
Design Project 2 – Wastewater Filtration Challenge

ENGINEER 1P13 – Integrated Cornerstone Design Projects in Engineering

Tutorial 06

THURS-18

Shayan Siddiqui (siddm47)

Jasmine Kalsi (kalsij8)

Karanveer Dhillon (dhillk27)

Hannah Ross (rossh14)

Andrew Jo (joh8)

Submitted: March 18, 2026

Course Instructors: Dr. Bryan Lee, Dr. Ebrahimi

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Academic Integrity Statement

The student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University.

Shayan Siddiqui

400617630



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Jasmine Kalsi

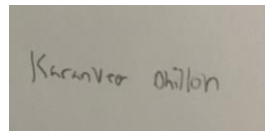
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The student is responsible for performing the required work in an honest manner, without plagiarism and cheating. Submitting this work with my name and student number is a statement and understanding that this work is my own and adheres to the Academic Integrity Policy of McMaster University.

Karanveer Dhillon

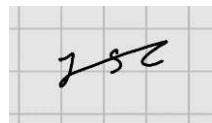
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Andrew Jo

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Hannah Ross

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Appendices

Appendix A: Project Schedule

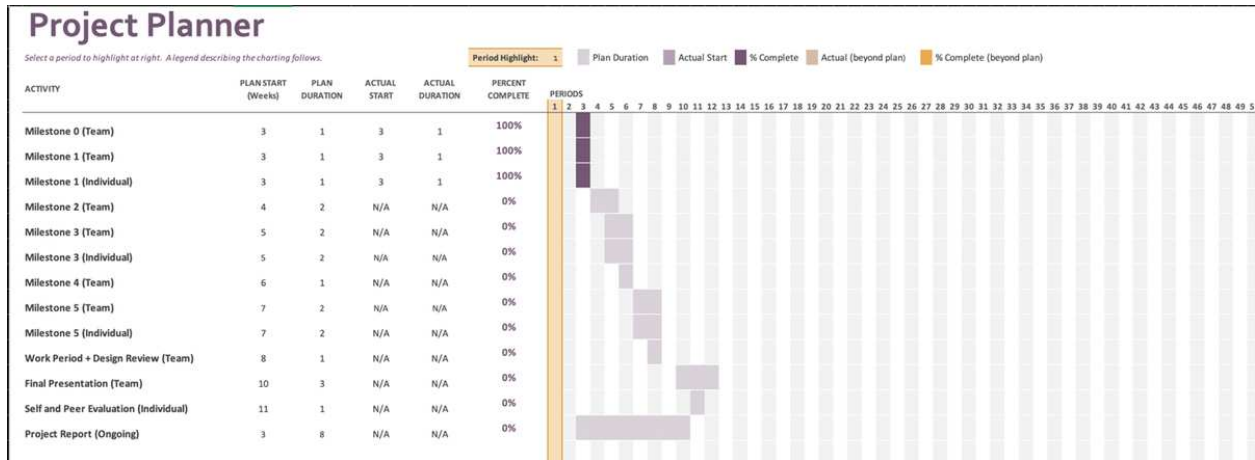


Figure 1 Preliminary Gantt Chart



Figure 2 Final Gantt Chart

Project 2 – Weekly Meeting Agendas & Minutes

ENGINEER1P13 | Scenario2:MicroplasticFiltration

Week 3 – Milestone 1: Research & Objective Tree

ENGINEER 1P13

MEETING WITH Thurs-18 – January 22, 2026

1

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	Shayan Siddiqui	Siddm47	Yes Yes Yes
Administrator	Hannah Ross	Rossh14	
Coordinator	Karanveer Dhillon	Dhillk27	
Subject Matter Expert	Andrew Jo	Joh8	Yes
Subject Matter Expert	Jasmine Kalsi	Kalsij8	Yes

AGENDA ITEMS

1. Review project scenario and objectives
2. Discuss microplastic filtration techniques
3. Assign research topics for filtration methods
4. Review citation requirements

MEETING MINUTES

We discussed the project scenario involving microplastic filtration in wastewater treatment systems. We investigated different filtration methods that could potentially remove microplastics from water. Mechanical filtration, membrane filtration, and biological filtration were identified as key techniques to research further. The team discussed how pore size and filtration efficiency influence microplastic removal. Each member was assigned a filtration method to research and collect credible sources for the next milestone.

POST-MEETING ACTION ITEMS

1. Research filtration techniques and supporting sources [Everyone]
2. Compare effectiveness of different filtration methods [Coordinator]
3. Prepare individual filtration research worksheet [All]

Week 4 – Milestone 2: Metrics and Regulations

ENGINEER 1P13

MEETING WITH Thurs-18 – January 29, 2026

1

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	Shayan Siddiqui	Siddm47	Yes Yes Yes
Administrator	Hannah Ross	Rossh14	
Coordinator	Karanveer Dhillon	Dhillk27	
Subject Matter Expert	Andrew Jo	Joh8	Yes
Subject Matter Expert	Jasmine Kalsi	Kalsij8	Yes

AGENDA ITEMS

5. Present individual mechanical filtration research compare and contrast findings
6. Discuss what makes a good filtration system for Scenario 2
7. Generate metrics for top 3 objectives identified in Milestone 1
8. Review relevant Canadian regulations (Health Canada filter regulations, microbeads policy)
9. Discuss sustainability considerations for material acquisition
10. Timeline update: Milestone 2 due end of lab

MEETING MINUTES

The team consolidated individual mechanical filtration research from Milestone 1. Each member presented their findings on filtration techniques and we compared and contrasted approaches for microplastic removal. We agreed that pore size, durability, and chemical resistance were the most critical properties for our filter. The team then generated measurable metrics for our top three objectives: filtration efficiency, mechanical durability, and environmental sustainability. We reviewed Health Canada filter regulations and the Microbeads in Toiletries Regulations to understand compliance requirements. The team discussed sustainable material sourcing and agreed to keep environmental impact as a key consideration going forward.

POST-MEETING ACTION ITEMS

4. Finalize metrics for all three objectives and document on Milestone 2 worksheet [All]
5. Review regulations for Scenario 2 and add notes to team document [SME]
6. Submit Milestone 2 team worksheet to Avenue [Admin]

Week 5 – Milestone 3: Conceptual Design – Material Selection

ENGINEER 1P13

MEETING WITH Thurs-18 – February 5, 2026

1

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	Shayan Siddiqui	Siddm47	Yes Yes Yes
Administrator	Hannah Ross	Rossh14	
Coordinator	Karanveer Dhillon	Dhillk27	
Subject Matter Expert	Andrew Jo	Joh8	Yes
Subject Matter Expert	Jasmine Kalsi	Kalsij8	Yes

AGENDA ITEMS

11. Review filtration material requirements
12. Analyze material properties using Granta
13. MPI derivation and discussion
14. Rank potential filtration materials

MEETING MINUTES

We evaluated the materials that could be used for the filtration system. We reviewed the results from Granta and discussed the importance of properties such as density, yield strength, and environmental compatibility. Using the Material Performance Index (MPI), we compared several materials under both stiffness-limited and strength-limited criteria. Each team member was assigned one MPI to complete individually using ANSYS-Granta EduPack. After analyzing the ranking results, we identified the materials that best met the requirements for performance and durability in water environments.

POST-MEETING ACTION ITEMS

7. Finalize material ranking and MPI calculations [SME]
8. Document selected material and reasoning [Admin]
9. Prepare material comparison for the next milestone [Manager]

Week 6 – Milestone 4: Material Selection and Porosity Calculations

ENGINEER 1P13

MEETING WITH Thurs-18 – February 12, 2026

1

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	Shayan Siddiqui	Siddm47	Yes Yes Yes
Administrator	Hannah Ross	Rossh14	
Coordinator	Karanveer Dhillon	Dhillk27	
Subject Matter Expert	Andrew Jo	Joh8	Yes
Subject Matter Expert	Jasmine Kalsi	Kalsij8	Yes

AGENDA ITEMS

15. Share and consolidate individual material rankings from Milestone 3
 16. Narrow material candidates down to 3 finalists
 17. Complete decision matrix evaluate finalists against objectives, constraints, and scenario-specific criteria
 18. Perform porosity calculations for selected material
 19. Verify effective elastic modulus/yield strength and assess material suitability on Ashby chart
- Timeline update: Milestone 4 due end of lab

MEETING MINUTES

The team consolidated all individual material rankings from Milestone 3 and compared results across all four MPs. We identified the three materials that appeared most consistently across the rankings and agreed to carry them forward as finalists. Using the decision matrix, we evaluated each finalist against our objectives filtration efficiency, mechanical durability, and environmental sustainability as well as scenario-specific criteria such as resistance to water and microplastic clogging. A final material was selected based on the highest overall score in the decision matrix. We then performed porosity calculations using the contaminant size radius for Scenario 2 (10–20 µm) and the fiber dimensions provided. The effective elastic modulus was calculated and plotted on the Ashby chart to confirm the material remained above the performance threshold after porosity adjustment.

POST-MEETING ACTION ITEMS

10. Finalize and document porosity calculations with full working shown [All]
11. Update Ashby chart with effective material properties and graphical justification [Coordinator]
12. Submit Milestone 4 team worksheet to Avenue [Admin]

Week 7 – Milestone 5: Design Embodiment – Eco Audit

ENGINEER 1P13

MEETING WITH TEAM XX - September 6, 2022

1

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	Shayan Siddiqui	Siddm47	Yes Yes Yes
Administrator	Hannah Ross	Rossh14	
Coordinator	Karanveer Dhillon	Dhillk27	
Subject Matter Expert	Andrew Jo	Joh8	Yes
Guest	Jasmine Kalsi	Kalsij8	Yes

AGENDA ITEMS

21. Review life cycle analysis of filtration materials
22. Discuss sustainability considerations
23. Create life cycle diagram for selected material
24. Review environmental impacts of filtration systems

MEETING MINUTES

We evaluated the sustainability aspects of the filtration system and the selected material, including raw materials sourcing, manufacturing, distribution, usage, and disposal. We discussed environmental impacts such as resource consumption, waste generation, and potential recycling opportunities. A life cycle diagram was created to show the different stages of the material's life cycle and how sustainability considerations influence the design process.

POST-MEETING ACTION ITEMS

13. Finalize life cycle diagram and references [Coordinator]
14. Review sustainability considerations for presentation slides [All]
15. Prepare PDF for final milestone submission [Admin]

Week 8 – Design Review and Work Period

ENGINEER 1P13

MEETING WITH Thurs-18 – March 5, 2026

1

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	Shayan Siddiqui	Siddm47	Yes Yes Yes
Administrator	Hannah Ross	Rossh14	
Coordinator	Karanveer Dhillon	Dhillk27	
Subject Matter Expert	Andrew Jo	Joh8	Yes
Subject Matter Expert	Jasmine Kalsi	Kalsij8	Yes

AGENDA ITEMS

25. Present porosity calculations to TA during Design Review
26. Review feedback from all milestones and identify gaps
27. Divide presentation sections among team members
28. Begin drafting slides confirm structure and content
29. Timeline update: confirm tasks remaining before final presentation

MEETING MINUTES

The team presented their porosity calculations to the TA during the Design Review. Feedback was received confirming that calculations were on the right track with minor clarifications needed on how porosity values were derived. The team then reviewed feedback from Milestones 1 through 5 and identified areas to address in the final presentation, particularly around strengthening the justification for material selection. Presentation sections were divided equally among all team members: Shayan — introduction and problem statement; Hannah — material selection and MPI; Karanveer — porosity calculations; Andrew — Eco Audit results; Jasmine — scenario context and sustainability regulations. The team agreed to have a full draft of slides ready before the next meeting.

POST-MEETING ACTION ITEMS

16. Draft assigned presentation slides before next meeting [All]
17. Address TA feedback on porosity section [Karanveer]
18. Compile all milestone worksheets for administrative report [Admin]

Week 9 – Presentation Preparation

ENGINEER 1P13

MEETING WITH Thurs-18 – March 12, 2026

1

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	Shayan Siddiqui	Siddm47	Yes Yes Yes
Administrator	Hannah Ross	Rossh14	
Coordinator	Karanveer Dhillon	Dhillk27	
Subject Matter Expert	Andrew Jo	Joh8	Yes
Subject Matter Expert	Jasmine Kalsi	Kalsij8	Yes

AGENDA ITEMS

30. Review completed presentation draft as a team
31. Practice run each member presents their section
32. Time the presentation (must stay within 7 minutes)
33. Refine slides based on feedback
34. Confirm submission before 11:59 PM the night before presentation
35. Prepare questions to ask another group during Q&A

MEETING MINUTES

The team reviewed the completed draft of the final presentation together. Each member delivered a practice run of their assigned section. The full presentation was timed at approximately 8 minutes, so the team worked together to trim content and tighten transitions. Slides were refined for clarity particularly the Ashby chart visual and the Eco Audit comparison graph. The team confirmed that all members are comfortable with their sections and do not require cue cards. A question was prepared to ask another group during the Q&A period. The team confirmed that the final presentation file will be uploaded to Avenue by 11:59 PM the night before the presentation.

POST-MEETING ACTION ITEMS

19. Finalize and upload presentation slides to Avenue by 11:59 PM the night before [Admin]
20. Review key design decisions to confidently answer Q&A questions [All]
21. Confirm all team members are available and prepared for presentation day [Manager]

Week 10 – Final Presentation Work Session

ENGINEER 1P13

MEETING WITH Thurs-18 – March 18, 2026

1

ATTENDANCE

Role	Name	Mac ID	Attendance (Yes/No)
Manager	Shayan Siddiqui	Siddm47	Yes Yes Yes
Administrator	Hannah Ross	Rossh14	
Coordinator	Karanveer Dhillon	Dhillk27	
Subject Matter Expert	Andrew Jo	Joh8	Yes
Subject Matter Expert	Jasmine Kalsi	Kalsij8	Yes

AGENDA ITEMS

36. Review current state of presentation slides as a team
37. Assign/confirm speaking sections for each team member
38. Work period — complete and finalize presentation slides
39. Practice run-through of full presentation
40. Time the presentation (must be under 7 minutes)
41. Address any gaps or missing content (problem statement, material selection justification, porosity, Eco Audit results)
42. Confirm slide upload to Avenue before 11:59 PM the night before presentation
43. Any final questions or concerns before submission

MEETING MINUTES

The team held a final work session to complete and review the presentation. All slides were finalized and each member confirmed their speaking sections. A full run-through was completed and timed at 6 minutes 45 seconds, within the 7-minute limit. Minor wording adjustments were made to the material justification and Eco Audit slides for clarity. The team confirmed the presentation file was uploaded to Avenue before the 11:59 PM deadline. All members confirmed their availability for the in-lab presentation. The team also reviewed anticipated Q&A questions and prepared concise responses.

POST-MEETING ACTION ITEMS

22. Confirm presentation upload to Avenue [Admin]
23. Arrive prepared and on time for the in-lab final presentation [All]
24. Ask at least one question to another group during Q&A period [All]

Appendix C: Comprehensive List of Sources

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Appendix D: Design Studio Worksheets

Project Two Milestone (Team) Worksheets

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MILESTONE 0 (TEAM): COVER PAGE

TeamID: Thurs-18

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID :
Hannah Ross	Rossh14
Karanveer Dhillon	dhillk27
Andrew Jo	joh8
Jasmine Kalsi	kalsij8
Shayan Siddiqui	Siddm47

Any student that is **not** present for Design Studio will not be given credit for completion of the worksheet and may be subject to a 10% deduction to their P-2 grade.

Insert your Team Portrait in the dialog box below



MILESTONE 0 – TEAM CHARTER

Team ID: Thurs-18

Project Leads:

Identify team member details (Name and MacID) in the space below.

Role:	Team Member Name:	MacID
Manager	Shayan Siddiqui	Siddm47
Administrator	Hannah Ross	Rossh14
Coordinator	Karanveer Dhillon	Dhillk27
Subject Matter Expert	Andrew Jo	Joh8
Subject Matter Expert	Jasmine Kalsi	kalsij8

MILESTONE 0 – PRELIMINARY GANTT CHART (TEAM MANAGER ONLY)

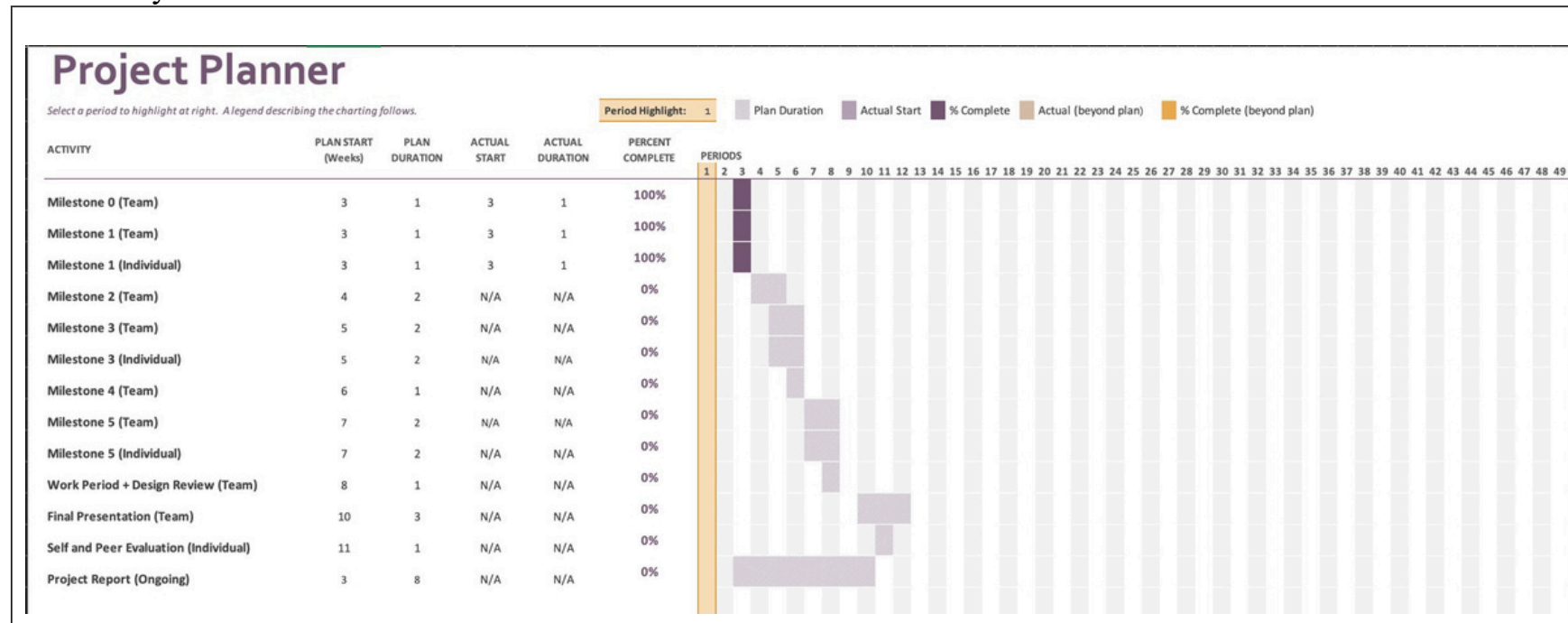
Team ID:

Thurs-18

Project Manager is completing this section!

