Microplastics Removal Through Water Treatment Plants- Current Knowledge and Future Directions

A Presentation by:

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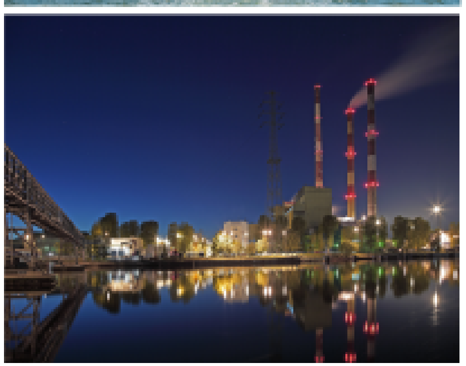


Microplastics in the News

Today's Topic

- Overview: Microplastics in Water Treatment Plants
- Removal with Conventional Water Treatment Technologies
- Removal with Emerging Treatment Technologies
- Management of Water Treatment Wastes
- Challenges and Data Gaps
- Conclusions and Future Research

Today's Topic

- Overview: Microplastics in Water Treatment Plants
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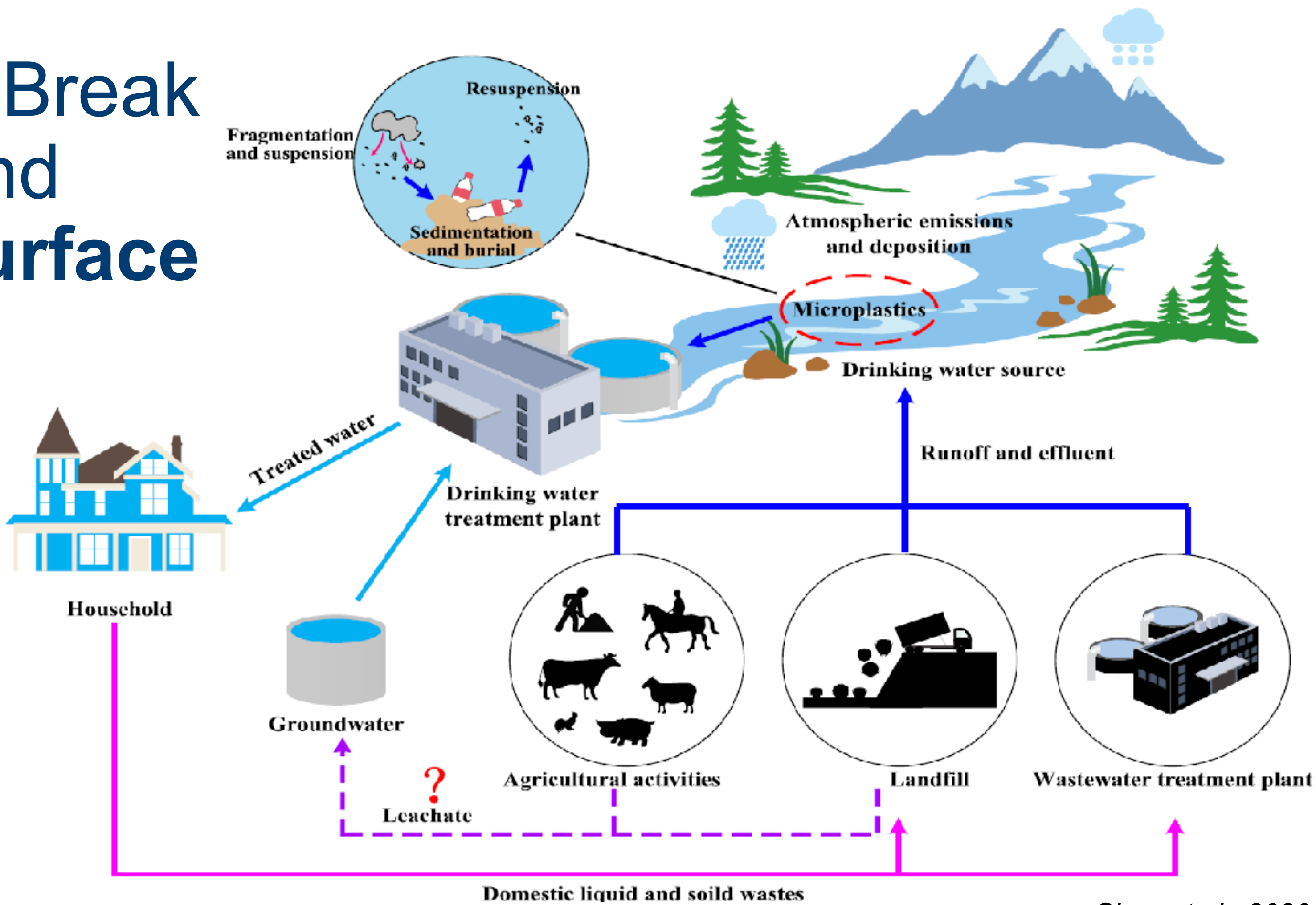
How Do Microplastics Enter Water Treatment Plants?

