

**Department of  
Biological Sciences**

From biomolecules to the biosphere



**UNIVERSITY OF  
CALGARY**

# **MICROPLASTICS, THEIR IMPACTS AND CONSUMER CHOICES**

**Dr. Lee Jackson, Professor**

**Scientific Director (Advancing Canadian Water Assets)**

# Plastic in our Environment



# Media Portrayal



# Freshwaters



Alberta Flyfishing

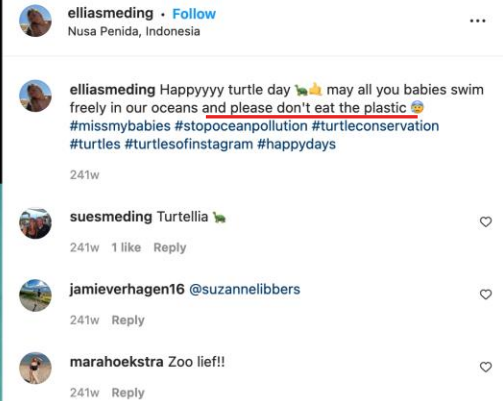
Boonsueb Patchim · 1 d · 🌐

This fish make me start to pick up the garbage along the river happy to catch him and let him free from garbage 1 in 1000000 maybe



# Social Media Awareness/Public Perspective

Ellia Smeding – British High Performance Speed Skater



# Social Media Awareness/Public Perspective



# Plastic in our Daily Lives



PET	HDPE	PVC	LDPE	PP	PS	Other grades
Polyethylene Terephthalate	High Density Polyethylene	Polyvinyl Chloride	Low Density Polyethylene	Polypropylene	Polystyrene	ABS, Acrylic, Nylon, EVA, PC, TPO, TPU, TPE
<u>Bottles</u> , containers, strapping, trays	<u>Bottles</u> , containers, pails, crates, barrels, pipe, IBC, geo liner (pond), agricultural plastic	Window profile, containers, siding, pipe, <u>food containers</u>	<u>Bottles</u> , containers, pails, crates, barrels, pipe, IBC, geo liner (pond), plastic bags	Film scrap (baled, roll stock), purging, lumps, <u>stretch wrap</u> , pipe, geo liner (pond)	<u>Containers</u> , trays, crates, FIBC (bulk bags, supersacks)	Polycarbonate sheet, Acrylic sheet, ABS pipe, conta

<https://albertaplasticsrecycling.com/resources-education/plastics-identification-codes/>

# Microplastics

## KNOW YOUR MICROPLASTICS

MICROPLASTICS ARE PIECES OF PLASTIC  
5 MILLIMETRES OR SMALLER.



### COMMON MICROPLASTICS:

#### FRAGMENTS



Small pieces of a larger plastic object.

#### FIBRES



The most common type of microplastic. Plastic strands from clothing.

#### FOAM



Pieces of food containers and coffee cups.

#### NURDLES



Plastic pellets usually used in manufacturing.

#### MICROBEADS



Beads used in soaps and cosmetics. Now labelled "toxic" in Canada, soon to be banned in personal care products. Look for "poly" on the label.



**MACROPLASTICS ARE ANY PLASTICS LARGER THAN 5 MILLIMETRES.**

Examples: plastics bags, bottle lids, bottles, food wrappers, etc.

## WHAT TO DO

### 1 REPORT PLASTICS POLLUTION



Download Swim Guide and tap "Report Pollution"



Visit [theswimguide.org/report](https://theswimguide.org/report)



Use hashtag [#plasticspollution](#) with your photo, date, and location.

### 2 CUT DOWN ON PLASTICS

Steer clear of plastic products. Look for natural alternatives or reusable containers. Don't buy cleansers and cosmetics with microbeads.

### 3 CLEAN UP PLASTIC POLLUTION, WHEN POSSIBLE

Use a pool or aquarium skimmer to remove plastic debris from the water. Throw the debris in the garbage, where it belongs.