Full Name of Team Manager:	MacID :
Shayan Siddiqui	Si ddm 47

Preliminary Gantt chart



MILESTONE 1 (TEAM): COVER PAGE

TeamID:

Thurs-18

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID :
Hannah Ross	Rossh14
Karanveer Dhillon	Dhillk27
Jasmine Kalsi	kalsij8
Andrew Jo	Joh8
Shayan Siddiqui	Siddm47

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MILESTONE 1 (STAGE 2) – OBJECTIVE TREES

Team ID:

Thurs-18

For your assigned engineering scenario, you will be submitting an objective tree agreed upon by the group. Each branch of the objective tree should have a minimum of 3 layers. This can be hand-drawn or done on a computer.

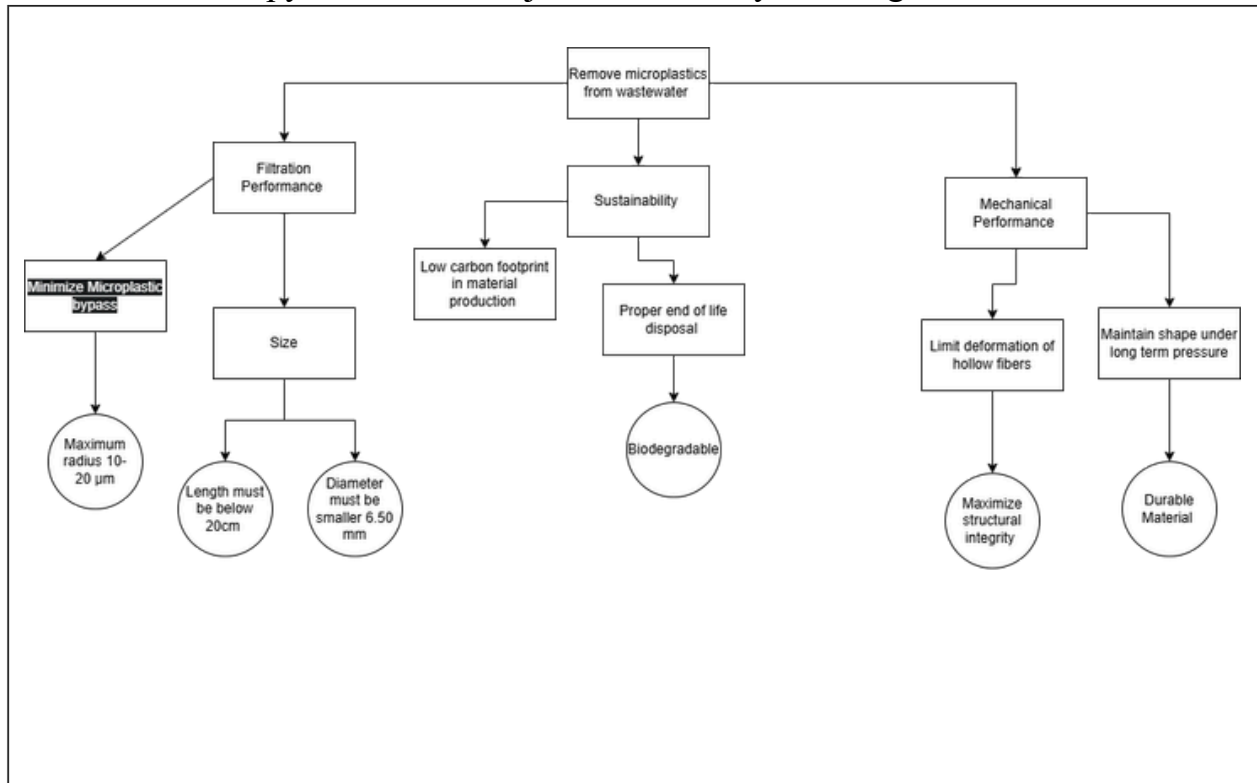
Engineering Scenario

The title of the scenario

Microplastic Filtration for Large-Scale Plan

Team objective tree diagram

Please insert a copy of the team objective tree for your assigned scenario.



MILESTONE 2 (TEAM) – COVER PAGE

Team

Thurs-18

Number:

--

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Shayan Siddiqui	Siddm47
Hannah Ross	Rossh14
Karanveer Dhillon	Dhillk27
Jasmine Kalsi	Kalsij8
Andrew Jo	Joh8

Any student that is ***not*** present for Design Studio will not be given credit for completion of the worksheet and may be subject to a 10% deduction to their P-2 grade.

MILESTONE 2 (STAGE 1) – MECHANICAL FILTRATION RESEARCH CONSOLIDATION

Team ID:

Thurs-18

As a team, discuss and consolidate the individual research you performed for mechanical filtration during Milestone 1. Compare and contrast your research and discuss what makes a good filtration system.

Summary of Research:

Mechanical filtration is a process of removing particles through surface and depth filtration [1]. This method of filtration is used mainly to removed large undissolved materials such as clay, sand or organic matter [2]. Mechanical filtration is usually part of a multi-step filtration process, and not the only process used to filter out impurities [3]. This process uses meshes, screens, or other media to filter out and trap impurities [4]. Some media that may be used can include activated carbon, sand, or gravel [2]. It can remove particles in a few way, larger particles get trapped quickly, while small particles can still get captured because the hit the grains and become stuck while moving though the bed [5].

There are three types of mechanical filtration. These include cartridge sediment filters, single, or multimedia filters [2]. Cartridge sediment filters work by pushing water through fibers where loose particles become trapped and filtered water flows through [2]. These filters can be made of paper, rayon, ceramic or other materials [6]. Single and multimedia filters use different media, such as sand or gravel, to capture impurities [7].

Over time, mechanical water filters may become clogged and need to be cleared out. This is done using the backwashing method, where the flow of the water is reversed upwards to lift the bed, and push out/flush away trapped solids [8]. Typically, mechanical filters are used in residential areas for small scale filtration [9].

A good filter is effective in being able to remove large particles and sediments with the aid of meshes, screens, or other filtration material. It should further be able to eliminate smaller particles through depth filtration techniques, to take untreated water and produce clean water in return. Other attributes of a strong filter can include durability and its ability to withstand high pressure flows of water, high/low temperatures, and interactions with chemicals, without breaking down.

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MILESTONE 2 (STAGE 2) – METRICS

Team ID:

Thurs-18

For your selected top three objectives fill out the table below with associated metrics (including units) for each objective.

Objective 1:	<p>Filtration Performance This objective checks how well the system actually cleans the water. We compare the water before and after filtration to see if it becomes clearer and more normal. If turbidity drops a lot and pH stays in a safe range, that means the filter is working.</p> <p>Metric:</p>
Unit/Metric:	<ul style="list-style-type: none"> • Turbidity before and after • pH before and after • Colour before and after • Odour rating before and after <p>Units:</p> <ul style="list-style-type: none"> • NTU (turbidity) • pH (Acidity) • Colour / Clarity • Odour: 1–10 rating scale

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Objective 2:	<p>Sustainable This objective checks if the design is environmentally friendly and not wasteful. A sustainable filter should last a long time, use low energy, and create minimal waste when it is used or replaced. The more reusable and low waste the system is, the better it scores here.</p>
Unit/Metric:	<p>Metric:</p> <ul style="list-style-type: none"> • Waste created per litre of clean water (organic waste or disposal mass) • Total amount of water it can treat before replacement (lifetime of filter) • % of materials that are reusable/recyclable <p>g/L (waste per litre treated)</p> <p>Units:</p> <ul style="list-style-type: none"> • Liters (amount of water it can filter) • % (reusable/recyclable content) •

Objective 3:	<p>Durability This objective checks how well the filter holds up over time without breaking or leaking. A durable design should be able to withstand repeated use, handling, and pressure without failing. If it lasts many cycles and doesn't leak, it meets this objective.</p>
Unit/Metric:	<p>Unit/Metric:</p> <ul style="list-style-type: none"> • Max load/force before cracking or leaking • Number of cycles survived (fill-drain, backwash, or assembly/disassembly) • Leak rate during a test • Drop test height survived without damage <p>N (force) or kPa (pressure rating)</p> <p>Units:</p> <ul style="list-style-type: none"> • cycles (count) • mL/min (leak rate) • m (drop height) •

MILESTONE 2 (STAGE 3) – REGULATIONS

Team ID:

Thurs-18

Based on your team’s assigned scenario, discuss regulations such as material acquisition, contaminant/waste standards, electricity standards, and optimal energy output.

Regulation 1:

Canada regulates plastic microbeads under CEPA. The government defines microbeads as plastic particles ≤ 5 mm, and the rules prohibit the manufacture, import, and sale of toiletries that contain plastic microbeads. [1], [2] This matters for filters because our scenario is about keeping plastics out of waterways, so our design choices should follow that same direction.

The regulation also states that we need to avoid using any filter media or parts that can shed plastic beads or plastic dust into the wastewater stream. [1]

The filter will concentrate microplastics into a solid waste stream, so we should treat captured plastics as controlled waste for collection and disposal rather than washing it back into the system. This supports compliance with the intent of microplastic control. [1], [2]

Regulation 2:

The Government of Canada introduced the Single-use Plastics Prohibition Regulations (SUPPR) as part of the broader goal of reducing plastic pollution and working toward zero plastic waste by 2030 [3]. The SUPPR prohibits the manufacture, import, and sale of six main single-use plastic categories, including checkout bags, cutlery, foodservice ware made from or containing certain problematic plastics, ring carriers, stir sticks, and straws (with limited exceptions for flexible straws for accessibility) [3].

This matters for our scenario because it shows Canada is moving toward stopping plastics from reaching the environment in the first place, not just cleaning them up after [3]. For our filtration work, it supports designing systems that reduce plastic release and also making sure the filter does not create new plastic pollution through shedding or poor disposal of captured material [3].

Regulation 3:

Health Canada, alongside the collaboration of the, Federal Provincial Territorial Committee on Drinking Water, has established a set of regulations to keep water at a specific standard for both safety and health concerns [4].

These parameters cover guidelines such as the limit of “Chloral hydrate in drinking water (2008),” which specifies keeping exposure levels of chloral hydrate below a certain concentration that would cause serious health effects, 0.2mg/L and above causing concern [4]. Other parameters covered underneath the following Guidance

Documents to ensure water is meeting an acceptable criterion to be deemed clean, is the Monitoring of Biological Stability of Drinking Water in Distribution Systems (2022) [4]. The parameter highlights the mandatory importance of minimizing potential risks to consumers by studying turbidity and the pressure of water, as well as to assess routinely for bacterial indicators such as E. coli and coliforms [5].

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Regulation 4:

Health Canada’s drinking water guideline summary table 1 sets treatment goals for key pathogens, including a minimum 3-log removal and/or inactivation for *Giardia* and *Cryptosporidium*, and a minimum 4-log reduction for enteric viruses [4]. It also emphasizes a source-to-tap approach (source protection, adequate treatment, and a well-maintained system), and states that disinfection is a critical barrier for reducing risk [4].

Even if a filter’s main job is particle removal, the filter still has to fit into a system that meets these pathogen reduction goals. So filtration should support the overall treatment train, not weaken it, and it should be treated as part of the multi-barrier safety approach [4].

Filtration should be evaluated not only by “looks clearer,” but by whether it helps the overall system meet treatment goals it shouldn’t create bypass pathways would reduce the effectiveness of the treatment [4].

If the system includes disinfection, the filtration step should make disinfection more effective by keeping water quality consistent, since Health Canada treats disinfection as one of the main safety barriers [4].

This also means we should track simple monitoring targets over time (not just one test) to show the system stays reliable and keeps risk low, because the guideline emphasizes ongoing treatment performance and risk control [4].

References (adhere to IEEE notation)

***references do not count toward word count / page limit

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Based on your team’s scenario, evaluate, and suggest sustainable practices, providing clear examples and justification.

1. Waste Management:

Key problem for sustainable practices is disposing and managing of the waste removed from the filter. Improper disposal of microplastic waste can present a large risk to both marine life and humans and animals on land. These risks include ingesting microplastic waste, which can introduce various health concerns. These risks highlight the importance of finding and adopting sustainable practices in terms of waste disposal and management.

After backwashing or filter cleaning, microplastics can be disposed of in controlled systems, which minimizes the risks of microplastics going into soil and water. While landfilling is not a permanent solution, controlled disposal is one of more practical options for large scale disposal, being used to dispose of about 75% of microplastic waste [1]. While it is not a common solution, 10% of microplastic waste is recycled [1]. Increasing the amount of waste that is recycled would be a key way to make the filtration process more sustainable. Currently, microplastic waste can be recycled and used to produce various useful materials. Waste can be used to produce material used for 3D printing, battery anodes, waxes, and even fuels or gasses [2]. To promote sustainability with microplastic filtration processes, it is important to focus on researching ways to increase the quality of recycled waste and find new ways to recycle waste. From a regulatory and sustainability perspective, engineers are expected to prevent secondary pollution rather than shift environmental harm elsewhere. Managing microplastic waste through controlled disposal and increased recycling aligns with Canada’s broader environmental protection goals and reduces the risk of non-compliance with pollution prevention principles.

2. Filter Lifespan

Long life of a filtration system improves sustainability by reducing the frequency of material replacements. Granular media filters, such as sand systems are durable because the filtration media does not easily break down and can withstand repeated loading and cleaning cycles without losing effectiveness [3]. Long life can be

improved through backwashing, which allows filters to be cleaned and reused instead of replaced after use. Backwashing would reduce material waste and need for manufacturing which would make the system more sustainable and more cost effective [4].

For a filter to be long lasting it does not only depend on the cleaning methods used, but the material the filter is made from. Filters must withstand continuous flow, repeated cleaning, and exposure to wastewater without degrading. Using durable and renewable materials can improve the long-term sustainability of microplastic filtration systems. Bio based and renewable polymers has become a interest in filtration system [5]. Designing filters with longer lifespans and durable materials supports sustainability goals by reducing material consumption, waste generation, and manufacturing demand over time. These choices align with regulatory expectations that engineered systems minimize environmental impact while maintaining reliable long-term performance.

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MILESTONE 3 (TEAM) – COVER PAGE

Team
Number:

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Shayan Siddiqui	Siddm47
Hannah Ross	Rossh14
Karanveer Dhillon	Dhillk27
Jasmine Kalsi	Kalsij8
Andrew Jo	Joh8

Any student that is ***not*** present for their scheduled Design Studio session will not be given credit for completion of the worksheet and may be subject to a 10% deduction to their P-2 grade.

MILESTONE 3 (STAGE 1) – PROBLEM DEFINITION

Team ID:

Thurs-18

1. Copy-and-paste the title of your *assigned* scenario in the space below.

Scenario 2: Microplastic Filtration for Large-Scale Plant

2. MPI selection

- List one primary objective and one secondary objective in the table below
- For each objective, list the MPI
- Write a short justification for your selected objectives

	Objective	MPI- stiffness	MPI- strength	Justification for this objective
Primary	Mass	MPI = $\sqrt{(E)}/\rho$	MPI = $(\sigma y^{2/3})/\rho$	Minimizing mass is the primary objective because a lighter filtration system reduces material usage, lowers transportation cost and installation costs.
Secondary	Production Energy	MPI = $\sqrt{(E)}/H_m\rho$	MPI = $(\sigma y^{2/3})/H_m\rho$	Minimizing production energy lowers environmental impact and cost of manufacturing the filtration system. Using lower energy material supports sustainability while maintaining sufficient durability for long term operation

ENGINEER 1P13 – Project Two: *Wastewater Filtration Challenge*

<p>Property Limit</p>	<p>Water (Fresh) AND Recycle AND Biodegradable</p>	<p>N/A</p>	<p>N/A</p>	<p>Our given scenario is about microplastics. The first limit we chose was water (fresh) this was a mandatory filter since we need our material to be excellent in freshwater conditions.</p> <p>The second limit was recyclable, since our goal is to eliminate microplastics we need the material that we're working with to be recyclable so that we don't add to the issue.</p> <p>The last limit was biodegradable because key material limits on contributing to microplastic is low biodegradable of plastics, instead of decomposing these materials fragment micro particles in the environment for decades.</p>
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ENGINEER 1P13 – Project Two: *Wastewater Filtration Challenge*

Milestone 4 (Team) – Cover Page

Team Thurs-18
Number:

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Shayan Siddiqui	Siddm47
Hannah Ross	Rossh14
Karanveer Dhillon	Dhillk27
Jasmine Kalsi	Kalsij8
Andrew Jo	Joh8

Any student that is ***not*** present for their scheduled Design Studio session will not be given credit for completion of the worksheet and may be subject to a 10% deduction to their P-2 grade.

