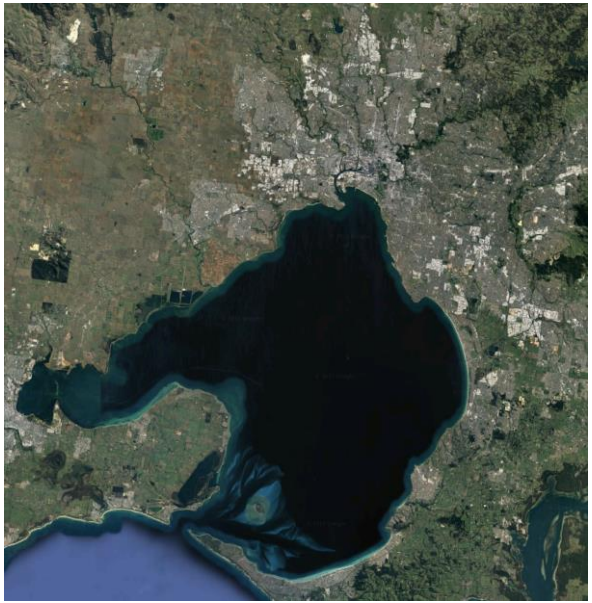

The McWap should be regularly tested for functionality

Modifications could improve our device

Thank You!

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