Microplastics can be found across waterways and on shorelines. To help simplify this macro problem, here are the 5 major types of microplastics. (Image via Lake Ontario Waterkeeper)

Microplastics = 250  $\mu\text{m}$  – 5 mm size

# The Canadian Arctic

## Researchers find microplastics in nearly every sample taken in the Eastern Canadian Arctic

A team of Canadian researchers has found evidence that microplastics and microfibers have infiltrated Arctic ecosystems, but the source of these tiny fragments is still unclear



*Canadian  
Geographic*

By **Samantha Pope**

June 30, 2020



A clump of tiny plastics on a finger. Microscopic fragments of plastic were found in almost every sample taken in the Eastern Canadian Arctic as part of a recent study. (Photo: iStock)



Contents lists available at [ScienceDirect](#)

Environment International

journal homepage: [www.elsevier.com/locate/envint](http://www.elsevier.com/locate/envint)



Full length article

## Discovery and quantification of plastic particle pollution in human blood

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### ARTICLE INFO

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### ABSTRACT

Plastic particles are ubiquitous pollutants in the living environment and food chain but no study to date has reported on the internal exposure of plastic particles in human blood. This study's goal was to develop a robust and sensitive sampling and analytical method with double shot pyrolysis - gas chromatography/mass spectrometry and apply it to measure plastic particles  $\geq 700$  nm in human whole blood from 22 healthy volunteers. Four high production volume polymers applied in plastic were identified and quantified for the first time in blood. Polyethylene terephthalate, polyethylene and polymers of styrene (a sum parameter of polystyrene, expanded polystyrene, acetonitrile butadiene styrene etc.) were the most widely encountered, followed by poly (methyl methacrylate). Polypropylene was analysed but values were under the limits of quantification. In this study of a small set of donors, the mean of the sum quantifiable concentration of plastic particles in blood was 1.6  $\mu\text{g}/\text{ml}$ , showing a first measurement of the mass concentration of the polymeric component of plastic in human blood. This pioneering human biomonitoring study demonstrated that plastic particles are bioavailable for uptake into the human bloodstream. An understanding of the exposure of these substances in humans and the associated hazard of such exposure is needed to determine whether or not plastic particle exposure is a public health risk.

# What Does Science Say About (Micro)plastic Pollution?



Main concerns are due to ingestion:

1. microplastics perceived as food by fish, amphibians, reptiles, birds
2. may cause abrasion to digestive tract once ingested
3. may have toxins absorbed to their surface (eg flame retardants)
4. release chemicals (recall bisphenyl-A (BPA) and MEC pulling polycarbonate bottles from their shelves in 2007) such as phthalates, that are biologically active.

DEHP: Di-2-ethylhexyl Phthalate

Makes plastic flexible, yet leaches out of plastics with repeated use, washing and heating. Is in medical devices and furniture products, personal care products and cosmetics. It is an endocrine disruptor that affects the ovaries, uterus, testes, kidneys, nervous system and thyroid\*.

Municipal wastewater treatment plants receive microplastics from our homes, hospitals industries and have not been designed to remove this emerging pollutant

\*Rowdhwahl and Chen (2018) Toxic Effects of Di-2-ethylhexyl Phthalate: An Overview. Biomed Research International  
doi: <https://doi.org/10.1155/2018/1750368>

# Partitioning of Microplastics in a WWTP

BSc Honours Thesis Project of Paige Jackson (Co-Supervised by Dr. Sean Rogers)