MILESTONE 4 (STAGE 1) – MATERIAL ALTERNATIVES AND FINAL SELECTION WORKSHEET

As a team, fill out the table below and narrow down the possible materials for your assigned scenario by choosing the 3 materials which showed up the most across all MPI rankings in the table above.

Team Member: ShayanSiddiqui

Material Ranking					
	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
<i>Assigned</i> MPI: $MPI = \sqrt{(E)/Hmp}$	Sisal Fiber	CoirFiber	Ceramic Foam	UHMWPE Fiber (Spectra, Dyneema)	RamieFiber

Team Member: HannahRoss

Material Ranking					
	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
<i>Assigned</i> MPI: $MPI = (\sigma y^{2/3})/\rho$	UHMWPE Fiber (Spectra, Dyneema)	Polyarylate fiber (Vectran)	CarbonFiber (HS Carbon)	CarbonFiber (HM carbon)	Polyamide Fiber (Nylon-6)

Team Member: Karanveer Dhillon

Material Ranking					
	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
<i>Assigned</i> MPI: $MPI = (\sigma y^{2/3})/\rho$	UHMWPE Fiber (Spectra, Dyneema)	Polyarylate Fiber (Vectran)	Carbon Fiber (HS Carbon)	Carbon Fiber (HM Carbon)	Polyamide Fiber (Nylon-6)

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Team Member: AndrewJo

Material Ranking					
	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
<i>Assigned</i> <i>MPI:</i> $MPI = \sqrt{(E) / \rho}$	Ramie Fiber	Sisal Fiber	Coir Fiber	Antler	Cellulose acetate (CA)

Team Member: JasmineKalsi

Material Ranking					
	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
<i>Assigned</i> <i>MPI:</i> $(\sigma_y^{2/3}) / H_m \rho$	Sisal Fiber	Coir Fiber	Ramie Fiber	Antler	Cellulose Acetate (CA)

Which materials show up the most?

Sisal Fiber: 3 Coir Fiber: 3 Avrg Rank: 2.33 Ramie Fiber: 3 Avrg Rank: 3 UHMWPE Fiber (Spectra, Dyneema): 3 Avrg Rank: 2 Antler: 2 Cellulose Acetate (CA): 2 Carbon Fiber (CS Carbon): 2 Carbon Fiber (HS Carbon): 2

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- Remember to save the datasheets of all 3 material finalists

Narrowing Material Candidate List to 3 Finalists	
<i>Material Finalist 1:</i>	Ramie Fiber
<i>Material Finalist 2:</i>	UHMWPE Fiber
<i>Material Finalist 3:</i>	Coir Fiber

As a team, compare material alternatives and make a final selection based on a simple decision matrix.

- As a team, consider *at least* 3 additional criteria that are relevant to your assigned scenario and discuss your 3 materials finalists for each criterion
- Feel free to pause at this stage and do some quick research on the materials finalists
 - You may refer to the material finalists’ datasheets for any relevant information that will enable your discussion.

Additional Criteria	Possible question prompt
Ease of access to material	Is the material easy to source in the country, are there tariffs due to international trade policy?
Chemical, weather and/or corrosion resistance	Will the material degrade over time (e.g. due to chemical resistance, corrosion resistance, fatigue resistance)?
Ease of maintenance	Consider maintenance if the part got damaged. Based on the material, is it easy to fix or will the entire part need replacement?

- To help you come up with your additional criteria, below are some question prompts that you may consider. Please note that you are not limited to these suggestions, and they may or may not be relevant to your assigned scenario
- Remember that:
- Your MPI ranking takes into consideration both material and mechanical properties relevant to the objectives of your assigned scenario.

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- Your additional considerations should not include previously evaluated objectives e.g. If minimizing the carbon footprint was either your primary or secondary objective, then it should not be an additional criterion

→ Compare the material alternatives and make a final selection based on a simple decision matrix

- Choose a range for the score (e.g., 1 to 5) for each material on each criterion. Give each material a score based on how successfully it meets each criterion. The higher the score, the better the material is for that criterion.
- Add additional rows as needed.
- Add up the total score for each material alternative.

Simple Decision Matrix – Template			
	<i>Material 1: Ramie Fiber</i>	<i>Material 2: Coir Fiber</i>	<i>Material 3: UHMWPE Fiber</i>
Ease of maintenance	Score: 3	Score: 4	Score: 5
Chemical, weather and/or corrosion resistance	Score: 3	Score: 4	Score: 5
Ease of access to material	Score: 3	Score: 5	Score: 3
<i>End of life Impact</i>	Score: 5	Score:5	Score:2
<i>Low cost of production</i>	Score: 3	Score:5	Score:2
<i>Environmental footprint</i>	Score: 4	Score: 5	Score:1
<i>Structural stability</i>	Score: 3	Score: 4	Score:5
TO TAL	24	32	23

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→ State your chosen material and justify your final selection

Justification	
Chosen Material:	Coir fiber
<p>Within our decision matrix, each factor was graded on a scale of 1-5. 1 being the lowest, 5 being the highest. Coir fiber consistently ranked around a 4 or 5, making it the most suitable material for our filter fiber due to its low production cost, long-term durability, ease of access, and positive end-of-life impact. Being able to easily source the material makes it a reasonable choice.</p> <p>Coir fiber is strong and can withstand weather and chemical damage, helping ensure a long service life and reducing the frequency of repairs or replacements. Coir fiber is known for having a high concentration of lignin, which is a polymer that provides stability in terms of physical structure as it increases wear resistance, as well as decay rates both biologically and physically [1]. Lignin also allows the fiber to withstand long-term exposure to moist environments, such as water submersion, which is very important for our design [2]. On our decision matrix, these properties heavily impacted our final material decision.</p> <p>Along with this, coir fiber has a high ease of maintenance, so when repairs are necessary, they are not overly expensive or environmentally damaging. Coir fiber is organic and can often be recycled, allowing it to have a low end-of-life impact and a low environmental footprint [3]. Coir fibers are harvested and manufactured in environmentally friendly ways, which increases sustainability and lowers even of life impact [4].</p> <p>Coir fiber’s strong performance in the decision matrix aligns with the results of the MPI analysis [5]. The material performance maximized stiffness and strength relative to density. Coir appeared most frequently selected materials across our MPI ranking, indicating that it provides an effective balance of mechanical efficiency and low weight. While its absolute strength and stiffness are lower than high-performance materials such as UHMWPE, its specific properties are good for loading conditions of a microplastic filtration system. When combined with its advantages of cost, availability, durability in wet environments and low environment impact, both MPI results and decision matrix support coir as the appropriate material [6]</p> <p>Sources:</p> <p>[1] “What Is Coir Fiber? Properties and Engineering Uses,” Engineer Fix. Accessed: Feb. 12, 2026. [Online]. Available: https://engineerfix.com/what-is-coir-fiber-properties-and-engineering-uses/(accessed Feb. 12, 2026).</p> <p>[2] “What Is Coir Fiber and How Is It Used?,” Biology Insights. Accessed: Feb. 12, 2026. [Online]. Available: https://biologyinsights.com/what-is-coir-fiber-and-how-is-it-used/(accessed Feb. 12, 2026).</p> <p>[</p>	

ENGINEER 1P13 – Project Two: *Wastewater Filtration Challenge*

[3] D. Verma, P. Gope, and M.K.Maheshwari, “Coir Fiber Reinforcement and Application in Polymer Composites: A Review,” *Journal of Materials and Environmental Science*, vol. 4, pp. 263–276, Oct. 2012. (accessed Feb. 12, 2026).

[4] “Manufacturing and design of coir fiber composites,” in *Coir Fiber and its Composites*, Woodhead Publishing, 2022, pp. 133–174. doi: [10.1016/B978-0-443-15186-6.00077-1](https://doi.org/10.1016/B978-0-443-15186-6.00077-1). (accessed Feb. 12, 2026).

[5] S. P. Nandan *et al.*, “Coir based biofiltration system for enhanced removal of water pollutants,” *Next Sustainability*, vol. 4, p. 100045, Jan. 2024, doi: [10.1016/j.nxsust.2024.100045](https://doi.org/10.1016/j.nxsust.2024.100045). (accessed Feb. 12, 2026).

[6] Admin, “The benefits of using coir fiber for filtration: A sustainable solution for Clean Water,” Your Number 1 Source for All Things from Indonesia, <https://globalfajar.com/the-benefits-of-using-coir-fiber-for-filtration-a-sustainable-solution-for-clean-water/> (accessed Feb. 12, 2026).

Summary of Chosen Material’s Properties

Material Name: Coir Fiber	Average value
Young’s modulus (GPa):	5
Yield strength (MPa):	125
Tensile strength (MPa):	165
Density (kg/m ³):	1185
Embodiment energy (MJ/kg)	10.8
Specific carbon footprint (kg/kg)	0.869
Number of Pores	1174.6
Pore Size (m)	1.8×10^{-5}

MILESTONE 4 (STAGE 2) – POROSITY CONDITIONS

Below, provide step-by-step calculations determining the porosity of your chosen material and its adjusted yield strength / elastic modulus. State all your assumptions and reference the project module for any values related to your scenario.

Porosity	0.2275
Number of Micro Pores	1174.6
Micro Pore Diameter (mm)	0.018
Micro Pore Length (mm)	1.7 3.1
Central Pore Diameter (mm)	20 6.50
Filter Fiber Length (cm)	
Filter Fiber Diameter (mm)	

Porosity Condition Calculations

Given for scenario 2 -
 Length (cm) = 20 cm = 200 mm
 Diameter (mm) = 6.50 mm
 Contaminant Size Radius = 10-20 nm = 0.01 mm
 Contaminant Size Diameter = 0.01 mm $\times 2 = 0.02$ mm

① Diameter of Micropore
 $r_{mc} < D_{contaminant}$
 $0.018 \text{ mm} < 0.02 \text{ mm}$

② Volume of singular Micropore
 $V = \pi r^2 h$
 $V = \pi (0.009)^2 (1.7)$
 $V = 4.32 \times 10^{-4} \text{ mm}^3$
 DMC = 0.018 mm
 Radius mc = 0.009 mm

③ Length of Micropore
 1/2 of fiber Diameter
 $L = 6.50 / 2 = 3.25 \text{ mm}$
 We made 10 more including smaller
 for air flow
 Length of Micropore = 1.7 mm

④ Diameter of Central pore
 Dpore $>$ Diameter hole
 $6.50 >$ Diameter pore
 Diameter = 2 (Micropore) + Diameter pore
 Dcp = Dp = 2Lmc
 Dcp = 6.50 - 2(1.7)
 Dcp = 3.1 mm

⑤ Volume of Central Pore
 $V = \pi r^2 h$
 $V = \pi (1.55)^2 (200)$
 $V = 1509.4 \text{ mm}^3$
 Dcp = 3.1 mm
 Radius cp = 1.55 mm
 Some length as
 filter

⑥ Volume of Filter Fiber
 $V = \pi r^2 h$
 $V = \pi (3.25)^2 (200)$
 $V = 6636.61 \text{ mm}^3$
 Diameter = 6.50 mm
 Radius = 3.25 mm

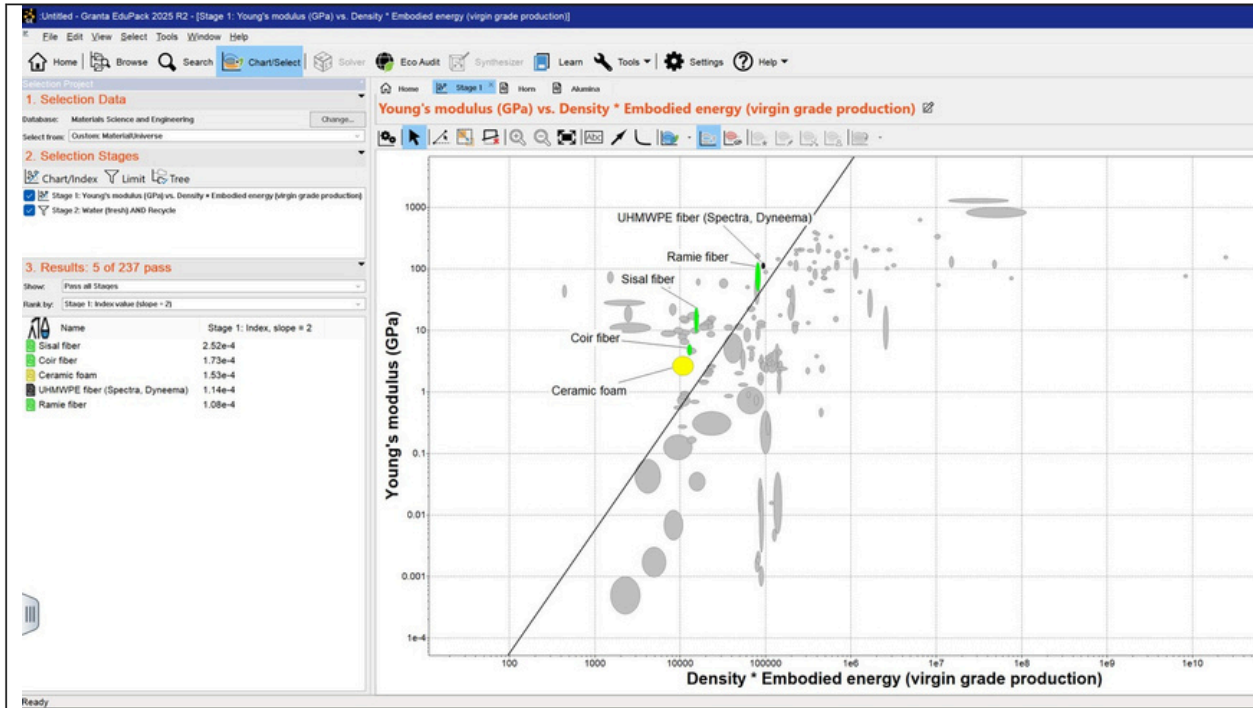
⑦ Micro Pore #
 \rightarrow We chose 1174.6 because
 of the volume of fiber is
 comparison to the cube volume
 of the micro pores and accounting
 for space!

⑧ Porosity \rightarrow
 $P = \frac{(\text{Micro pore} \# \cdot V \text{ of singular Micropore}) + (V \text{ of Central Pore})}{V \text{ of Filter Fiber}}$
 $P = \frac{(1174.6) \cdot (4.32 \times 10^{-4}) + (1509.4)}{6636.61}$
 $P = 0.2275$

⑨ Young Modulus Calculation
 $E = E_0(1-p)^2$
 $E = 0(1-0.2275)^2$
 $E = 2.98 \text{ (kPa or MPa)}$

MILESTONE 4 (STAGE 3) – EFFECTS OF POROUS CONDITIONS

Based on the porosity from Stage 2, is your selected material still a viable option as a wastewater treatment filter? Explain. Provide a graphical justification using a notated Ashby chart from Granta.



Coir fiber is still a viable option for our microplastic filtration scenario because the porosity-adjusted Young's modulus is 2.98 GPa, which still falls within the typical stiffness range reported for coir fiber (about 1 to 10 GPa). Even after accounting for porosity, the adjusted stiffness stays above our MPI threshold line on the Ashby chart, meaning the material should still be stiff enough to hold its shape and handle flow and cleaning without collapsing. This matters for microplastic filtration because the filter needs to stay structurally stable so pore pathways do not widen or deform and let microplastics bypass the system.

MILESTONE 5 (TEAM) – COVER PAGE

Team

Thurs-18

Number:

--

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Shayan Siddiqui	Siddm47
Hannah Ross	Rossh14
Karanveer Dhillon	Dhillk27
Jasmine Kalsi	Kalsij8
Andrew Jo	Joh8

Any student that is ***not*** present for their scheduled Lab A session will not be given credit for completion of the worksheet and may be subject to a 10% deduction to their P-2 grade.

MILESTONE 5 (STAGE 2) – LIFE CYCLE INVENTORY

As a team, fill out the table with the corresponding material information and processes for your life cycle inventory. Provide references for the information and list them below.