Plastics Break Down and Enter **Surface Waters**



Shen et al., 2020

Overview: Microplastics in Water Treatment Plants

Removal with Conventional Treatment Technologies

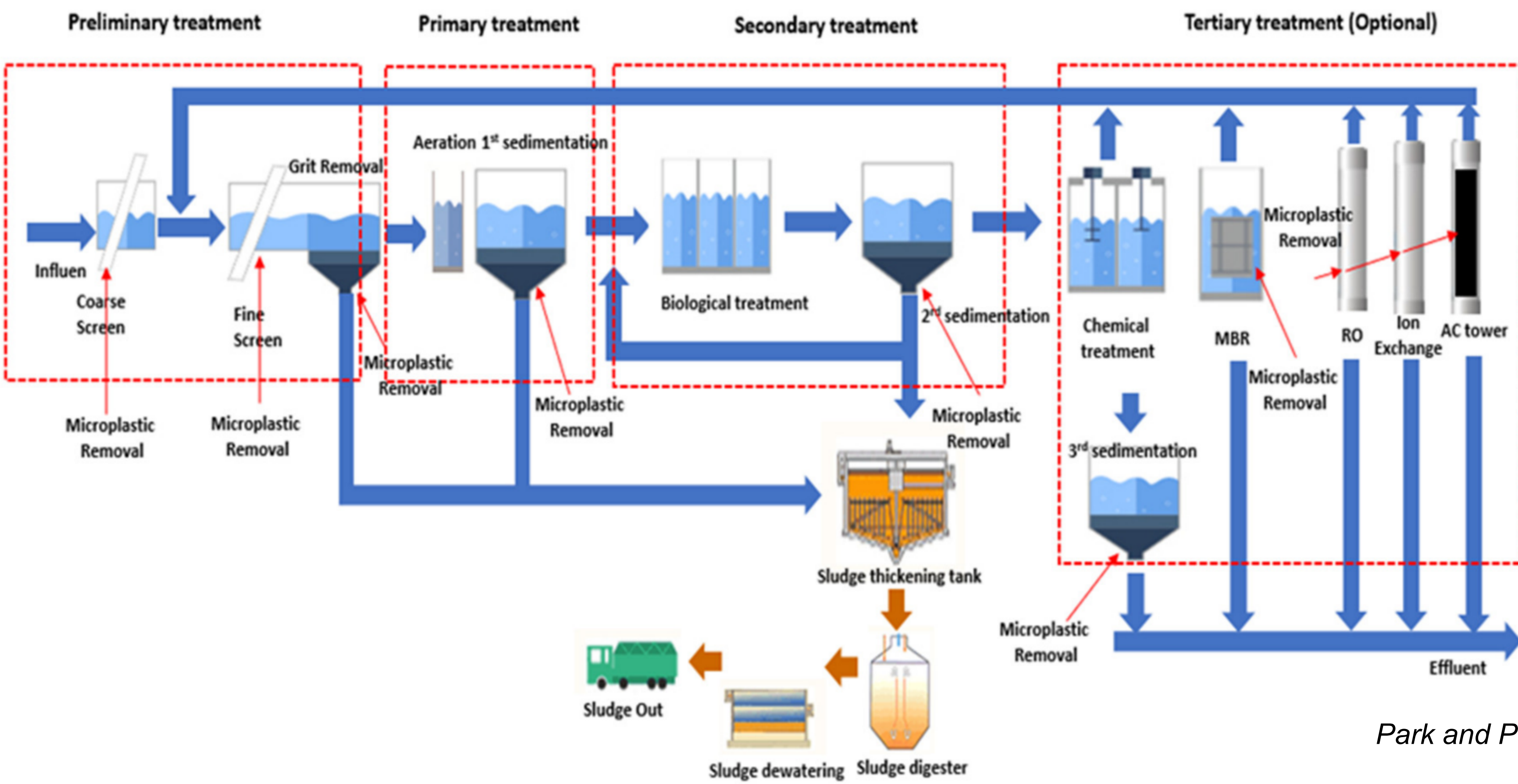
Removal with Emerging Technologies

Management of Water Treatment Systems

Challenges and Data Gaps

