

## **World-wide Search and Review of Advanced Sewerage-System Design and Technology**

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**Abstract.** Separate source collection and treatment of urine has several potential advantages as compared to traditional wastewater treatment methods. While urine constitutes only 1% of total domestic wastewater volume, it contributes 50-80% of the total nutrients (nitrogen and phosphorus). These nutrients are costly and difficult to remove by classic wastewater treatment methods, and inefficient removal results in nutrient overloading to surface water. Separation of urine at the source provides the ability to capture nutrients for future use as fertilizer, thus minimizing point source loading of nutrients to surface water. Because urine rarely contains pathogens, separate urine treatment offers the ability to capture nutrients in the absence of pathogens prior to combination with fecal material containing high levels of pathogens. In addition, urine is the primary source of pharmaceuticals present in domestic wastewater and source separation can enable removal of these pharmaceuticals, preventing their release into the environment. According to recent studies, removing micropollutants from urine will reduce the ecotoxicological hazards posed by micropollutants in the environment by as much as 50%. While source collection and treatment of urine can offer advantages over traditional wastewater treatment methods, technologies for doing so are still in the development phase and have not been demonstrated on a large scale. Research conducted in Switzerland, by the Swiss Federal Institute of Aquatic Science and Technology, incorporates social, economic, and technical aspects of urine source separation and treatment, as well as investigations of physical, chemical, and biological treatment methods. The Ecosan Program (Recycling Oriented Wastewater Management and Sanitation Systems) in Germany is currently implementing a urine and brownwater source separation and treatment system in a 300-person office building with reuse plans for agriculture. In addition, NASA has researched membrane-based methods for treatment of urine on space missions for water reclamation. These and other research groups have laid the foundation for further development, optimization, and application of urine separation and treatment technologies. The research conducted at Colorado State University this year will review and synthesize research to date and will direct a path forward for future demonstration studies. Funded by the Water Environmental Research Foundation through the EPA's "Innovation and Research for Water Infrastructure for the 21<sup>st</sup> Century" Program