Material	Mass(kg)	Process	EndofLife
Coir Fiber	9.151	N/A	Reuse
Ramie Fiber	11.5	N/A	Reuse
UHMWPEFiber	7.46	N/A	Recycle

mass calculations

Filter Fiber w/ Pores Volume = (Filter Fiber Volume) - (Volume of all Pores)
 $= 16636.61 \text{ mm}^3 - [(4.88 \times 10^{-4}) \times (174.6) + 1209.44]$

Filter Fiber w/ Pore V = 1526.70 mm^3

* # of Filter Fiber = 1500

Filter Volume = (Filter Fiber with Pore V) * (# of Filter Fiber)
 $= (1526.70 \text{ mm}^3) (1500)$
 $= 2290050 \text{ mm}^3$

Coir Fiber

$m = d \times V$
 $m = (1.19 \times 10^{-3} \text{ g/mm}^3) (2290050 \text{ mm}^3)$
 $m = 2725.06 \text{ g}$
 $m = 2.725 \text{ kg}$

$d = 1.19 \times 10^{-3} \text{ g/mm}^3$
 $d = 1.19 \times 10^{-3} \frac{\text{kg}}{\text{mm}^3} \cdot \frac{1 \text{ m}^3}{1 \times 10^9 \text{ mm}^3} \times \frac{1000 \text{ g}}{1 \text{ kg}}$
 $d = 1.19 \times 10^{-3} \text{ g/mm}^3$

Ramie Fiber

$m = d \times V$
 $m = (1.5 \times 10^{-3} \text{ g/mm}^3) (2290050 \text{ mm}^3)$
 $m = 3435.08 \text{ g}$
 $m = 3.435 \text{ kg}$

$d = 1.5 \times 10^{-3} \text{ kg/m}^3$
 $d = 1.5 \times 10^{-3} \text{ g/mm}^3$

UHMWPE Fiber

$m = d \times V$
 $m = (9.7 \times 10^{-4} \text{ g/mm}^3) (2290050 \text{ mm}^3)$
 $m = 2219.35 \text{ g}$
 $m = 2.219 \text{ kg}$

$d = 970 \text{ kg/m}^3$
 $d = 9.7 \times 10^{-4} \text{ g/mm}^3$

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References

[1] journal.tex, “Coir Fiber: Properties, Production Process and Advantages,” The Textile Journal. Accessed: Feb. 26, 2026. [Online]. Available: <https://thetextilejournal.com/coir-fiber-properties-production-process-and-advantages/>

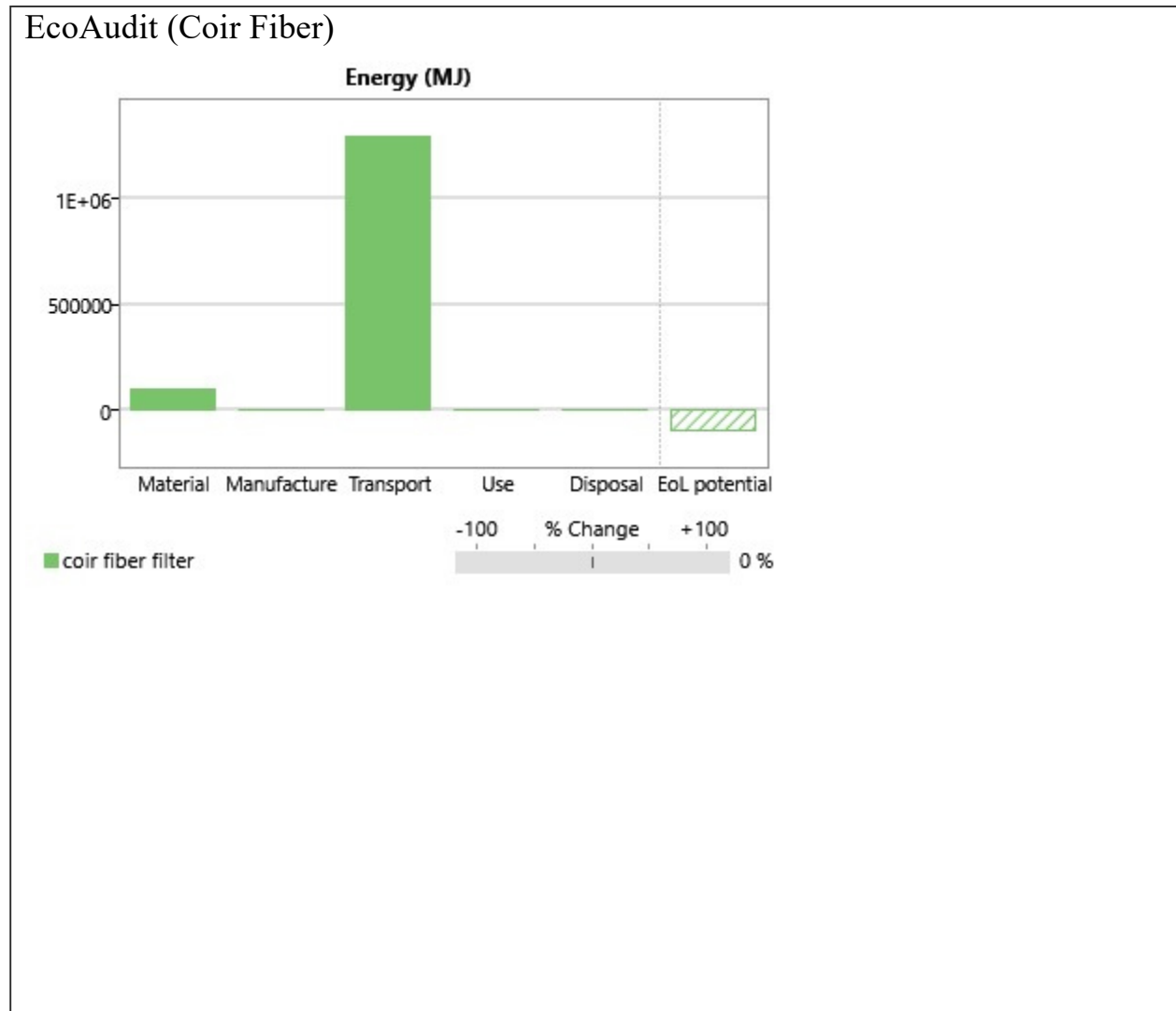
[2] “Comparing Lifespans: The Ultimate Water Filter Chart - Water Filter Stuff.” Accessed: Feb. 26, 2026. [Online]. Available: <https://waterfilterstuff.com/comparing-lifespans-the-ultimate-water-filter-chart/>

[3] “Advanced recycling offers sustainable end-of-life solution for UHMW-PE | Sustainable Plastics.” Accessed: Feb. 26, 2026. [Online]. Available: <https://prod.sustainableplastics.com/news/advanced-recycling-offers-sustainable-end-life-solution-uhmw-pe>

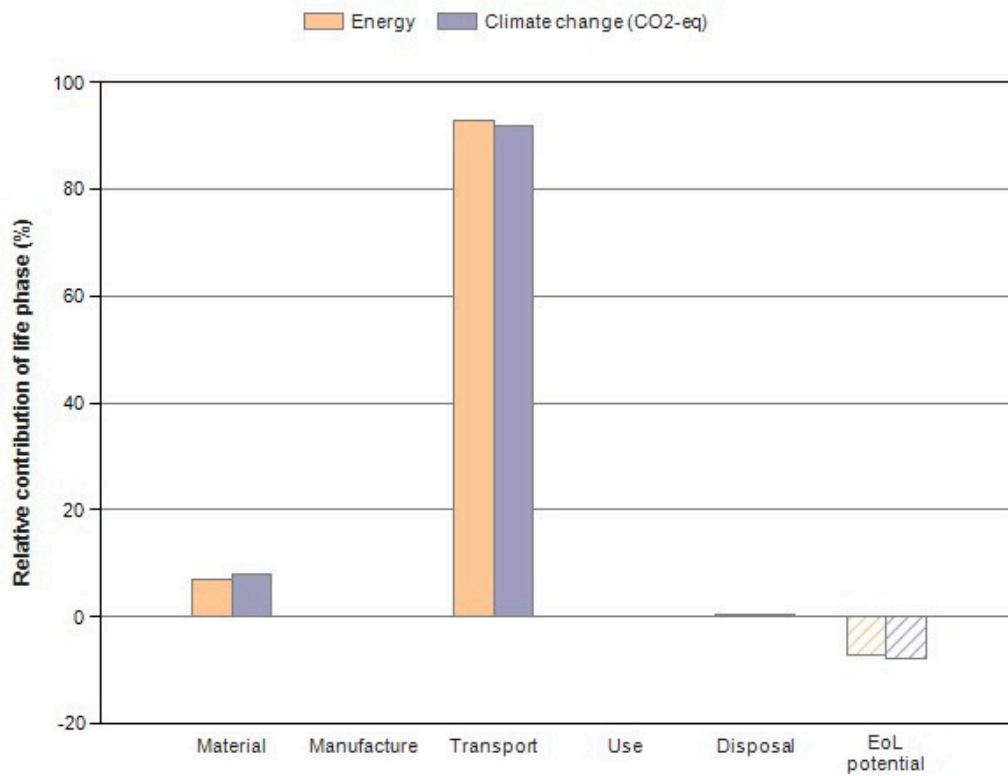
[4] “How Long Do Water Filters Last? (By Type + Signs to Replace).” Accessed: Feb. 26, 2026. [Online]. Available: <https://qualitywaterlab.com/info/how-long-do-water-filters-last/>

MILESTONE 5 (STAGE 3) – ECO AUDITS

As a team, provide a screenshot of your results from performing the Granta Eco-Audit for all three of your top material choices. Include the summary chart as well as the tabular information for the energy cost and CO2 footprint of each material.



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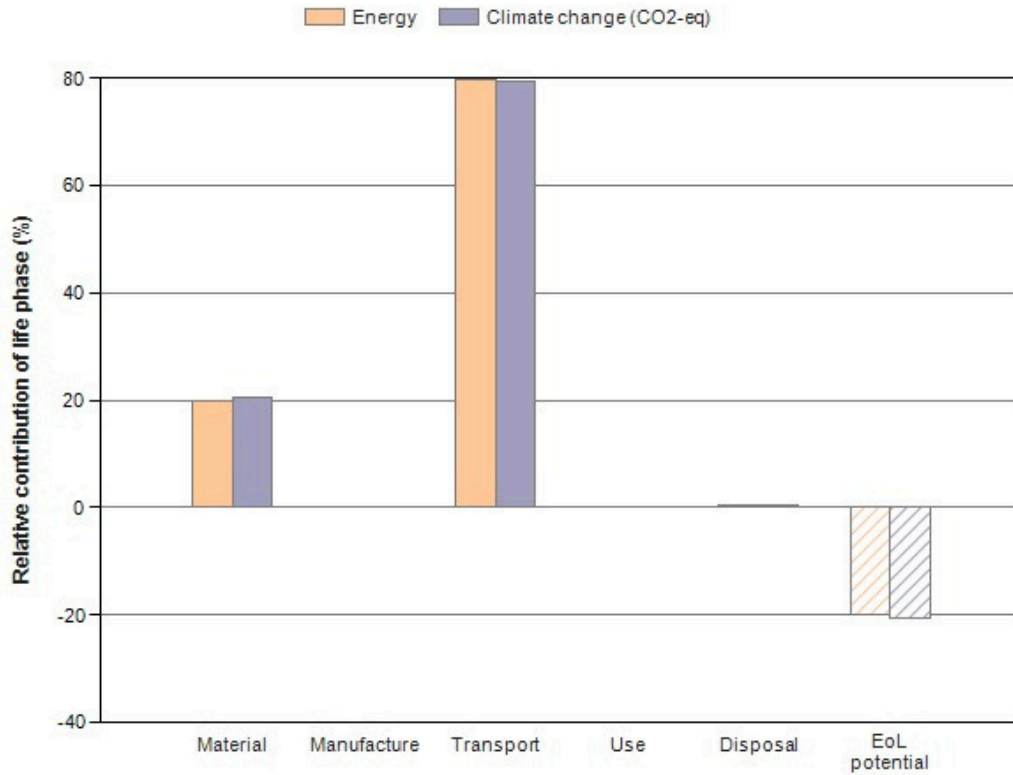


[Energy details](#)

[Climate change \(CO2-eq\) details](#)

Phase	Energy (MJ)	Energy (%)	Climate change (CO2-eq) (kg)	Climate change (CO2-eq) (%)
Material	9.87e+04	7.1	7.94e+03	8.0
Manufacture	0	0.0	0	0.0
Transport	1.3e+06	92.8	9.17e+04	91.9
Use	0	0.0	0	0.0
Disposal	1.83e+03	0.1	128	0.1
Total (for first life)	1.4e+06	100	9.98e+04	100
End of life potential	-9.87e+04		-7.94e+03	

Eco-Audit (Ramie Fiber)

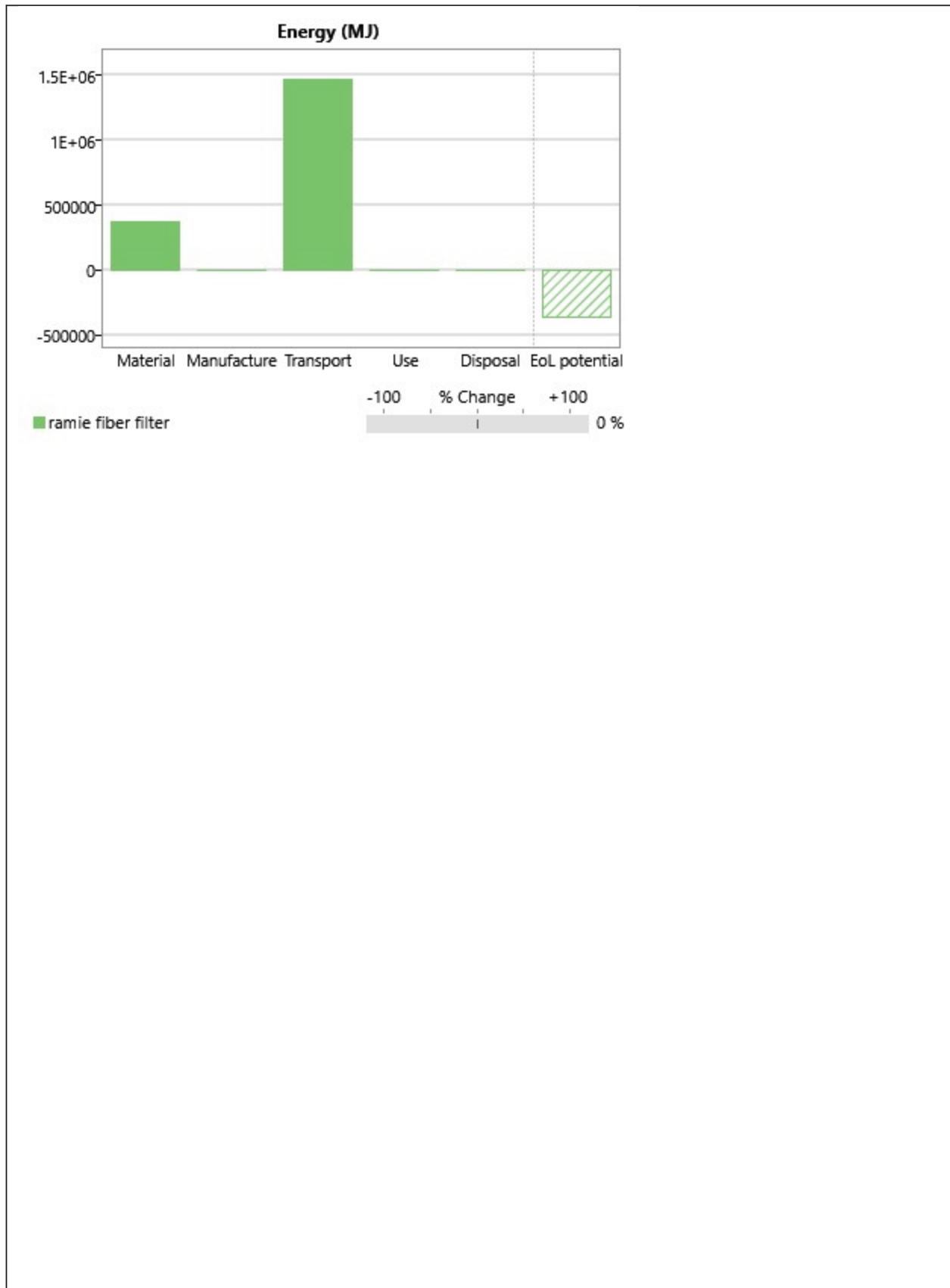


[Energy details](#)

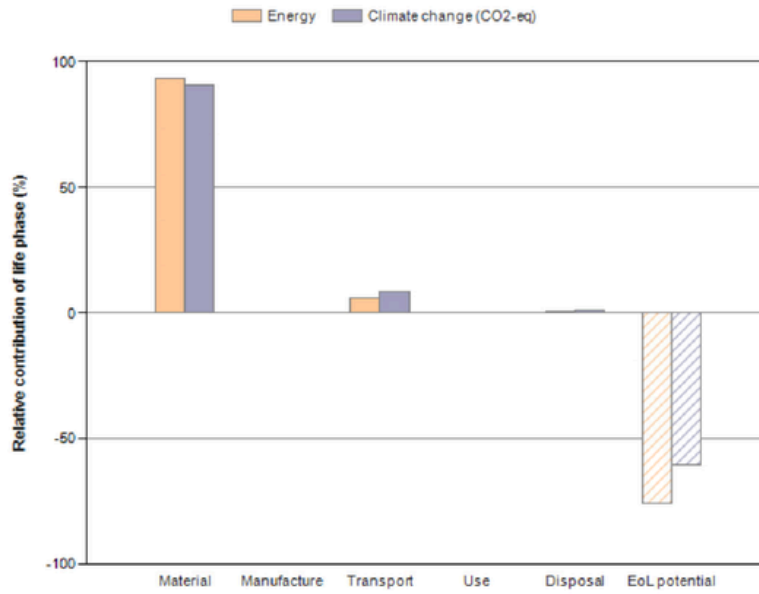
[Climate change \(CO2-eq\) details](#)

Phase	Energy (MJ)	Energy (%)	Climate change (CO2-eq) (kg)	Climate change (CO2-eq) (%)
Material	3.68e+05	19.9	2.7e+04	20.5
Manufacture	0	0.0	0	0.0
Transport	1.47e+06	79.9	1.04e+05	79.4
Use	0	0.0	0	0.0
Disposal	2.3e+03	0.1	161	0.1
Total (for first life)	1.84e+06	100	1.32e+05	100
End of life potential	-3.68e+05		-2.7e+04	

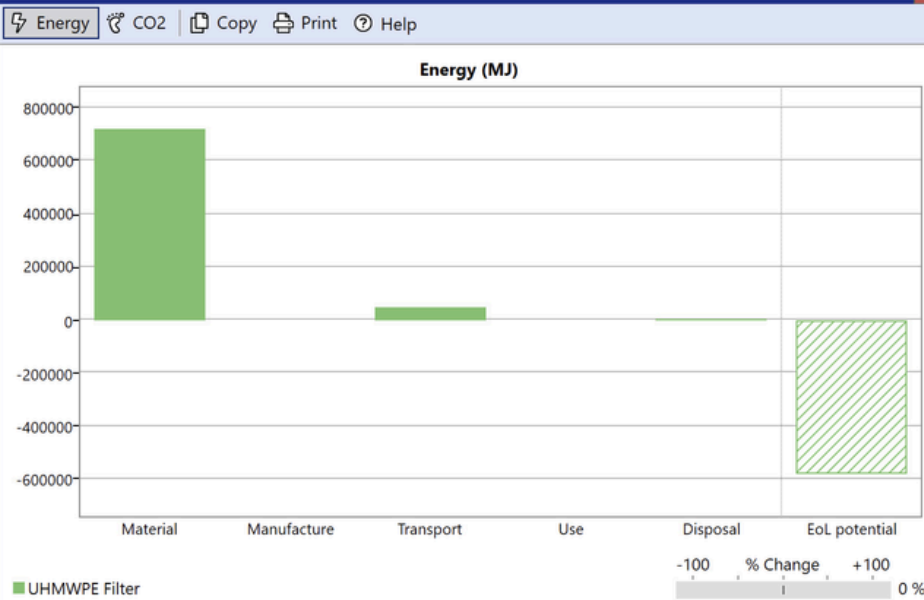
ENGINEER 1P13 – Project Two: *Wastewater Filtration Challenge*



Eco-Audit (UHMWPE Fiber)



Phase	Energy (MJ)	Energy (%)	Climate change (CO2-eq) (kg)	Climate change (CO2-eq) (%)
Material	7.18e+05	93.3	3.38e+04	90.7
Manufacture	0	0.0	0	0.0
Transport	4.66e+04	6.1	3.11e+03	8.3
Use	0	0.0	0	0.0
Disposal	5.22e+03	0.7	366	1.0
Total (for first life)	7.7e+05	100	3.73e+04	100
End of life potential	-5.82e+05		-2.27e+04	



MILESTONE 5 (STAGE 4) – DISCUSSION OF ECO AUDIT IMPLICATIONS

As a team, discuss the implications of the results from the Eco-Audit of all three materials. What do you conclude? Be sure to reference any appropriate values from the energy cost and CO2 footprint table.