Sampling Final Effluent



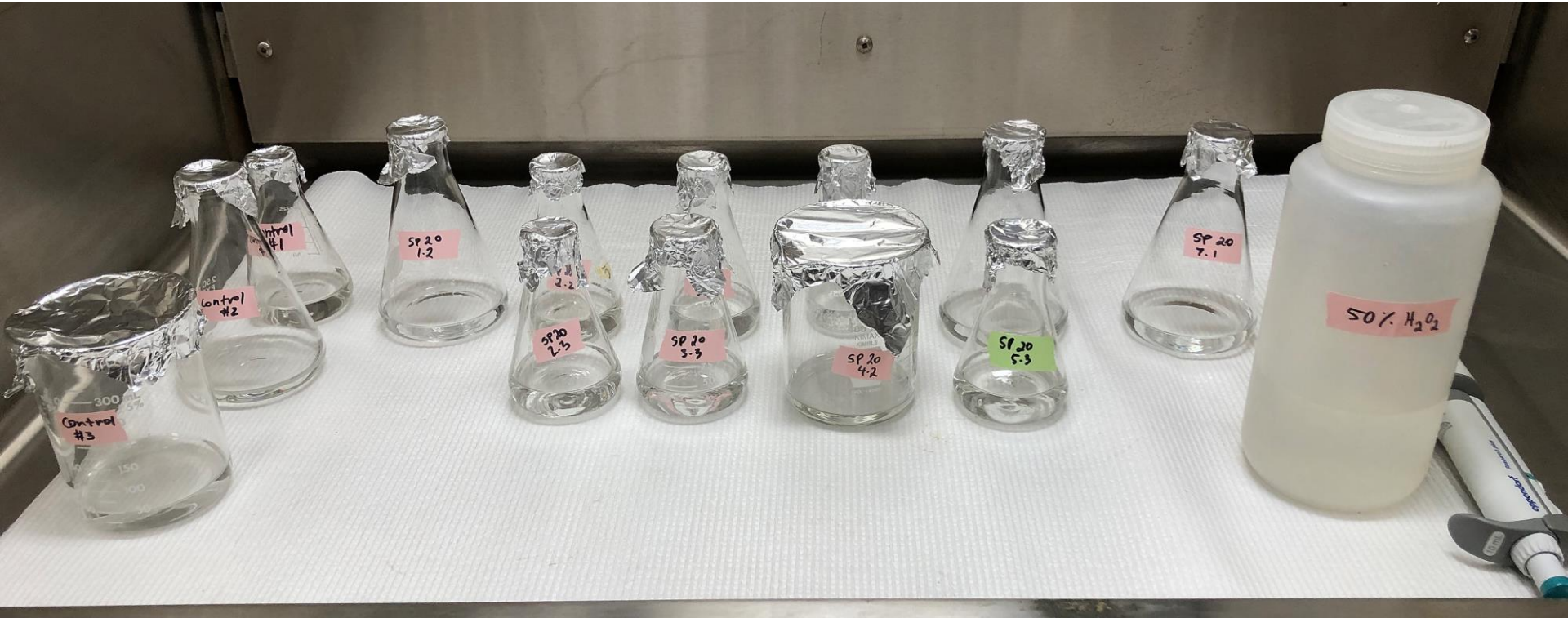
Sampling Ultra-Filtration Effluent

# Initial Screening



Initial Screening (250  $\mu\text{m}$ ) and collection

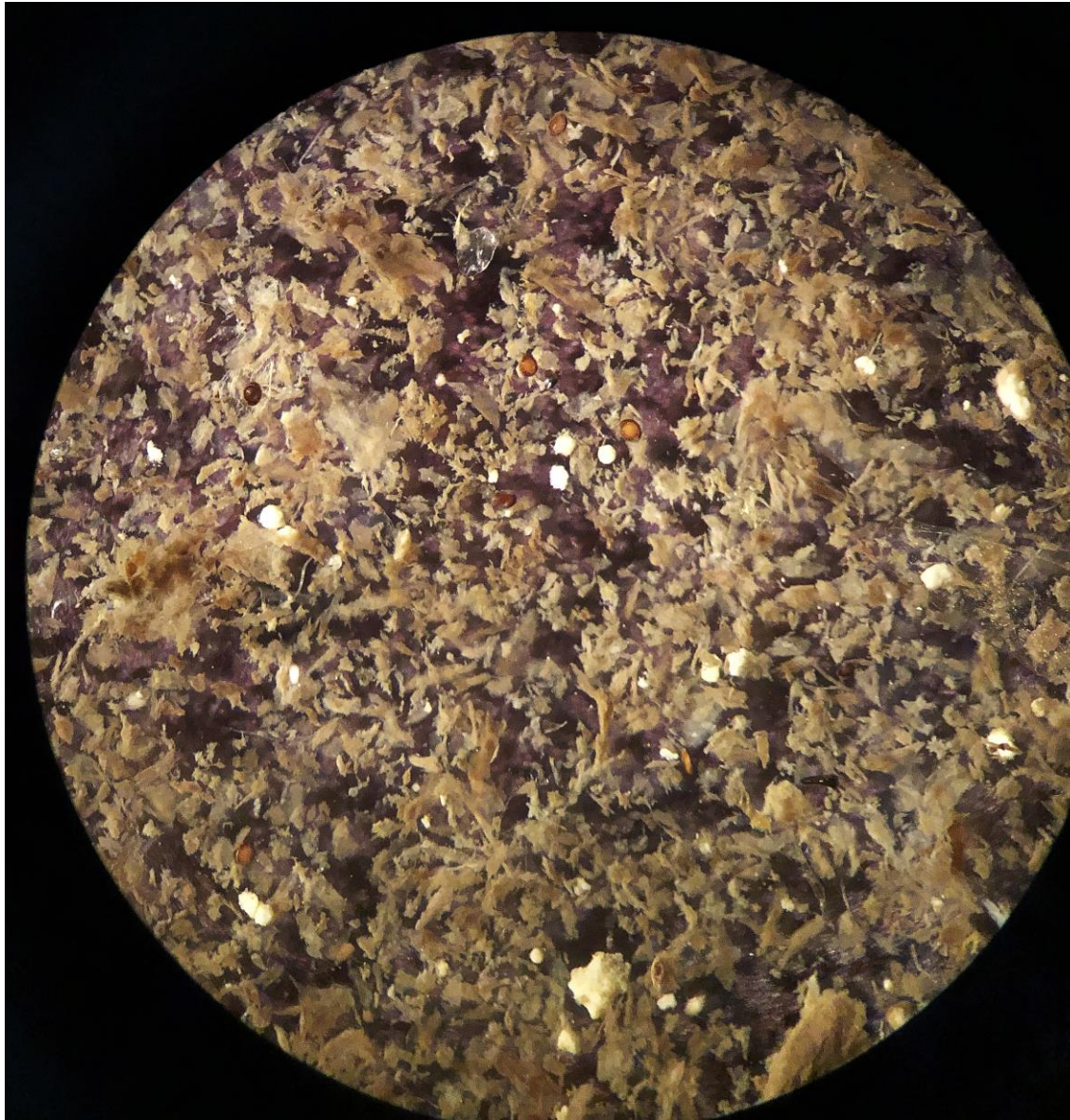
# Final Effluent Digestion



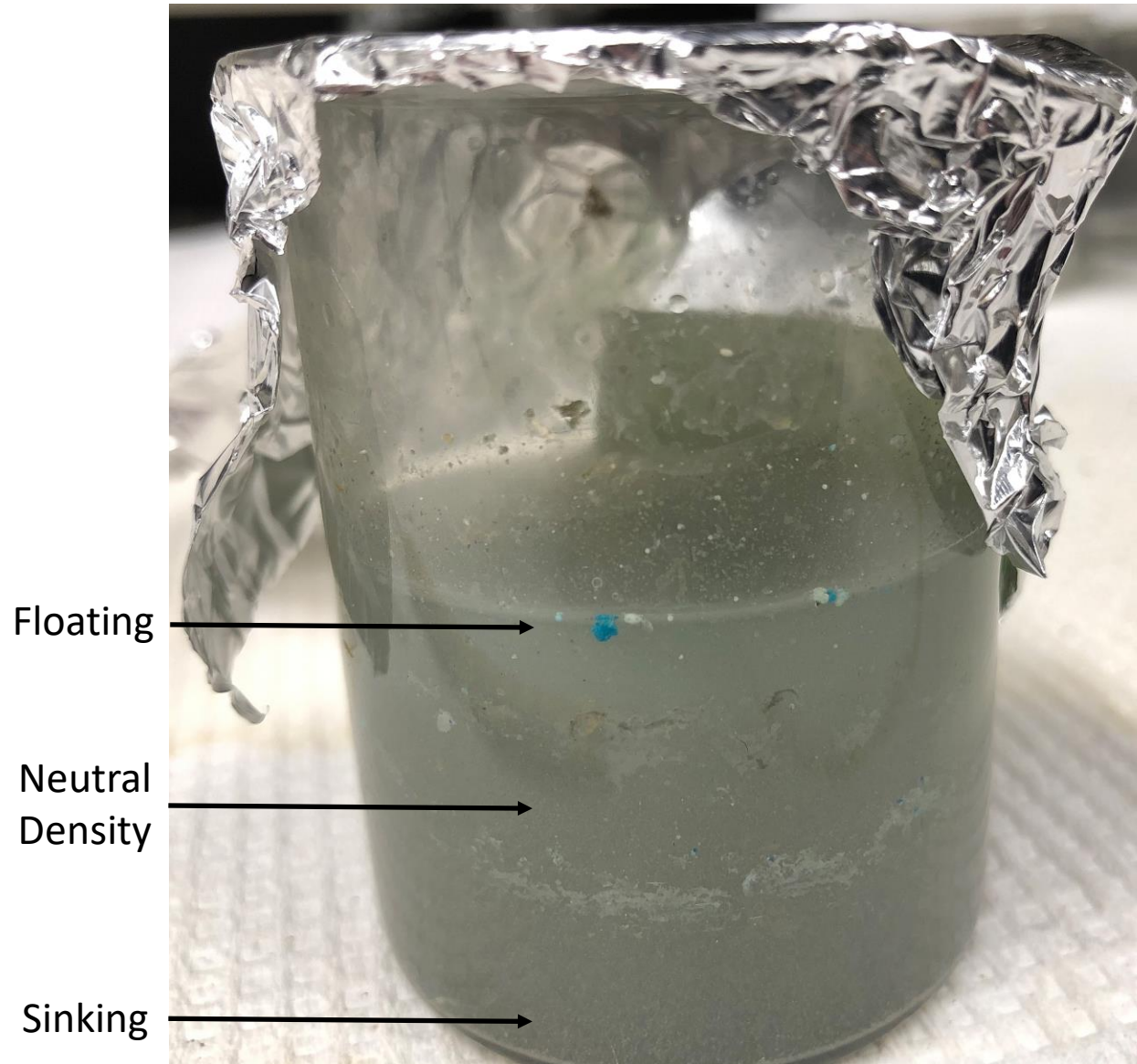
# Biosolids Digestion



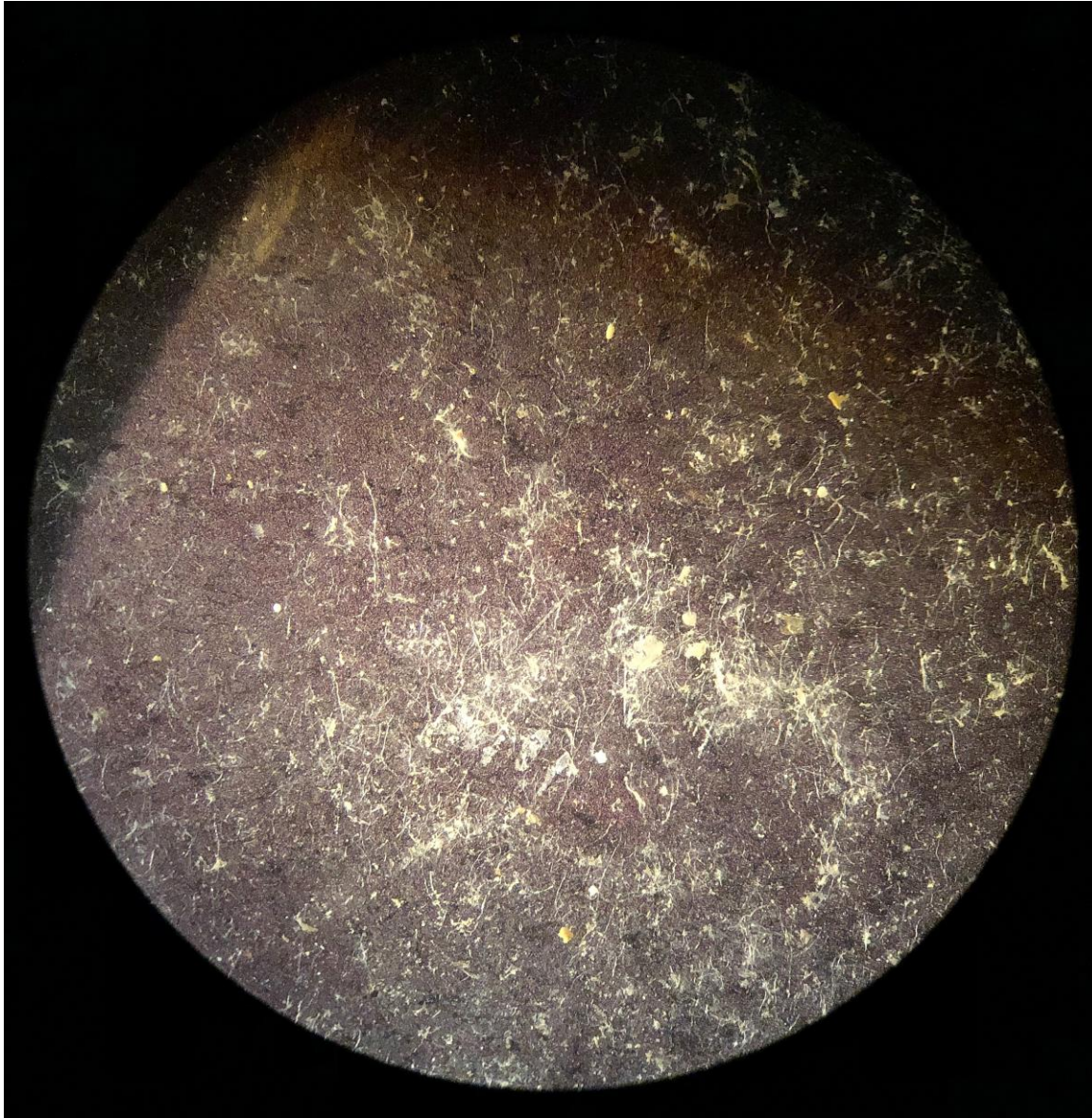
# Ultra-Filtration Membrane Backflush



# Membrane Backflush, Post-digestion