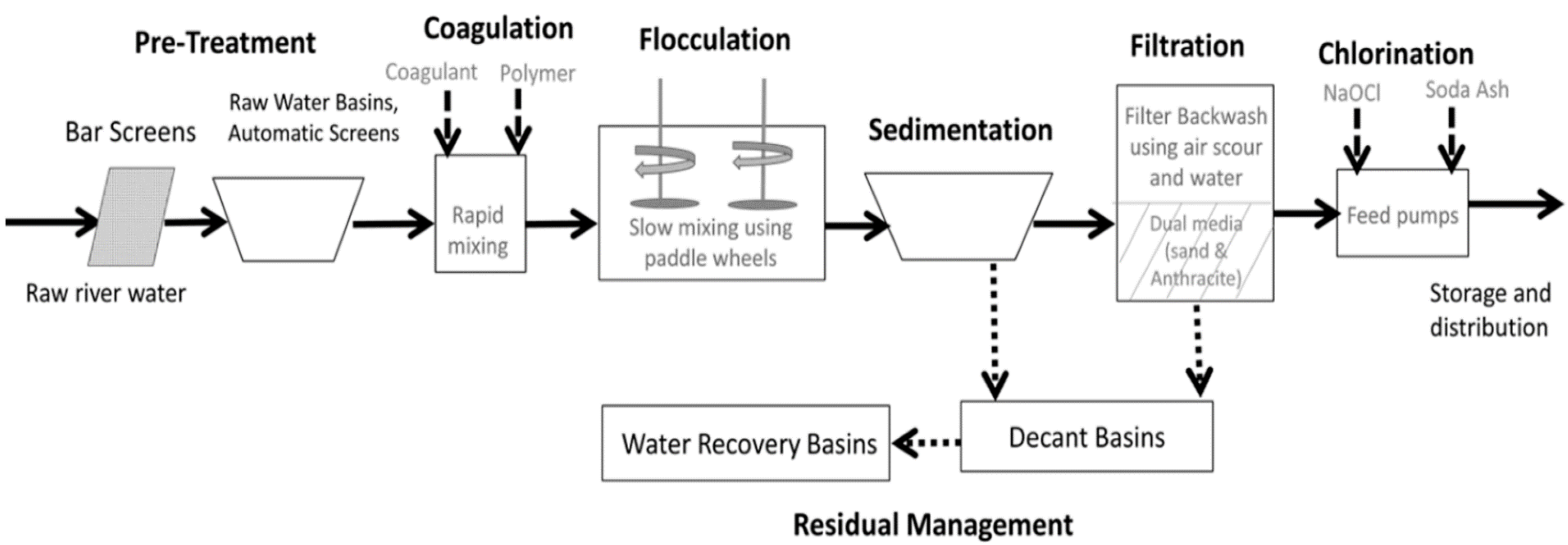
Conclusions and Future Research

Conventional Wastewater Treatment Plants

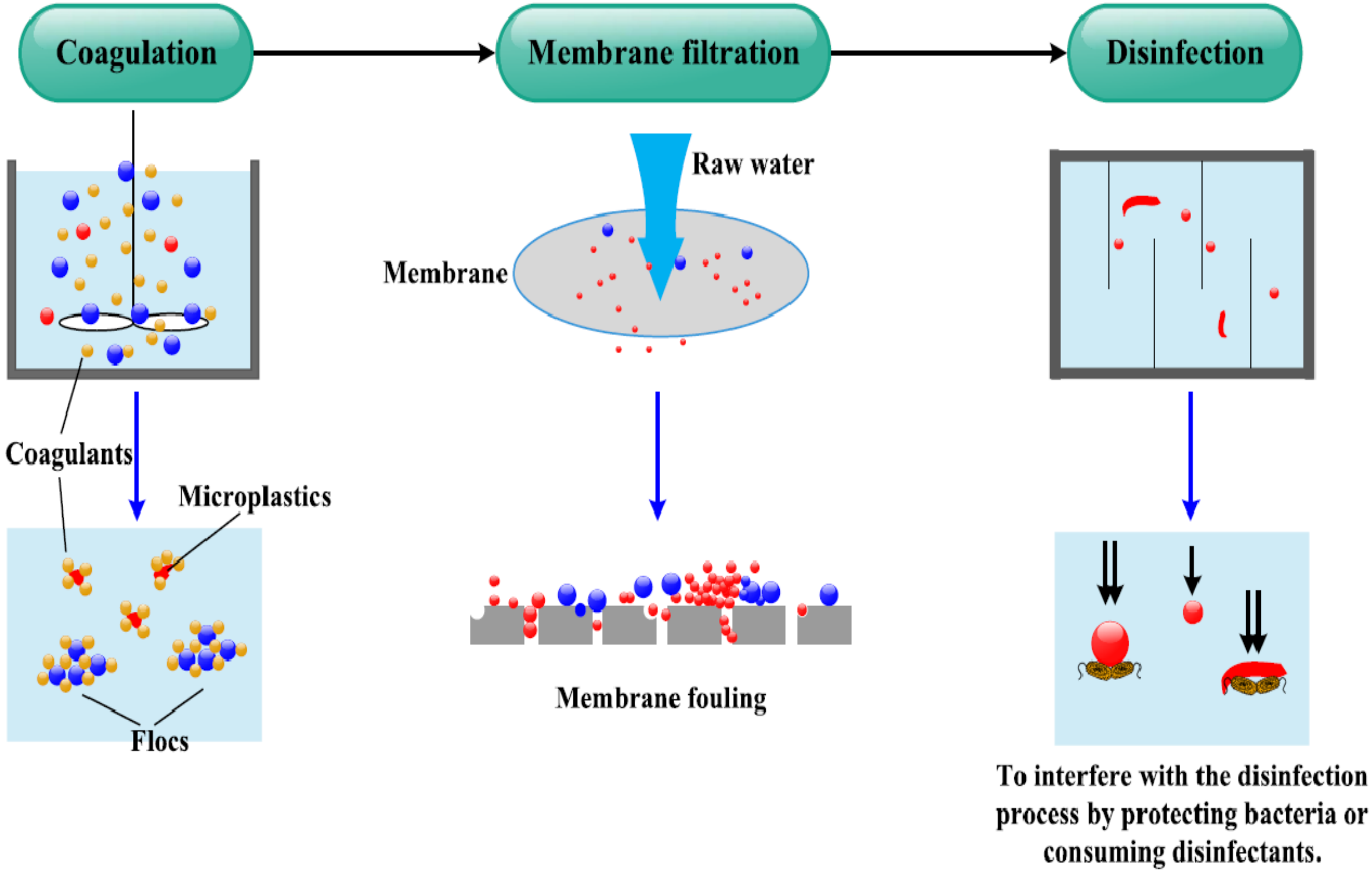


Park and Park., 2021