The results from the eco-audits for each of our three materials provides information regarding energy usage within material, transportation, and end of life potential. In each of the graphs, the energy usage within manufacturing is very low. This is since there are no available processes within Granta, so manufacturing is not being accurately calculated, although in reality, there would be a manufacturing process for the production of our filter. The largest portions of energy usage were present within the transportation and material stages. When comparing the first two (ramie and coir fiber), ramie fiber used lower energy in transport than coir fiber. They are both very high compared to UHMWPE fiber, because both are transported primarily by air, while UHMWPE fiber is transported only by land. Ramie fiber transport has a shorter flight distance than coir fiber, resulting in less energy used in this area.

Each of our materials have a negative end of life value on the graph, which implies a positive end of life impact. This is because all of our materials can be either reused or recycled, which allows for energy to be recovered.

When looking at the graphs, UHMWPE fiber appears to be the best material for our filter, although it is not necessarily the most practical material for our application. UHMWPE fiber is typically used for more heavy-duty applications, such as marine rope, fishing nets, and cut-resistant clothing [1]. These properties are not ideal for microplastic filtration.

Volume of filter is impacted by the mass of the fiber as mass is equal to density * volume. Porosity is calculated by the volume of filter so if the mass of materials decreases, then porosity will increase due to high permeability.

[1]

[1] “The high modulus polyethylene or ultra high modulus weight polyethylene UHMWPE fibers, yarns, fabrics, and technical textiles.” Accessed: Feb. 26, 2026. [Online]. Available: <https://imattec.com/uhmwpe.php>

MILESTONE 1 (INDIVIDUAL) – COVER PAGE

Team
Number:

Thurs- 18

Please list full name and MacID.

Full Name:	MacID:
Shayan Siddiqui	Siddm47

MILESTONE 1 (STAGE 1) – FILTRATION TECHNIQUES RESEARCH

Team ID:

Thurs-18

Stage 1: Filtration Techniques Research

Individually, perform research on at least 2–3 filtration techniques, citing at least 5–10 credible sources. **NOTE:** One of the filtration techniques **MUST** be **mechanical filtration**, as the research will be used in future milestones.

Technique 1: Granular Media Filtration

Granular media filtration is basically the “sand filter” method. Water flows through a bed of media (usually sand, sometimes anthracite too), and the small spaces between the grains trap dirt and suspended particles, so the water looks way less cloudy [1]. This is considered mechanical filtration because it is mostly physical removal, since the filter is catching particles and not changing them chemically [2]. It can remove particles in a few ways. Bigger particles get blocked quickly, and smaller particles can still get captured because they hit the media grains and stick while moving through the bed [3].

This technique is usually used as part of a full treatment process, not as the only step. A lot of systems do coagulation and settling before filtration, so tiny particles clump together and become easier to filter out [2]. Over time the filter gets loaded up, and then it becomes harder for water to pass through, which is when you need to clean it [3]. The most common cleaning method is backwashing, where you reverse the flow upward to lift the bed and flush out the trapped solids [4]. The backwashing tech brief also explains that operators use turbidity and headloss as main signs for when it is time to backwash, because that shows how clogged the filter is and how clean the filtered water is [4]. Overall, granular media filtration is a strong base step for turbidity and suspended solids, but it will not remove most dissolved contaminants by itself [2].

Technique 2: Granular activated carbon (GAC)

Granular activated carbon is also a bed that water passes through, but it is mainly for dissolved contaminants, not just dirt. The key idea is adsorption, which means dissolved chemicals stick to the carbon surface and pores as water flows through [5]. The EPA describes GAC as a proven technology with high removal for many VOCs, and it is commonly used to help with taste and odour problems too [2]. In my opinion, it is best as a polishing step after mechanical filtration, because the sand filter handles the dirt first and then the carbon focuses on dissolved organics [2].

GAC does not last forever though. The carbon fills up over time, and you can get breakthrough where removal drops and contaminants start passing through more easily [2]. That is why systems need a plan for replacement or regeneration [5]. The Water Quality Association fact sheet also points out that carbon quality matters, like durability and indicators like iodine number, since you want carbon that performs well and does not break down easily [5]. So overall, GAC is a good choice when the goal is removing dissolved organic contaminants and improving taste and smell, but it needs maintenance planning [5].

Technique 3: ION Exchange

Ion exchange is mainly for dissolved ions, so it targets a different problem than sand filtration. Water flows through resin beads, and the resin can swap ions in the water with ions on the resin [2]. For nitrate removal, nitrate gets captured onto the resin as the water passes through [6]. This matters because a mechanical sand filter is not designed to remove dissolved ions like nitrate, so ion exchange is used when nitrate is the real issue [6].

A big thing with ion exchange is that the resin has a capacity limit. After some time, the resin becomes exhausted and needs regeneration or replacement [6]. Health Canada's nitrate and nitrite technical document also explains that monitoring matters, especially around times when the unit is close to regeneration, since performance changes across the cycle [6]. The downside is that regeneration can create a waste stream that needs proper handling, so it is effective, but not "set it and forget it" [2], [6].

Citations:

[1] Ontario Ministry of Health, “Treatment Options; Small drinking water system (factsheet),” Government of Ontario, Feb. 13, 2024. [Online]. Available: <https://www.ontario.ca/files/2024-02/moh-sdws-factsheet-treatment-options-en-2024-02-13.pdf>. [Accessed: Jan. 22, 2026].

[2] U.S. Environmental Protection Agency, “Overview of Drinking Water Treatment Technologies,” Mar. 28, 2025. [Online]. Available: <https://www.epa.gov/sdwa/overview-drinking-water-treatment-technologies>. [Accessed: Jan. 22, 2026].

[3] Environmental Protection Agency (Ireland), Water Treatment Manual: Filtration, 2020. [Online]. Available: <https://www.epa.ie/publications/compliance--enforcement/drinking-water/advice--guidance/EPA-Water-Filtration-Manual.pdf> [Accessed: Jan. 22, 2026].

[4] Z. Satterfield, P.E., “Filter Backwashing,” National Environmental Services Center, Tech Brief, vol. 5, no. 3, Fall 2005. [Online]. Available: <https://actat.wvu.edu/files/d/638db309-5274-42c9-a8c3-7f8be496c607/filter-backwashing.pdf>. [Accessed: Jan. 22, 2026].

[5] Water Quality Association, “Granular Activated Carbon (GAC) Fact Sheet,” 2016. [Online]. Available: https://wqa.org/wp-content/uploads/2022/09/2016_GAC.pdf. [Accessed: Jan. 22, 2026].

[6] Health Canada, Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Nitrate and Nitrite, Jun. 2013. [Online]. Available: <https://healthycanadians.gc.ca/publications/healthy-living-vie-saine/water-nitrate-nitrite-eau/alt/water-nitrate-nitrite-eau-eng.pdf>.

[Accessed: Jan. 22, 2026].

MILESTONE 3 (INDIVIDUAL) – COVER PAGE

Team **Thurs-18**
Number:

Please list full name and MacID.

Full Name:	MacID:
Shayan Siddiqui	Siddm47

MILESTONE 3 (STAGE 2) – MATERIAL SELECTION: MPI AND MATERIAL RANKING

Team ID:

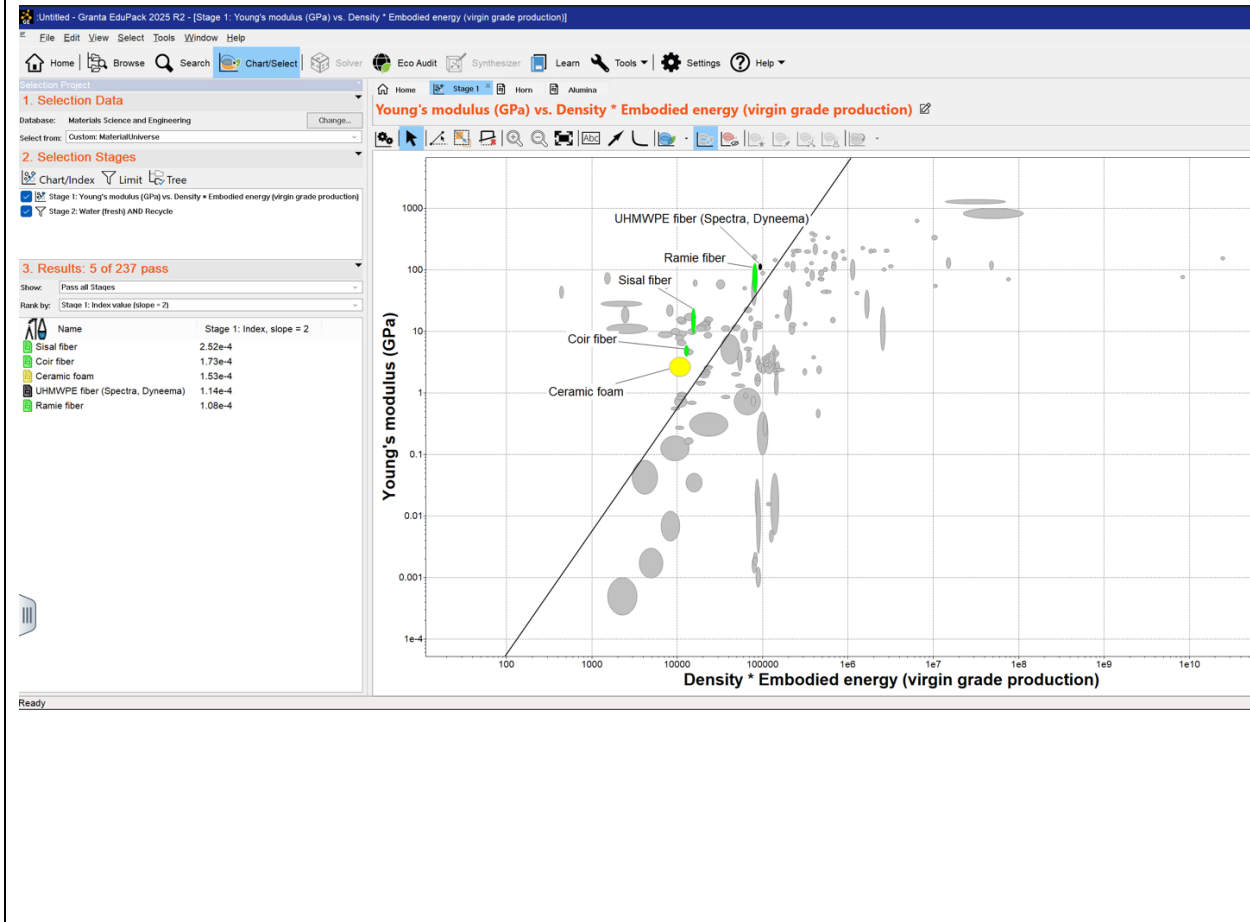
Thurs-18

Document the results of your materials selection and ranking on the following pages.

→ Each team member is required to complete this worksheet

Material Property Chart		
Assigned MPI	Property Limits	Objective
$MPI = \sqrt{(E)/Hmp}$	<ul style="list-style-type: none">- Water (Fresh)- Recyclable	<p>Our given scenario is about microplastics. The first limit I chose was water (fresh) this was a mandatory filter since we need our material to be excellent in freshwater conditions.</p> <p>The second limit was recyclable, since our goal is to eliminate microplastics we need the material that we're working with to be recyclable so that we don't add to the issue.</p>

Insert a screenshot of the material property chart with MPI guideline. Please clearly label the top 5 materials with their names in the plot.



Material Ranking

	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
Assigned MPI: MPI = $\sqrt{(E)/Hmp}$	Sisal Fiber	Coir Fiber	Ceramic Foam	UHMWPE Fiber (Spectra, Dyneema)	Ramie Fiber

MILESTONE 5 (INDIVIDUAL) – COVER PAGE

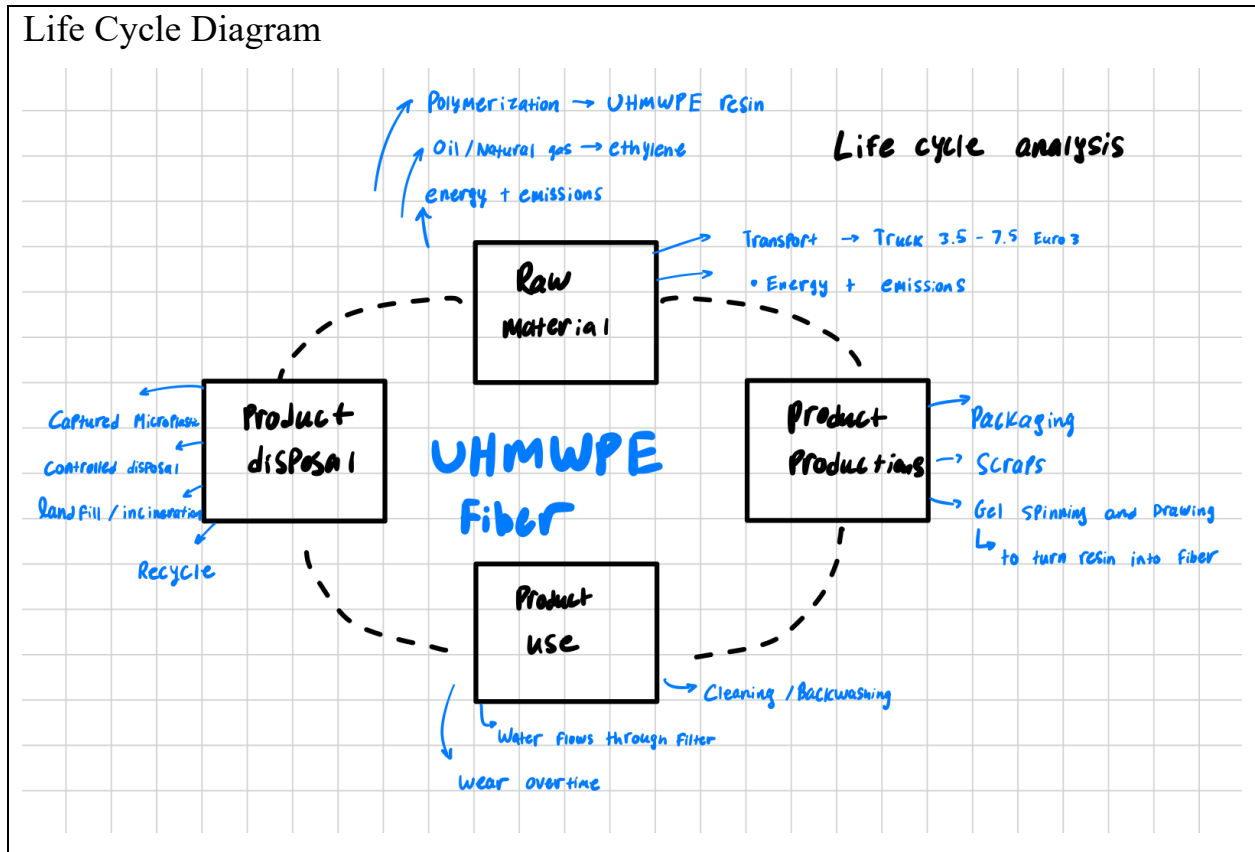
Team
Number:

Please list full name and MacID.

