

Engineering Resilient Urban Ecosystems

The primary focus of Biopolus is the development of integrated smart nature-based technologies and solutions for improving the circularity, efficiency, and climate resiliency of cities.



Biopolus harnesses ecological engineering to create operational living systems that harness clean water, energy, food, nutrients and minerals from wastes and available resources.



Biopolus urban planning and consulting integrates existing infrastructure with high-tech urban circularity infrastructure and NBS-nature-based solutions to create resilient and sustainable urban metabolic pathways.

Sustainable technological solutions are usually fragmentary and insufficient during building, architecture, and urban design, with solutions for water, energy, and waste handled separately and without a holistic approach. **Solutions must be interconnected and woven into the fabric of the environment, establishing an engineered ecosystem that supports circular and sustainable metabolic flows.**

Biopolus works with all partners, including local stakeholders, to **create and implement NBS-nature-based solutions that work with or leverage the existing built environment** while simultaneously **enhancing the natural environment**. This dual approach maximizes **beauty, liveability, and biodiversity**, all while maintaining a strong focus on **symbiotic benefits for cost-effectiveness and efficiency**.

Decentralized NBS Solutions for Accelerated Positive Impacts Locally



Figure 1. Attractive and compact, this decentralized NBS facility uses Biopolus MNR technology to treat and recycle 50m³/day wastewater, with options for energy & organic waste recovery.

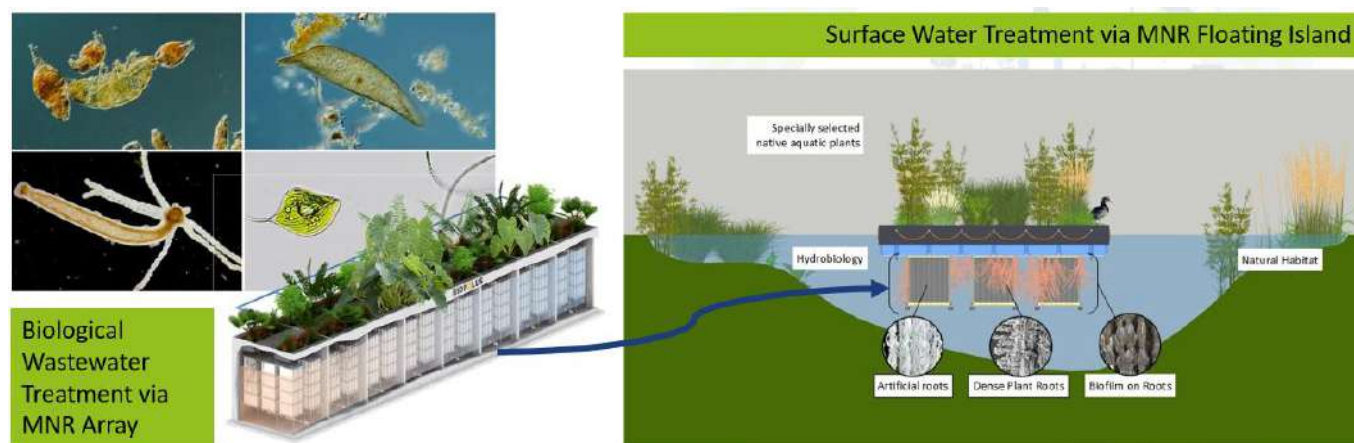
Incorporating NBS with circular economy principles directly and effectively benefits local communities by transforming urban risks into assets.

This integrated approach—using systems like SUDs (Sustainable Drainage Systems) and NBS solutions like Biopolus’ small, decentralized NBS WWT facility for wastewater treatment, flood, and drought prevention—works with new and existing infrastructure to generate rapid, tangible local impacts. Locals

immediately experience enhanced liveability through cleaner waterways and restored green spaces that boost biodiversity and mental well-being. Furthermore, flood risk is lowered, offering economic security, while the circular recovery of water, nutrients, and heat from waste streams leads to cost-

effective and resilient local utilities, establishing a more resource-independent and sustainable urban community.