Conventional Drinking Water Treatment Plants

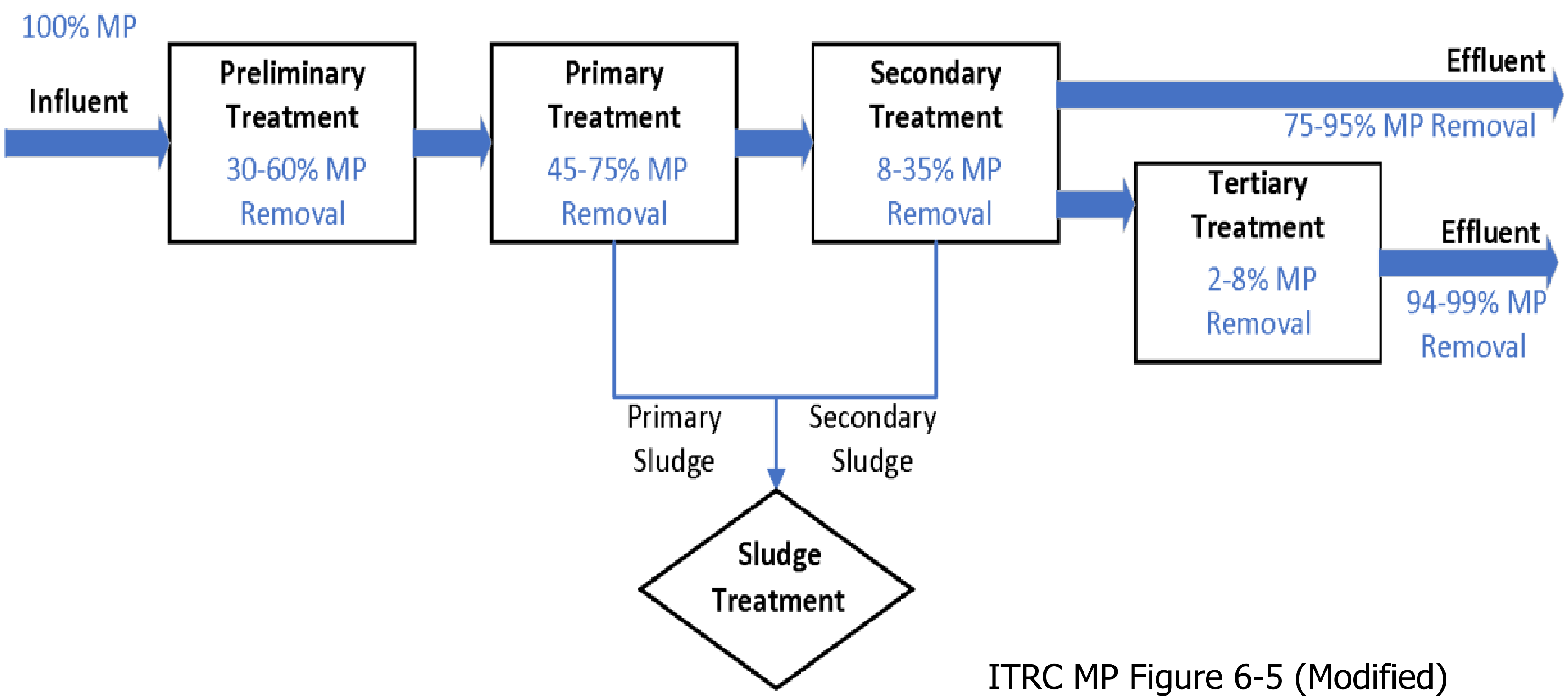


Challenges Encountered



Shen et al., 2020