Full Name:	MacID:
Shayan Siddiqui	Siddm47

MILESTONE 5 (STAGE 1) – LIFE CYCLE DIAGRAM

In the space below, copy and paste a life cycle diagram for one of the three top material choices for your filter design. Include citations for each of the process steps within the filter’s life cycle.



References

- [1] Z. Wang *et al.*, “Polymer Physics behind the Gel-Spinning of UHMWPE Fibers,” *Macromol. Rapid Commun.*, Apr. 2024. [Online]. Available: <https://onlinelibrary.wiley.com/doi/10.1002/marc.202400124>. [Accessed: Feb. 26, 2026].
- [2] W. Wang *et al.*, “Synthesis of Ultra-High-Molecular-Weight Polyethylene by ...” *ACS Publications*, 2024. [Online]. Available: <https://pubs.acs.org/doi/10.1021/prechem.3c00103>. [Accessed: Feb. 26, 2026].
- [3] S. Gao *et al.*, “High-value recycling of ultrahigh molecular weight polyethylene,” *Polymer*, 2025. [Online]. Available: <https://www.sciencedirect.com/science/article/abs/pii/S0032386125007116>. [Accessed: Feb. 26, 2026].

Project Two Milestone (Individual) Worksheets

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Milestone 3 (Individual) – Cover Page	5
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Milestone 5 (Individual) – Cover Page	8
Milestone 5 (Stage 1) – Life cycle Diagram	9

MILESTONE 1 (INDIVIDUAL) – COVER PAGE

Team Number:

Thurs-18

Please list full name and MacID.

Full Name:	MacID:
Karanveer Dhillon	Dhillk27

MILESTONE 1 (STAGE 1) – FILTRATION TECHNIQUES RESEARCH

Team ID:

Thurs-18

Stage 1: Filtration Techniques Research

Individually, perform research on at least 2–3 filtration techniques, citing at least 5–10 credible sources. **NOTE:** One of the filtration techniques MUST be **mechanical filtration**, as the research will be used in future milestones.

Mechanical Filtration:

- Physical filtration method that removes particle by size using meshes, screens, or fibrous. [1]
- Commonly used in wastewater treatment plants due to simplicity, reliability, and scalability. [1]
- Effective for microplastics removal when pore sizes are comparable to microplastic dimensions (10-20um) [2]
- Examples include pile cloth media filters and disc filters, which allow continuous operation and periodic cleaning [2].

Membrane Filtration

- Use permeable membranes to separate contaminants decided on pore size and applied pressure [4]
- Includes microfiltration, ultrafiltration, and reverse osmosis [4]
- Microfiltration and ultrafiltration are effective for micron sized microplastics [3]
- Offers high removal efficiency but can have higher energy use and fouling issues [5]

Biological Filtration

- Relies on biofilms attached to filter media to remove contaminants [6]
- Common system includes biosand filters and trickling filters [6].
- Primarily targets organic matter, but biofilms can trap suspended particles, including some microplastics. [6]
- Typically used along mechanical or membrane filtration to improve overall treatment performance[6]

Work cited

[10] “The Science Behind Mechanical Filtration: How It Works and Its Benefits,” *Olympian Water Testing*, Jun 7, 2023. [The Science Behind Mechanical Filtration: How It Works and Its Benefits - Olympian Water Testing, LLC](#). Accessed Jan 22, 2026.

[11] G. L. Hawkins et al., Mechanical Filtration Methods and Devices, Univ. of Georgia Cooperative Extension, Field Report B1523, June 9 2023. [Mechanical Filtration Methods and Devices | CAES Field Report](#). Accessed Jan 22, 2026.

[3] “Membrane technology for microplastic removal: Microplastic occurrence, challenges, and innovations” *ScienceDirect*. [Membrane technology for microplastic removal: Microplastic occurrence, challenges, and innovations of process and materials - ScienceDirect](#). Accessed Jan. 22, 2026.

[4] “Remediation of Micro- and Nanoplastics by Membrane Technologies,” *PMC*. [Remediation of Micro- and Nanoplastics by Membrane Technologies - PMC](#). Accessed Jan. 22, 2026.

[5] “Effects of microplastic on submerged nanofiltration for advanced drinking water treatment,” *Scientific Reports*, Nat. Publishing Group. [Effects of microplastic on submerged nanofiltration for advanced drinking water treatment | Scientific Reports](#). Accessed Jan. 22, 2026.

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MILESTONE 3 (INDIVIDUAL) – COVER PAGE

Team Number:

Thru-18

Please list full name and MacID.

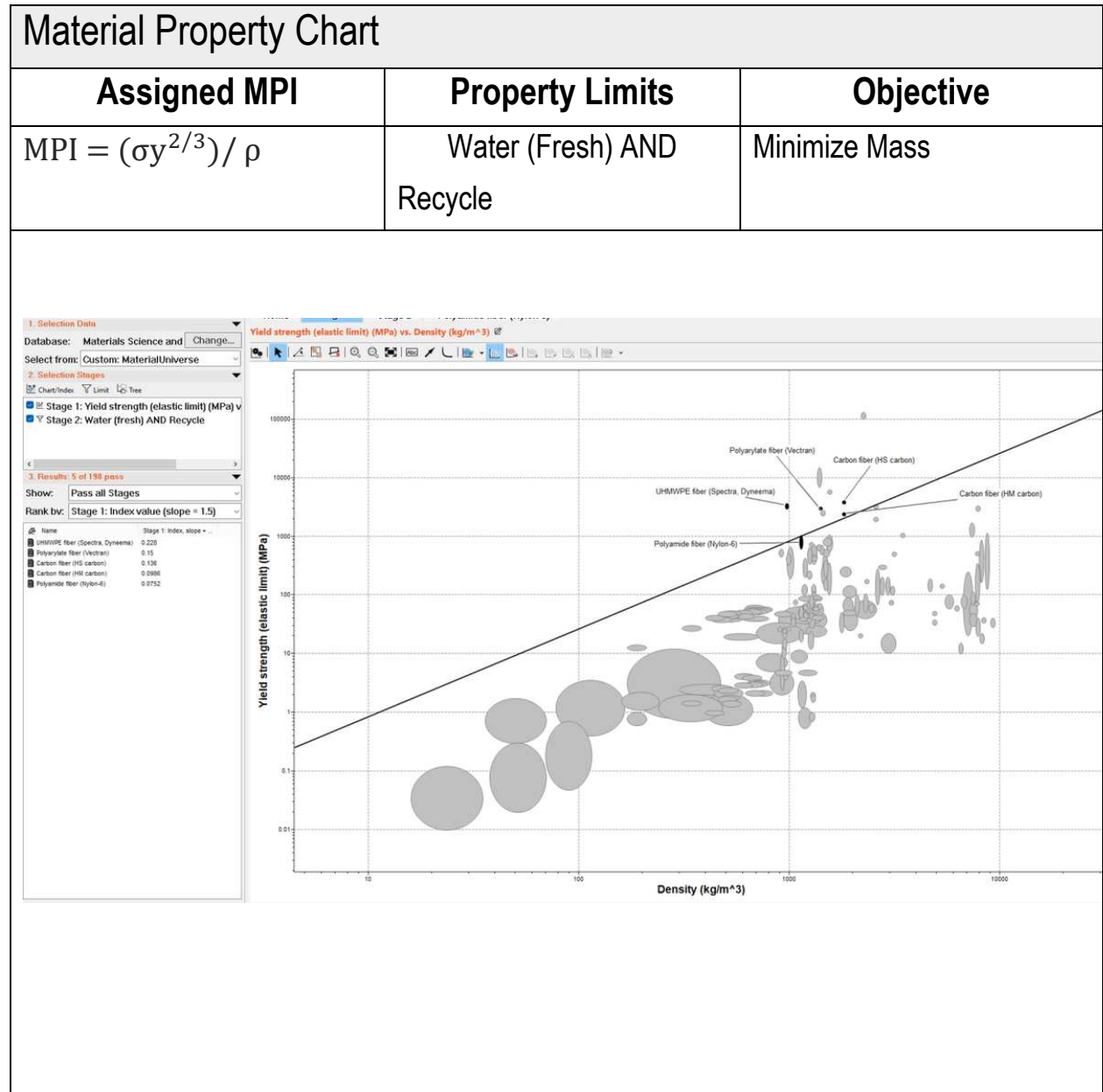
Full Name:	MacID:
Karanveer Dhillon	Dhillk27

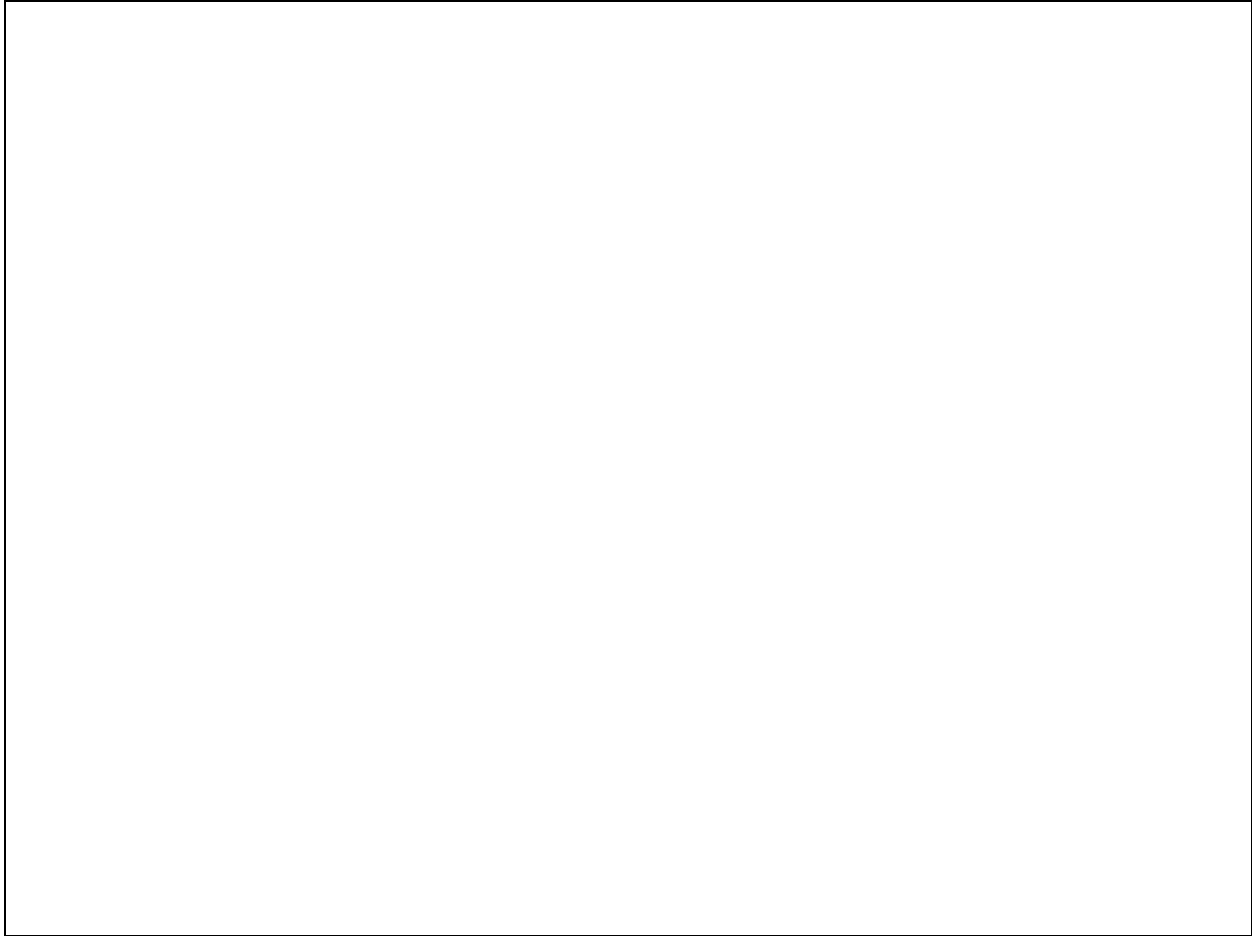
MILESTONE 3 (STAGE 2) – MATERIAL SELECTION: MPI AND MATERIAL RANKING

Team ID: Thur-18

Document the results of your materials selection and ranking on the following pages.

→ Each team member is required to complete this worksheet





Material Ranking					
	Rank 1: UHMWPE Fiber (Spectra, Dyneema)	Rank 2: Polyarylate Fiber (Vectran)	Rank 3: Carbon Fiber (HS Carbon)	Rank 4: Carbon Fiber (HM Carbon)	Rank 5: Polyamide Fiber (Nylon- 6)
<i>Assigned MPI:</i>	0.228	0.15	0.136	0.0986	0.0752

MILESTONE 5 (INDIVIDUAL) – COVER PAGE

Team Number:

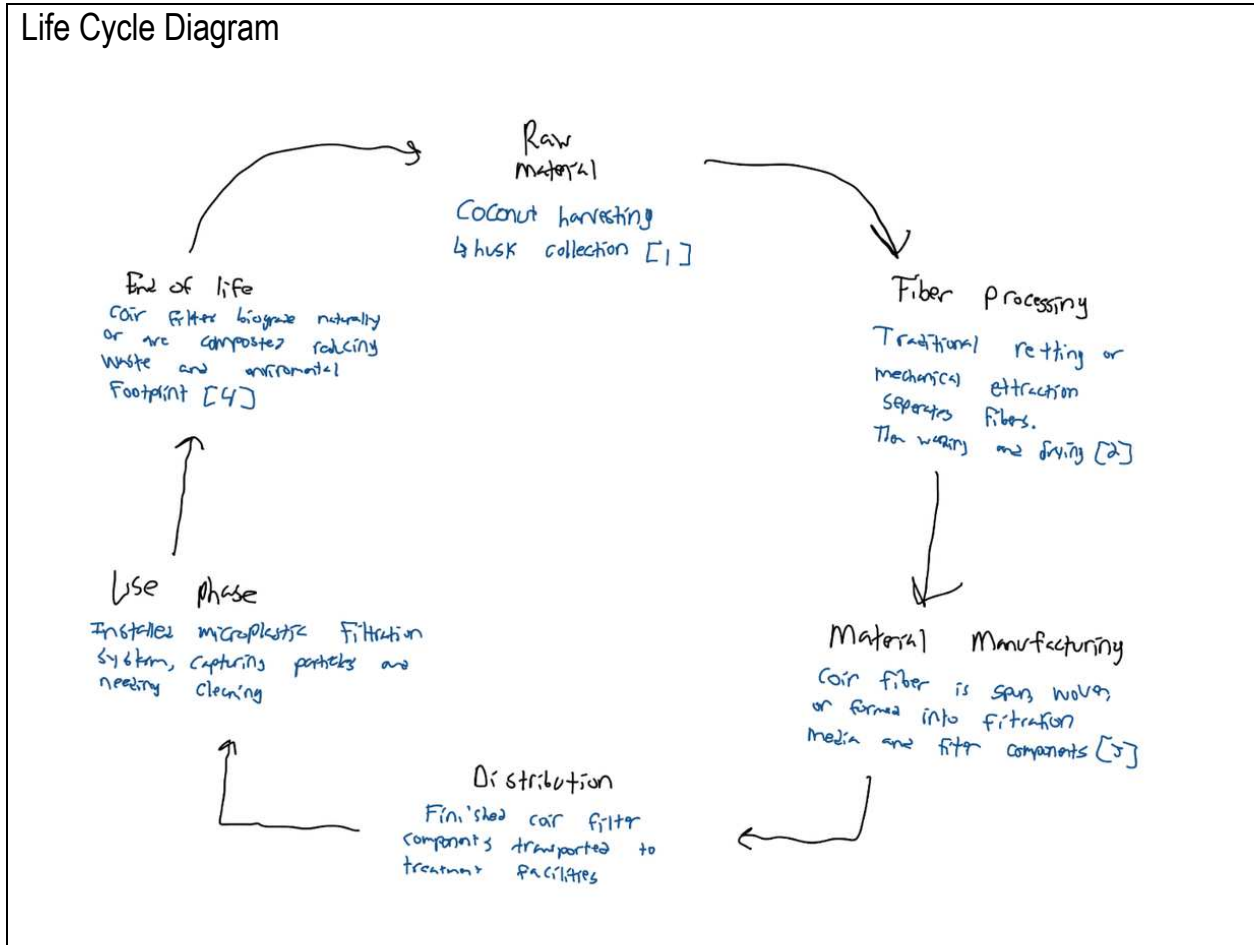
Thrus-18

Please list full name and MacID.

Full Name:	MacID:
Karanveer Dhillon	Dhillk27

MILESTONE 5 (STAGE 1) – LIFE CYCLE DIAGRAM

In the space below, copy and paste a life cycle diagram for one of the three top material choices for your filter design. Include citations for each of the process steps within the filter's life cycle.



References

- [1] Coir, "The coir fiber extraction process," Coir.com, <https://coir.com/coconut/the-coir-fiber-extraction-process/> (accessed Feb. 25, 2026).
- [2] 3. Coir Fibre Processing, <https://www.fao.org/4/Y3612E/y3612e04.htm> (accessed Feb. 25, 2026).
- [3] "Home: Food and agriculture organization of the united nations," FAOHome, <https://www.fao.org/home/en> (accessed Feb. 25, 2026).
- [4] "Coir Fibre: Properties, sourcing, and diverse uses," Biology Insights, <https://biologyinsights.com/coir-fibre-properties-sourcing-and-diverse-uses/> (accessed Feb. 25, 2026).

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MILESTONE 1 (INDIVIDUAL) – COVER PAGE

Team Number:

Thurs-18

Please list full name and MacID.

