## Executive Summary

Current water treatment processes represent an effective method for removing particles across a wide size range (from dissolved and colloidal up to particles of a few mm), and microplastics (MPs) can be considered as another type of particle. Hence, this project aimed to provide a sound understanding of how current drinking water processes manage the presence of microplastics (MPs) and whether their presence in potable water may pose a potential risk to human health. With this purpose, the following objectives were considered:

1) Review existing literature on occurrence of MPs in water sources, drinking water, the relative importance of different sources of inputs to water and removal by drinking water processes.
2) Review the methods of analysis that have been used to determine MPs in water.
3) Summarize existing knowledge on human exposure to MPs through food, water and air and any associated risk assessments.
4) Conduct bench scale experiments to determine the efficiency of removal of a different sizes and types of MPs by a range of drinking water treatment processes.
5) Based on the findings of the bench study and other aspects, propose an approach to monitoring a small number of final waters for MPs.

Microplastics were found to be ubiquitous in surface water bodies (i.e. lakes, reservoirs and rivers) worldwide. At the catchment level, most of the documents linked MP presence to urban areas where domestic effluents and industrial activities were suggested as main MP sources. From a quantitative point of view, MP abundances showed high variability (0 to 519,000 MP/$m^3$) owing to environmental variations and sampling uncertainties. Overall, 50 μm was the most reported lowest size value, since researchers found it very difficult to visually separate MPs from non-plastic particles and the particle size threshold for detection by FTIR is 20 μm. Regardless of water body or geographical location, fibres between 50 and 300 μm were numerically dominant in most of the documents. From a chemical point of view, the polymers more frequently identified were polypropylene (PP) and polyethylene (PE).

Uptake of MPs in the human gastrointestinal tract is restricted to the fraction of particles < 150 μm (i.e. ≤ 0.3% of the exposed dose). Only particles < 20 μm in size are thought to be able to reach other organs following ingestion. Some evidence suggested an association of ingested MPs with local inflammation, altered gut microbiome and altered lipid metabolism that may impact human health. Nevertheless, the contribution from MPs to total daily exposure is likely to be low or insignificant. While there is a potential risk to the lungs from any suitably small low solubility particles or fibres if inhaled in sufficient quantity, this is considered unlikely for human exposure to MPs in the environment. It is noted that potential risks to human health from exposure to MPs are generally difficult to quantify due to the considerable variability in physical and chemical properties and the lack of a harmonised/standardised method for identifying and/or quantifying microplastics in foods and biological specimens. Nonetheless, this assessment concluded that the risk of adverse health effects from exposure of humans to microplastics in the environment is small. Lack of data precludes consideration of the effects of nanoplastic particles.

Under laboratory-controlled conditions, bench and pilot trials involved four common plastics [PE, PP, polystyrene (PS), and polyethylene terephthalate (PET)] in three different particle shapes (spheres, fibres, and fragments) whose sizes ranged between 20 and 150 µm. To consider matrix effects, the trials were conducted with synthetic and raw waters. In jar tests, coagulation separated 96% of the initial MP load (approximately 1000 particles per litre) in both matrices. Entrapment of MPs inside the flocs' porous aggregates explained the removal mechanism. For plastics lighter than water (PE, PP), smaller particle size seemed to favour removal as smaller MPs incorporated better to the flocs. For heavier plastics (PS, PET), no changes in sinking behaviour were observed between coagulation and free settling. In terms of morphology, spheres and fibres removed better than irregular fragments. Continuous-flow trials in a pilot plant corroborated that coagulation removed the bulk of MPs entering the treatment. In this case, filtration played a critical role to fully retain those minimal numbers of MPs escaping coagulation.

For the tested materials and sizes, results herein reported confirm that coagulation-flocculation (i.e. clarification of water by adding a reagent that destabilizes suspended particles allowing their aggregation in settling flocs heavier than water) combined with filtration (i.e. removal of suspended particles by passing the suspension through a porous material) are robust and flexible processes. These can treat waters containing MPs varying in abundance, composition, and properties without compromising the quality of the final effluent. For monitoring purposes, the two critical points at the water works are the raw water at influent and post-filtration effluents.