# Raw Influent, Post-digestion



# Microscopy



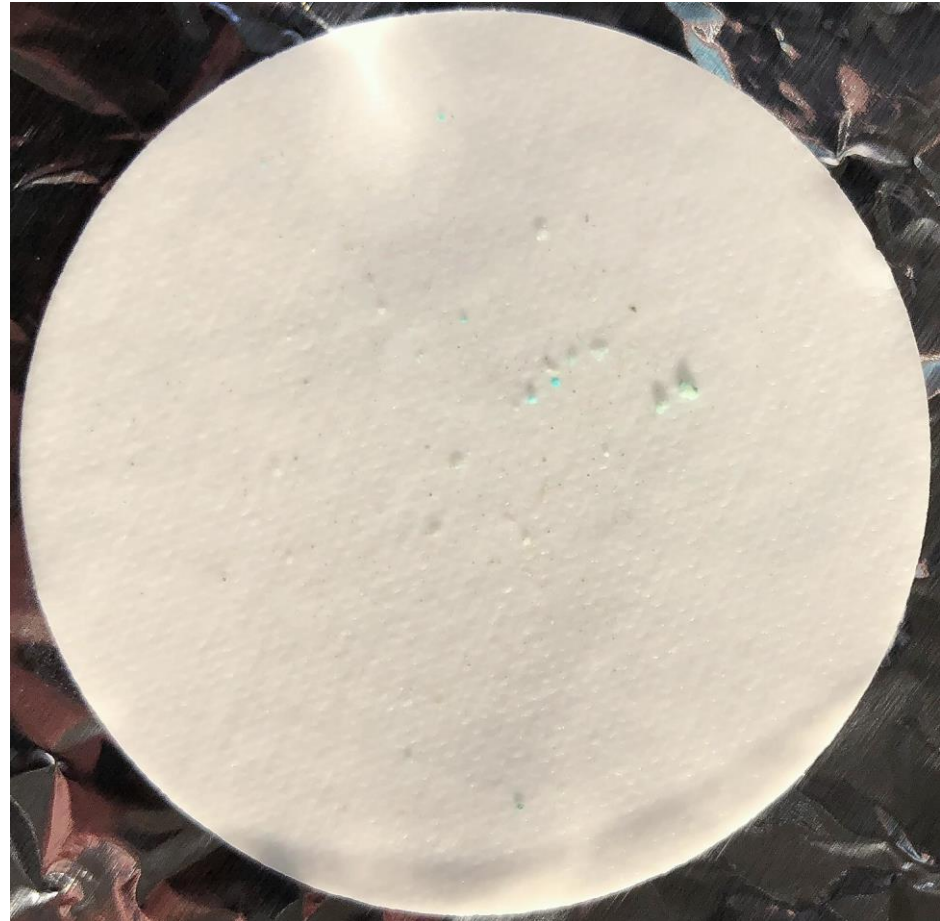
# Example Filters and Plastics

Biosolids



Fibres (zoomed in)

Final Effluent



Nurdles and Foam

Name	Abbreviation	Typical Density (g/cm <sup>3</sup> )
Expanded Polystyrene	EPS	0.02
Polypropylene	PP	0.89
Polyethylene	PE	0.96
Acrylonitrile-butadiene-styrene	ABS	1.05
Polystyrene	PS	1.06
Polyamide (Nylon)	PA	1.14
Polymethyl methacrylate	PMMA	1.18