Full Name:	MacID:
Hannah Ross	Rossh14

MILESTONE 1 (STAGE 1) – FILTRATION TECHNIQUES RESEARCH

Team ID:

Thurs-18

Stage 1: Filtration Techniques Research

Individually, perform research on at least 2–3 filtration techniques, citing at least 5–10 credible sources. **NOTE:** One of the filtration techniques **MUST** be **mechanical filtration**, as the research will be used in future milestones.

Mechanical Filtration:

Mechanical filtration is a process in which particles are trapped within a mesh filter or cartridge as untreated water passes through [1]. This filtration technique is used primarily to remove large undissolved materials such as sand, clay, and organic matter [1].

- Three types of mechanical filtration include Cartridge sediment filters, single or multimedia filter [1].

Cartridge sediment filters are used for a single water trap, which is often found under a kitchen sink [1]. These filters work by pushing water through the fibres, where loose contaminants become suspended, and the rest of the water passes through [1].

Single and multimedia filters are used to treat water by combining different media, such as sand or gravel, which capture impurities [2]. Untreated water passes through the filter tank and is pushed through the press, where impurities are suspended, and the filtered water continues to pass through [1].

Gravity Filtration:

Gravity filtration is a process in which the natural pull of gravity is used to separate solids from contaminated water [3]. Water passes through a filter paper, and as gravity pulls the liquid downward, loose particles are trapped and held [3]. This process is cost-efficient, as it requires minimal equipment and makes use of the natural force of gravity.

- This method is commonly used in the pharmaceutical and chemical industries, and is used to filter out bacteria, chemicals, or loose solids that are in the water [3].
- This process can be used to filter water on both small and large scales [3].

Vacuum filtration:

Vacuum filtration is a process in which pressure is created to pull liquid through a layer of filter paper or membrane, where impurities are suspended and captured [4]. A vacuum pump is used to achieve the different levels of pressure between layers [4].

- Different pore sizes may be used within the filters for different applications. The size impacts the speed of the process, the size of the solids that are captured [4].
- These filters are used for simple purifications within coffee makers or vacuums [4].
- Vacuum filtration is ideal for filtering thick and heavy solutions and is used in many industries, including chemical, environmental, and scientific research [5].

[1] G. L. H. Lessl Pamela R. Turner, Uttam K. Saha, Jason, "Mechanical Filtration Methods and Devices," CAES Field Report. Accessed: Jan. 22, 2026. [Online]. Available:

<https://fieldreport.caes.uga.edu/publications/B1523/mechanical-filtration-methods-and-devices/>

[2] S. Aqua, "Complete Guide to Multimedia Filters in Water Treatment Plants," Water Filtration Media. Accessed: Jan. 22, 2026. [Online]. Available: <https://www.starkefiltermedia.com/multimedia-filters-a-high-performance-solution-for-water-treatment-efficiency/>

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[4] chemtalk, "What is Vacuum Filtration?," ChemTalk. Accessed: Jan. 22, 2026. [Online]. Available: <https://chemistrytalk.org/what-is-vacuum-filtration/>

[5] Ella, "What is a Vacuum Filtration System? Complete Guide," AELAB | Laboratory Equipment and Scientific Instrument Supplier. Accessed: Jan. 22, 2026. [Online]. Available: <https://aelabgroup.com/what-is-a-vacuum-filtration-system-complete-guide/>

MILESTONE 3 (INDIVIDUAL) – COVER PAGE

Team Number:

Thurs-18

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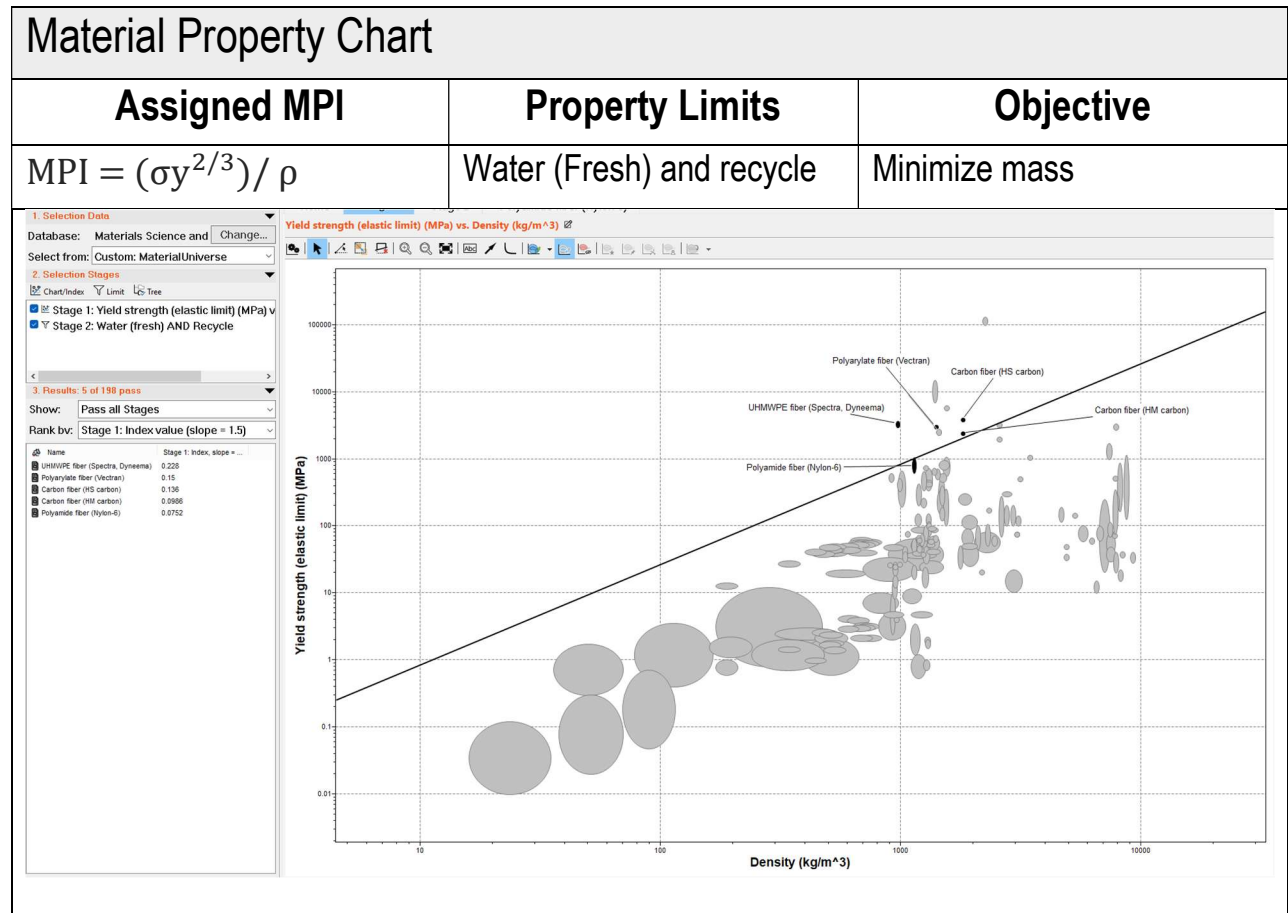
Full Name:	MacID:
Hannah Ross	Rossh14

MILESTONE 3 (STAGE 2) – MATERIAL SELECTION: MPI AND MATERIAL RANKING

Team ID: Thurs-18

Document the results of your materials selection and ranking on the following pages.

→ Each team member is required to complete this worksheet



Material Ranking					
	Rank 1: UHMWPE Fiber (Spectra, Dyneema)	Rank 2: Polyarylate fiber (Vectran)	Rank 3: Carbon Fiber (HS Carbon)	Rank 4: Carbon Fiber (HM carbon)	Rank 5: Polyamide Fiber (Nylon-6)
<i>Assigned MPI:</i>	0.228	0.15	0.136	0.0986	0.0752

MILESTONE 5 (INDIVIDUAL) – COVER PAGE

Team Number:

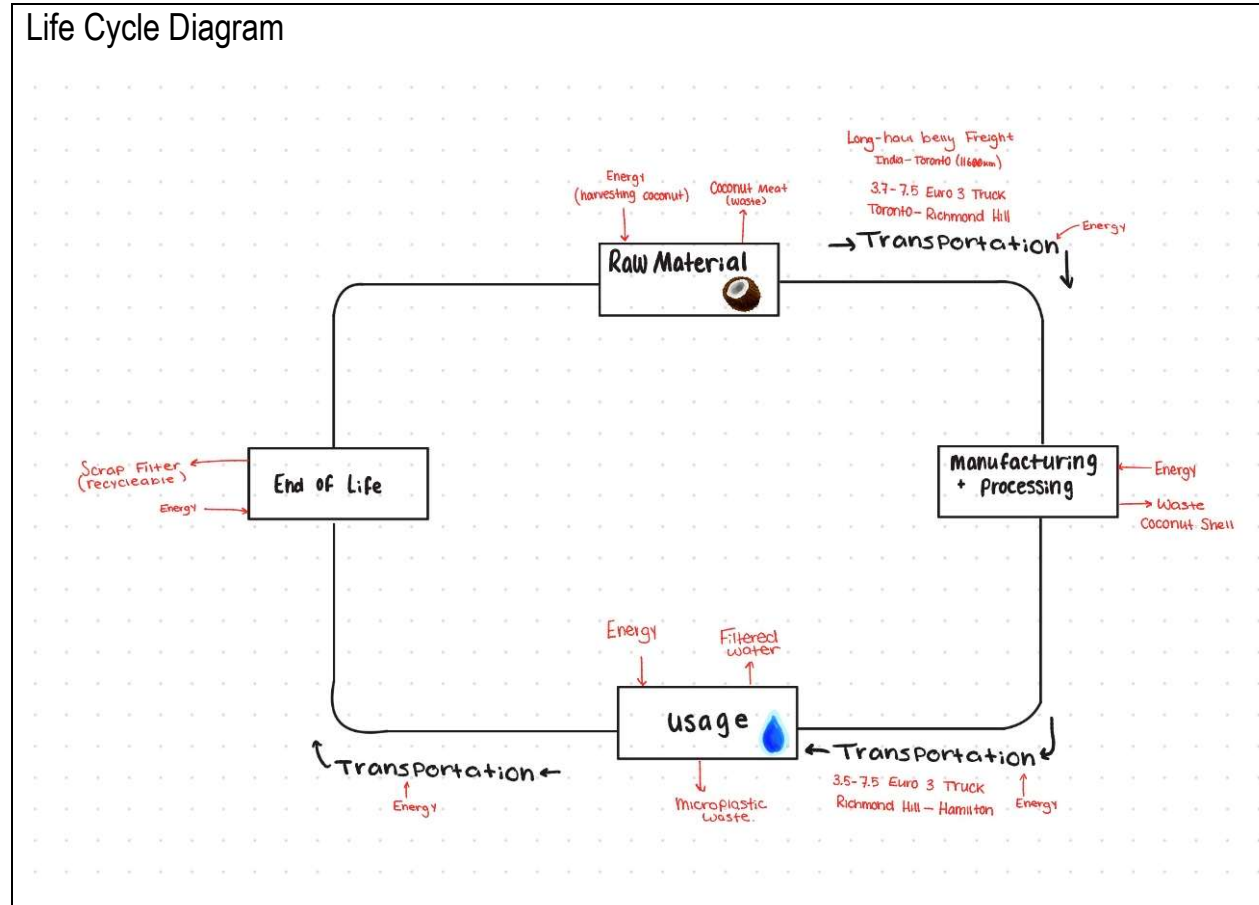
Thurs-18

Please list full name and MacID.

Full Name:	MacID:
Hannah Ross	Rossh14

MILESTONE 5 (STAGE 1) – LIFE CYCLE DIAGRAM

In the space below, copy and paste a life cycle diagram for one of the three top material choices for your filter design. Include citations for each of the process steps within the filter’s life cycle.



References

[1] journal.tex, “Coir Fiber: Properties, Production Process and Advantages,” The Textile Journal. Accessed: Feb. 26, 2026. [Online]. Available: <https://thetextilejournal.com/coir-fiber-properties-production-process-and-advantages/>

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MILESTONE 1 (INDIVIDUAL) – COVER PAGE

Team Number:

Thurs-18

Please list full name and MacID.

Full Name:	MacID:
Andrew Jo	Joh8

MILESTONE 1 (STAGE 1) – FILTRATION TECHNIQUES RESEARCH

Team ID:

Thurs-18

Stage 1: Filtration Techniques Research

Individually, perform research on at least 2–3 filtration techniques, citing at least 5–10 credible sources. **NOTE:** One of the filtration techniques **MUST** be **mechanical filtration**, as the research will be used in future milestones.

Mechanical Filtration:

- Mechanical filtration removes particles through surface and depth filtration. [1]
- Surface filtration is used to remove most of the particles. [1]
- During the surface filtration, sieving process traps the large particles, and smaller particles pass through the surface layer and get remove by depth filtration. [1]
- It's mostly used for household water filters, coffee brewing, and swimming pools etc.... [2]

Gravity Filtration:

- Primarily used in laboratory to separate solid from liquid. [2]
- You put the mixture of solid and liquid in the funnel that's covered with filter paper.[2]
- After putting the mixtures, because of the gravity, liquid passes through the funnel but the solid remains on the paper. [2]
- You can also see Gravity filtration from making Tea. [2]

Depth Filtration:

- This filtration is built to create a media that catches unwanted particles throughout medium itself. [3]
- These are mostly used in instances when there's a lot of heavy degree of particles in the water. [3]
- large particles are captured in water while it's traveling, at the same time, maximum volumes of particles are captured by fibres. [3]

Surface Filtration:

- It uses two mechanisms, which is sieve retention and adsorption. [2]

- Common materials used in this filtration is woven, membranes, and metallic screens etc.....[2]
- This filtration is used to focus on removing particles from fluids by trapping them on the surface. [4]
- The advantage of this filtration is the ability to achieve high throughputs and low pressure drops compared to other filtrations. [4]

Membrane Filtration:

- It is a separation method by the to separate molecules of different sizes and characteristics. [5]
- It also uses two mechanisms which is size exclusion and adsorption. [2]
- Between the two sides of special membrane, it has the driving force that has difference pressure. [5]
- Polysulfone, polyamide, and polyether sulfone are the most common materials used in this filtration. [5]

[1] Danamark, "Mechanical Filtration | Resources," Danamark, Jul. 13, 2018. <https://danamark.com/resources/mechanical-filtration/>

[2] gd-admin, "12 Types of Filtration Techniques You Should Know," <https://www.hengko.com/>, Aug. 25, 2023. <https://www.hengko.com/news/types-of-filtration-techniques/>

[3] Filerder, "Getting Back to Basics: What is Depth Filtration?," Filerder Filter Systems. <https://www.filerder.co.uk/blog/getting-back-to-basics-what-is-depth-filtration/>

[4] FCPL, "Basic Principle of Surface Filtration – Filter Concept," Filter Concept, May 12, 2023. <https://filter-concept.com/industrial/basic-principle-of-surface-filtration/>

[5] "What is membrane filtration?," www.alfalaval.ca. <https://www.alfalaval.ca/products/separation/membranes/what-is-membrane-filtration/>

MILESTONE 3 (INDIVIDUAL) – COVER PAGE

Team Number:

Thurs-18

Please list full name and MacID.

Full Name:	MacID:
Andrew Jo	Joh8

MILESTONE 3 (STAGE 2) – MATERIAL SELECTION: MPI AND MATERIAL RANKING

Team ID: Thurs-18

Document the results of your materials selection and ranking on the following pages.

→ Each team member is required to complete this worksheet

Material Property Chart		
Assigned MPI	Property Limits	Objective
$MPI = \sqrt{(E)/\rho}$	Water(fresh)and biodegrade	<p>Our given scenario is about microplastics. The fist limit we chose was water (fresh) this was a mandatory filter since we need our material to be excellent in freshwater conditions.</p> <p>The second limit was recyclable, since our goal is to eliminate microplastics we need the material that we're working with to be recyclable so that we don't add to the issue.</p> <p>The last limit was biodegradable because key material limits on contributing to microplastic is low biodegradable of plastics, instead of decomposing these materials fragment micro particles in the environment for decades.</p>

Insert a screenshot of the material property chart with MPI guideline. Please clearly label the top 5 materials with their names in the plot.