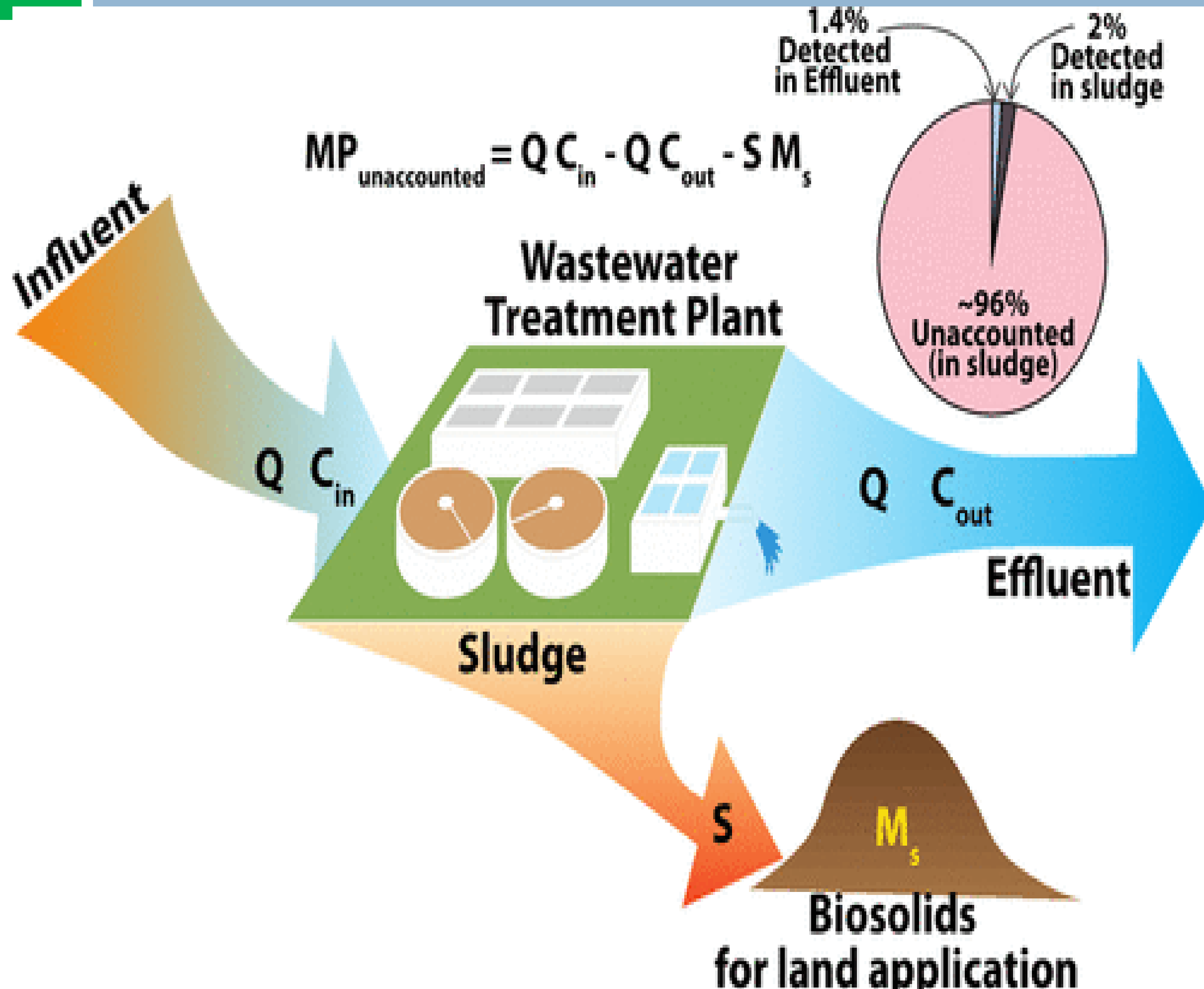
Microplastics Removal in Wastewater Treatment Plants



ITRC MP Figure 6-5 (Modified)

Source: Renee Lu, modified from Ali et al. (2021)