Polycarbonate	PC	1.21
Cellulose Acetate	CA	1.3
Polyvinyl chloride	PVC	1.39
Polyethylene terephthalate	PET	1.39
Polytetrafluoroethylene	PTFE	2.2

**Table 1: Common polymers (densities derived from Teegarden<sup>2)</sup>)**

Teegarden DM (2004) Polymer Chemistry: Introduction to an Indispensable Science.  
National Science Teachers Association Press.

# Sampling ACWA's ultra-filtration module influent and effluent



## Follow-up Research

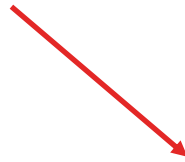
Q: Is membrane filtration (0.02  $\mu\text{m}$  pore size) a viable option to remove microplastics?

# What Are Our Options As Consumers/Concerned Citizens?



Chemical Exposure Issues

Microplastic Production Issues



Technological solutions  
Behavioural solutions

# Chemical Exposure Issues



## Concern

## Option

Exposure to phthalates from plastic food storage containers

☒ Microwave in glass or ceramic; bake in glass, ceramic or metal

Ingestion of microplastics and phthalates from plastic water bottles

☒ In Calgary drink tap water (it is very high quality), use refillable stainless steel bottles (Kleen Kanteen, Corksickle, etc.) or drink out of glass

Exposure through consumer products

☒ Purchase non-plastic items (natural fibre clothing, cardboard deodorant, silk or hemp dental floss).....