Material Ranking					
	Rank1: Ramie Fiber	Rank2: Sisal Fiber	Rank3: Coir Fiber	Rank 4: Antler	Rank5: Cellulose acetate (CA)
<i>Assigned MPI:</i>	0.00578	0.00272	0.00187	0.0016	0.00132

MILESTONE 5 (INDIVIDUAL) – COVER PAGE

Team Number:

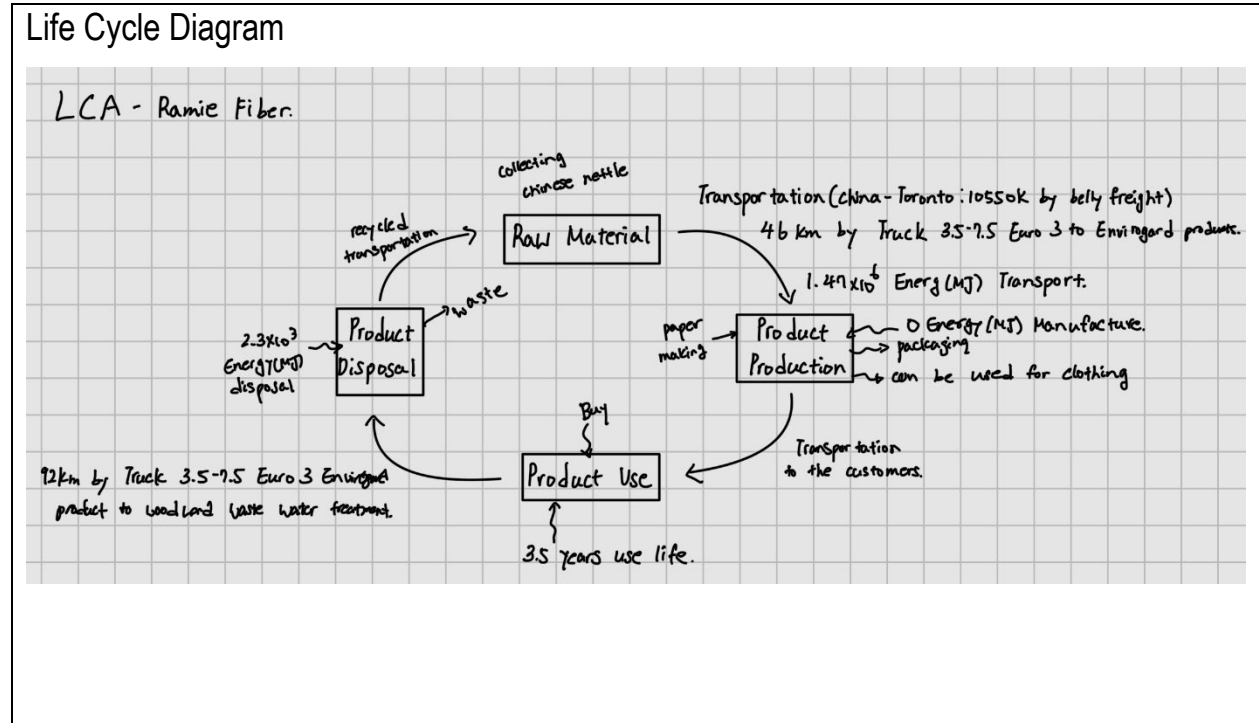
Thurs-18

Please list full name and MacID.

Full Name:	MacID:
Andrew Jo	Joh8

MILESTONE 5 (STAGE 1) – LIFE CYCLE DIAGRAM

In the space below, copy and paste a life cycle diagram for one of the three top material choices for your filter design. Include citations for each of the process steps within the filter's life cycle.



References

[1] "Comparing Lifespans: The Ultimate Water Filter Chart - Water Filter Stuff." Accessed: Feb. 26, 2026. [Online]. Available: <https://waterfilterstuff.com/comparing-lifespans-the-ultimate-water-filter-chart/>

[2] "How Long Do Water Filters Last? (By Type + Signs to Replace)." Accessed: Feb. 26, 2026. [Online]. Available: <https://qualitywaterlab.com/info/how-long-do-water-filters-last/>

Project Two Milestone (Individual) Worksheets

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- Milestone 5 (Individual) – Cover Page**..... 9
- Milestone 5 (Stage 1) – Life cycle Diagram..... 10

MILESTONE 1 (INDIVIDUAL) – COVER PAGE

Team Number:

THURS-18

Please list full name and MacID.

Full Name:	MacID:
Jasmine Kalsi	kalsij8

MILESTONE 1 (STAGE 1) – FILTRATION TECHNIQUES RESEARCH

Team ID:

THURS-18

Stage 1: Filtration Techniques Research

Individually, perform research on at least 2–3 filtration techniques, citing at least 5–10 credible sources. **NOTE:** One of the filtration techniques MUST be **mechanical filtration**, as the research will be used in future milestones.

Distillation:

- Water is heated to boiling, and the water vapor rises to a condenser [1]
- Cold water is used to lower the temperature so the condensed vapour can be stored [1]
- Most of the contaminants stay in the liquid phase vessel, however leftover contaminants can be called “carry-over” in the distilled water [1]
- Pesticides and herbicides with boiling points lower than 100 deg Celsius become concentrated in the water (they cannot be removed effectively) [1]
- Distilled water lacks oxygen and minerals and can be acidic [1]
- Distillation processes can also be expensive and require a lot of energy [1]
- Some of the specific inorganic compounds that distillation filters out includes metals (lead,) nitrate, and iron from contaminated water [2]
- To maintain distillation units, unevaporated pollutants left in the boiling chamber need to be regularly flushed to a septic or sewer system, or hand cleaned if calcium and magnesium gather at the bottom [2]
- The price of distillation units ranges from 300-1200 dollars [2]

Ion Exchange:

- Ion exchange percolates water through bead-like spherical resin materials [1]
- Ions in the water exchange for ions fixed to the beads [1]
- One process of ion-exchange is softening, which is a pretreatment method to reduce the hardness of water before a different filtration, reverse osmosis, happens [1]
- The other method is deionization, where beads exchange hydrogen ion for cations, or hydroxyl ions for anions [1]
- In natural water, concentrations of dissolved salts which dissociate in water, form charged ions, impurities that are ionic can affect the reliability of any boiler or process system [3]

- To remove the dissolved ions from water, the following systems are used where ion exchange resins can remove all silicic and carbonic acids and demineralize the water [3]

Mechanical Filtration:

- In the following process, untreated water passes through a mesh filter that traps suspended particle on the surface [4]
- Mechanical water filters remove material such as sand, clay, and other organic matter, however, cannot remove dissolved chemicals or small particles alone [4]
- Mechanical filtration is successful in removing said small particles only in combination with other water treatment equipment [4]
- Microfiltration devices can filter out bacteria and other microorganisms from water if the filter pores are smaller than the bacteria [4]
- Cartridge sediment filters is a type of mechanical filter, the medium of the filter is made of paper, rayon, fiber, ceramic or other materials, this can further be broken down into pleated type or depth type filters [4]
- Single filters and multimedia filters can be used before UV filters or to prevent build up in machines [4]

Reverse Osmosis:

- RO (Reverse Osmosis) is a process that removes impurities in water by forcing the water through a semi-permeable membrane [5]
- This filtration method is most effective for removing dissolved salts and minerals (magnesium, sulfate, heavy metals, lead, etc.) [5]
- Water pressure pushes tap water through a membrane to remove the contaminants, unlike other filtration processes which collect the impurities, RO pushes water through a series of filters and the contaminants are flushed down the drain [5]
- RO is cost effective, does not require a form of electricity/power, and removes about 95-99% of its contaminants [5]
- The stages of a RO system include a sediment filter, a carbon filter, the RO membrane, and lastly a polishing filter to clean the water [5]

Ultraviolet Radiation:

- UV radiated filters work by breaking chemicals and damaged cells so they cannot reproduce in water as they have higher energy and cause ionization in atoms [6]

- Although UV light comes from the sun, it is generated artificially through electric currents through vaporized gas, water is then pumped into a chamber with a UV bulb [6]
- The rays produced are specific to the frequency that can most effectively attack microbes, some of these bacteria can include E. coli and giardia [6]
- The advantages of UV filtration are the absence of harsh chemicals to filter the water, therefore being more safe and environmentally friendly by not emitting any by-products [6]
- However, UV filtration is usually used alongside another filtration unit, as contaminants such as metals, salts, and chlorine cannot be taken out using UV [6]
- In addition, UV filtration needs both electricity and clear water to work effectively [6]

References

- [1] APEC Water, "Different Water Filtration Methods Explained," *APEC WATER*, Feb. 03, 2024. https://www.apecwater.com/blogs/water-health/quality-water-filtration-method?srsId=AfmBOoorT1aYKWwHjtCCrM_JX3IMMwPjD7qBuVasFSc13MEIOJlLVJaM (accessed Jan. 22, 2026).
- [2] M. Kamrin, N. Hayden, B. Christian, D. Bennack, and F. D'Itri, "Distillation For Home Water Treatment," *www.extension.purdue.edu*, 1990. <https://www.extension.purdue.edu/extmedia/WQ/WQ-12.html> (accessed Jan. 22, 2026).
- [3] Veolia Water Technologies, "Water Handbook - Ion Exchange & Water Demineralization | SUEZ," *www.watertechnologies.com*, 2025. <https://www.watertechnologies.com/handbook/chapter-08-ion-exchange> (accessed Jan. 22, 2026).
- [4] University of Georgia Field Report, "Mechanical Filtration Methods and Devices | CAES Field Report," *CAES Field Report*, Nov. 26, 2019. <https://fieldreport.caes.uga.edu/publications/B1523/mechanical-filtration-methods-and-devices/> (accessed Jan. 22, 2026).
- [5] ESP Water, "What is Reverse Osmosis Water Filtration?," *ESP Water*, 2024. <https://espwaterproducts.com/pages/understanding-ro?srsId=AfmBOoq3y-KWeiByPhunzrMYeqQgzMvEwNj7f3VAyrCXP9dWlleTFBQK> (accessed Jan. 22, 2026).
- [6] K. Royer, "UV Water Purification: Ultra-Violet, Ultra-Effective," *aquasana.com*, 2024. <https://www.aquasana.com/info/uv-water-purification-ultra-violet-ultra-effective-pd.html?srsId=AfmBOoq9Hsc7k8koxOQqDc5hoVPRp1mAZiNhpXZOuN0aEqqZwgED7Zo1> (accessed Jan. 22, 2026).

MILESTONE 3 (INDIVIDUAL) – COVER PAGE

Team Number: THURS-18

Please list full name and MacID.

Full Name:	MacID:
Jasmine Kalsi	Kalsij8

MILESTONE 3 (STAGE 2) – MATERIAL SELECTION: MPI AND MATERIAL RANKING

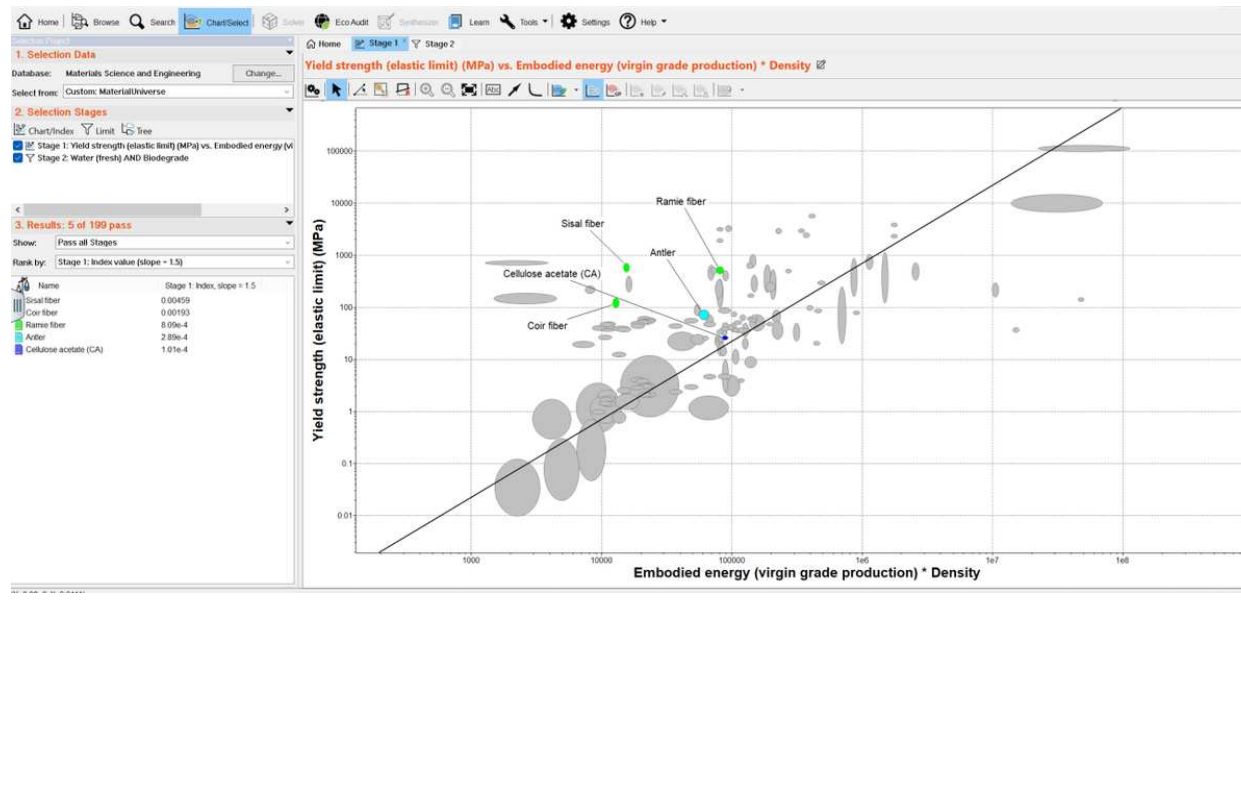
Team ID: THURS-18

Document the results of your materials selection and ranking on the following pages.

→ Each team member is required to complete this worksheet

Material Property Chart		
Assigned MPI	Property Limits	Objective
$MPI = (\sigma_y^{2/3}) / H_m \rho$	Water (Fresh) and Biodegradable	<p>For Microplastic Filtration for a Large-Scale Plant, both fresh water and biodegradability were important objectives to consider picking effective materials.</p> <p>“Fresh water” as a limit set to “excellent” allowed the materials on the chart to be reduced to items that can help create an efficient filtration that satisfies the function of the filter to take out microplastics and microbeads.</p> <p>“Biodegrade” as a limit to minimize the energy production is effective to help reduce the energy required to create the materials for the filter, this further aligns with our personal objectives of creating a sustainable filter composed of material that can be recycled at its end of life.</p>

Insert a screenshot of the material property chart with MPI guideline. Please clearly label the top 5 materials with their names in the plot.



Material Ranking					
	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
<i>Assigned MPI:</i>	Sisal Fiber 0.00459	Coir Fiber 0.00193	Ramie Fiber 8.04E-4	Antler 2.89E-4	Cellulose Acetate (CA) 1.01E-4

MILESTONE 5 (INDIVIDUAL) – COVER PAGE

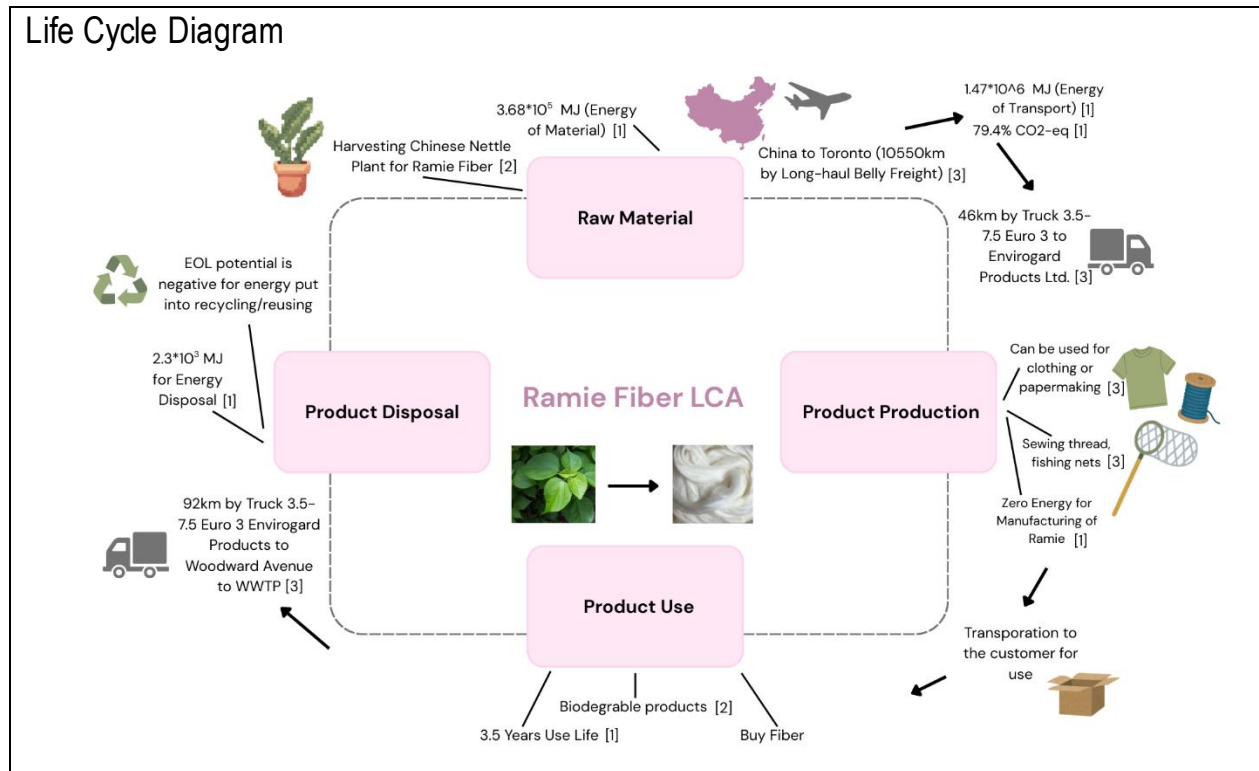
Team **THURS-18**
Number:

Please list full name and MacID.

Full Name:	MacID:
Jasmine Kalsi	kalsij8

MILESTONE 5 (STAGE 1) – LIFE CYCLE DIAGRAM

In the space below, copy and paste a life cycle diagram for one of the three top material choices for your filter design. Include citations for each of the process steps within the filter's life cycle.



References

- [1] Butterworth-Heinemann, *Materials and the Environment: Eco-informed Material Choice*, Oxford: Ashby, M.F., 2021
- [2] "What is Ramie," Hartmann & Forbes [Online]. Available: <https://hartmannforbes.com/blog/what-is-ramie>. [Accessed: February 26, 2026].
- [3] "Ramie," CargoHandbook [Online]. Available: <https://www.cargohandbook.com/Ramie>. [Accessed: February 26, 2026].