Unaccounted Microplastics in Wastewater Sludge: *Where Do They Go?*



Koutnik et al., 2021

Sampling Artifacts and Detection Limits

- A lack of uniform protocols in sampling and analysis

Fragmentation of plastics during wastewater treatment

- Heat and Physical stress

Biodegradation of MPs at WWTPs

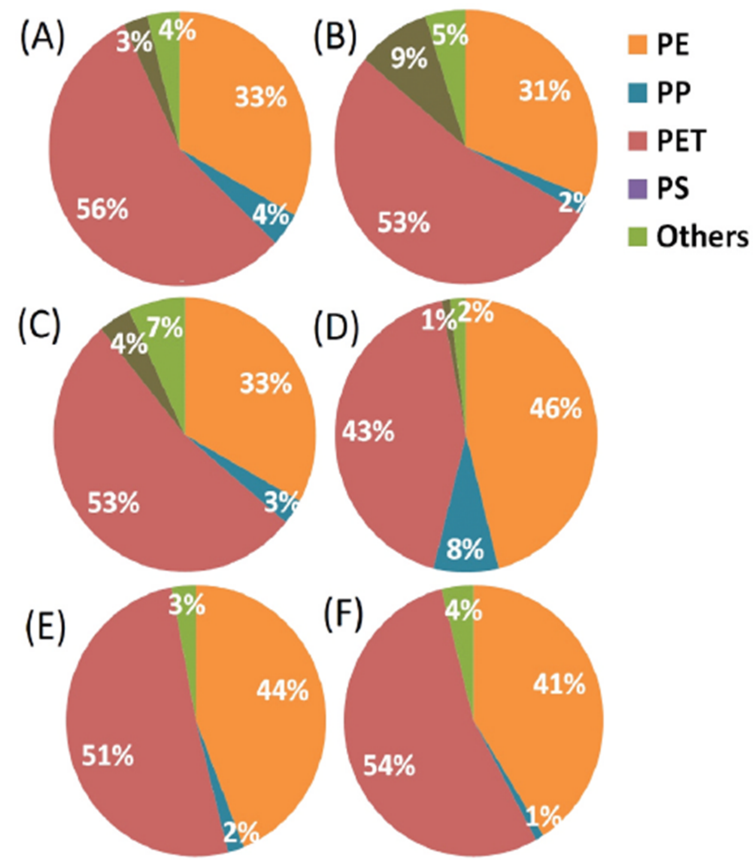
- Fragmentation, heat, carbon source

Microplastic Removal in Drinking Water Treatment Plants

Comparison of microplastics removal efficiency with other studies.

Country	Raw water	System steps	MP size	MP (items/L) Raw water	MP (items/L) Treated water	Removal efficiency (%)	Referenc
Czech Republic	Large reservoir	Coagulation/flocculation and sand filtration	0.2–100 μm	1473 ± 34	443 ± 10	70	Pivokon: et al. (2(
Czech Republic	Small reservoir	Coagulation/flocculation, sedimentation, sand and GAC filtration	do	1812 ± 35	338 ± 76	81	Pivokon: et al. (2(
Czech Republic	River	Coagulation-flocculation, flotation, sand filtration and GAC filtration	do	3605 ± 497	628 ± 28	83	Pivokon: et al. (2(
Germany	Ground water	Aeration and filtration	>20 μm	0–7 items/ m^3	0–3 items/ m^3	-	Mintenig (2019)
Czech Republic	Úhlava River at Milence	Coagulation, flocculation, sand filtration,CO_2, lime and ClO_2 treatment	1–100 μm	23 ± 2	14 ± 1	39.13	Pivokon: et al. (2(
Czech Republic	Úhlava River at Plzeň	Lime milk, coagulation, flocculation, sedimentation, KMO_4 oxidation, sand filtration, ozonation, GAC filtration, UV treatment, CO_2, lime and chlorine treatment	do	1296 ± 35	151 ± 4	88.34	Pivokon: et al. (2(
China	Yangtze River	Coagulation/flocculation, sedimentation, sand filtration, ozonation combined with GAC filtration	1–100 μm	6614 ± 1132	930 ± 72	82.1–88.6	Wang et (2020)
India	Ganga River	Chlorination, coagulation, pulse clarification and sand filtration	25–100 μm	17.86 ± 2.66	2.75 ± 0.92	85.39	Present :

D.J.Sharkar et al., 2021



Percentage distribution of plastic types (PE, PP, PET, PS and others) at the different water treatment steps (A. Raw water; B. Pre-disinfection; C. Flocculation; D. Pulse clarification; E. above Sand filtration