# Consumer Choice - Deodorant



# Microplastic Production Issues

## Concern

Production of microplastics from clothing/blankets

Single clothes wash may release 700,000 microplastic fibres, study finds

Tiny plastic particles released by synthetic fabrics can cause harm to marine life when they enter rivers and oceans



Microfibres found inside the body of a North American fish. Photograph: Rachel Ricotta/AP

Each cycle of a washing machine could release more than 700,000 microscopic plastic fibres into the environment, according to a study.

## Option

- ☒ Purchase natural fibre (cotton, wool) clothing
- ☒ Purchase tightly woven synthetics (will feel smooth rather than fuzzy)
- ☒ Wash synthetic clothes less frequently
- ☒ Be mindful of wash cycle and temperature
- ☒ Use a fibre collection device
- ☒ Spot-clean fleeces
- ☒ Air dry clothes

# Washing Machine Fibre Collections Options\*

## Filtrol

The Filtrol 160 is a patented, reusable filter that easily attaches to your washing machine discharge hose to remove synthetic clothing fibers like polyester, nylon, rayon, and acrylic. It also removes all traces of sand, hair and pet fur from your clothing, making your laundry come out cleaner. But most importantly, The Filtrol 160 also helps prevent microfibers from polluting waterways and harming marine life.

When the filter gets full, you can easily wash it out and place the nasty fibres in the bin, or buy a replacement filter for a reasonable price.

Price: \$139.99



## The Lint LUV-R

Of all the microfiber filters, this one is a bit more complex than the others, and it requires installation. It also costs a bit more (\$140) but it's well worth it: the Lint LUV-R is super efficient, and is guaranteed to protect your plumbing, septic system and our marine environments by efficiently removing lint and microplastics from washing machine discharge.

This is also an excellent filter for anyone whose house uses greywater to wash the dishes and water the garden: without this filter, you could well end up eating microparticles of your clothing stuck to plates and glasses, and microplastics could end up in your garden, contaminating plants and the animals that eat them.

Price: \$140



\*All consumers should do their research regarding manufacturers' claims and 'real-world' performance

# Washing Machine Fibre Collections Options

## 4. Coraball

This is one of the microfiber filters that was inspired by coral, because this beautiful invention of nature does exactly what we need to. Namely, it catches tiny things from flowing water. Using those same principles in their design, the folks behind the Cora Ball have created something you just drop or throw into your washing machine to catch microplastic particles.

An independent test investigating the effectiveness of the Cora Ball out of Dr. Chelsea Rochman's lab at the University of Toronto showed that one Cora Ball catches 26% of the microfibers from flowing down the drain. That's not a whole lot, so the more balls you put in with the wash, the better! Three are recommended.

**Price:** From \$38.99



## 2. Eleanos Reusable Washing Machine Floating Net Bags

This little device protects the oceans by catching the microfibers that shed off our clothes in the washing machine. Just throw a few into your washing machine, and do your laundry as usual. It is easy to use and easy to clean. When the traps get a bit dirty, just remove the fibers and safely put them in the trash. That means they will not reattach to clothing, enter the water system, or fly off into the air.

**Price:** \$7.98



## 3. Guppyfriend

Take this sweet little bag with you wherever you go! It's easy to use – just place your synthetic clothing in the bag, seal it, and throw it into your washing machine. When you start to notice the bag is getting a bit dirty, just peel off the fibers and bin them safely in your trash. The bags are not huge, but will fit synthetic undies, workout gear and swimwear.

**Price:** \$34.95



# Take-home Messages (and actions)



- (Micro)plastics are everywhere on earth (that has been sampled)
- Each of us can affect positive change to reduce (micro)plastic pollution through
  - our behaviours
  - our consumer choices
- Voice your opinion as a consumer to manufacturers
- Thank companies when they improve processes and products that reduce plastic pollution
- Advocate for the use of high value plastics that have reuse and recycling options