Overview: Microplastics in Water Treatment Plants

Removal with Conventional Technologies

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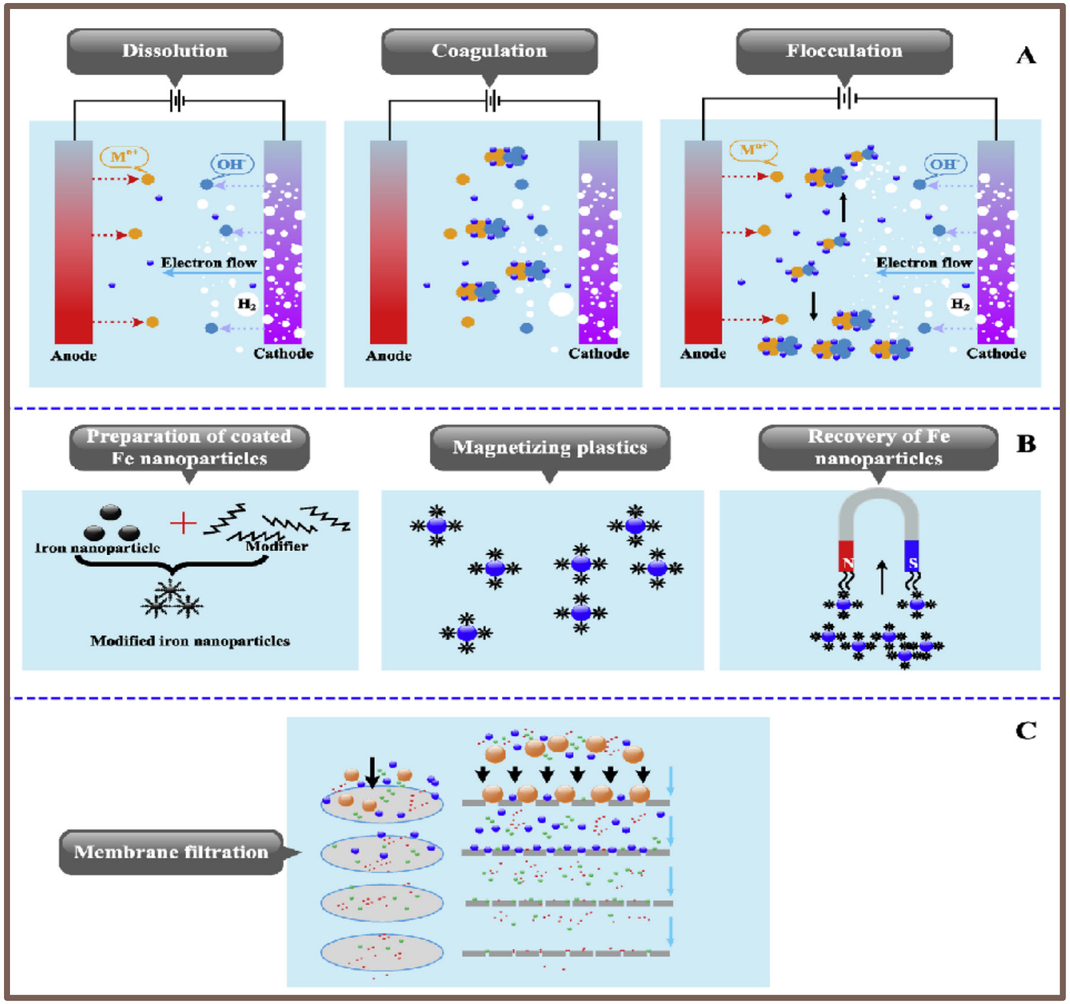
Selected Emerging Technologies



Shen et al., 2020

A. Electrocoagulation
   i. Laboratory Scale
   ii. Optimum removal efficiency~99.24% (Perren et al., 2018)
B. Magnetic Extraction
   i. Better removal of small MPs (<20 μm)
   ii. Suitable for drinking water treatment and not preferred for sediment
C. Membrane Separation
   i. Fouling
D. Sol-Gel Method

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Management of Water Treatment Wastes

Sludge	Membranes	Filtration Concentrate
• Landfill • Incineration • Agriculture • Cement, glazed tiles and ceramic[1,2,3] • Lime stabilization • Composting • Anaerobic digestion • Thermal drying	• Reusing ROs for NF and UF[4] • As geotextile for stabilizing rocks and retarding grass • No studies available prior to their reuse and recycling	• Electrodialysis and shear enhanced NF/RO to remove nutrients[5] • UV and TiO_2 in photo-oxidative removal of diclofenac (> 95%), ibuprofen (> 95%) and naproxen (< 65%) from the concentrate of a nanofiltration • No studies available targeting the microplastics

1 Dahhou et al, 2018 2 Cremades et al., 2018 3 Rodriguez et al., 2010 4 Mohamedou et al., 2010 5 Arola et al, 2019

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Key Challenges and Knowledge Gaps

- No two WWTPs are identical:
  - Connectivity of wastewater system
  - Wastewater treatment processes
  - Sludge treatment process

- Sources of microplastics to WWTPs
- Effect of different wastewater and sludge treatment processes
- Lacking standardized methodologies
- A full-size distribution of plastic particles in sludge

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Conclusions and Future Research

- Efficiency of microplastics removal
- Range of compositions in the effluent of WWTPs
- Gaps related to the efficiency of treatment technologies
- More research related to the fate of MPs in the WTPs as wells as technologies removing MPs

What do all these things have in common?

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