Bioengineering the Natural Environment



The **Biopolus Metabolic Network Reactor (MNR)** is a nature-based technology for **high-level water treatment**. It relies on a uniquely **engineered ecosystem** containing **2,000 to 3,000 species** (microbes, plants, and higher-level organisms). The MNR treats various water types—including **wastewater and urban surface water**—by utilizing natural and synthetic roots to provide optimal surface area for a robust, **aerated microbial biofilm** that actively breaks down contaminants.

Complex NBS Stormwater Management at the Pileparken 6 Housing Complex in Gladsaxe, DK as part of the euPOLIS project aimed to improve public health in cities by introducing nature-based solutions into urban planning practices.

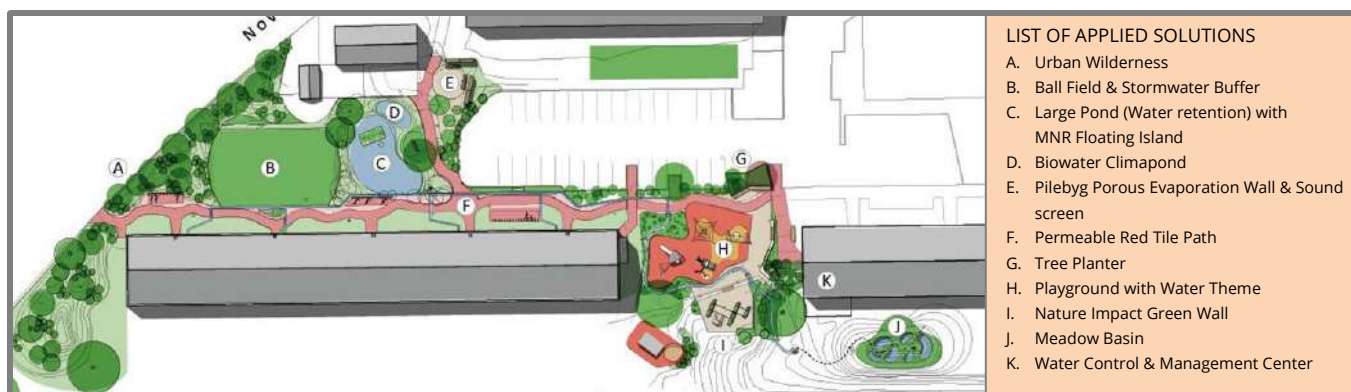


Figure 2. Picture above is a depiction of the Gladsaxe site with applied solutions (listed A-K).

Overall, the project sought to demonstrate the potential of integrating recreational green spaces with stormwater management, and to provide valuable, data-driven insights into the viability of balancing water retention, evaporation, and infiltration as methods for climate adaptation in urban areas.

Biopolus was responsible for the planning and design of the integrated water management and aeration / circulation system, in addition to the MNR floating island water treatment installation. Benefits of the system include: stormwater retention, water treatment & good ecological water quality maintenance, flood prevention, climate change adaptation, ecosystem restoration, increased biodiversity, and human health benefits through leisure areas and interaction with nature.

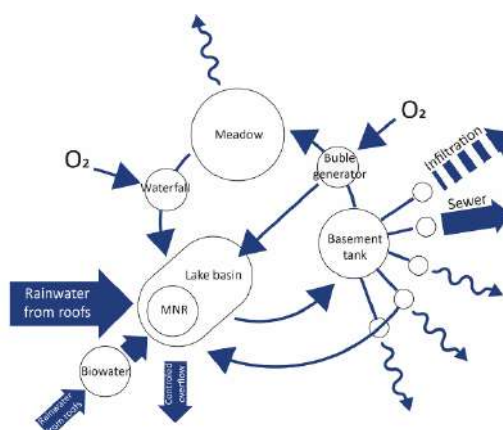


Figure 4. (left) Attractive, complex, nature-based ecologically engineered environment (with MNR floating island) designed to treat and maintain good ecological quality surface water. (right) Diagram of the stormwater management system. The design focuses on balancing water infiltration, evaporation, and retention to establish an ecosystem that is resilient to extreme weather events (wet seasons, droughts, and heavy rain).

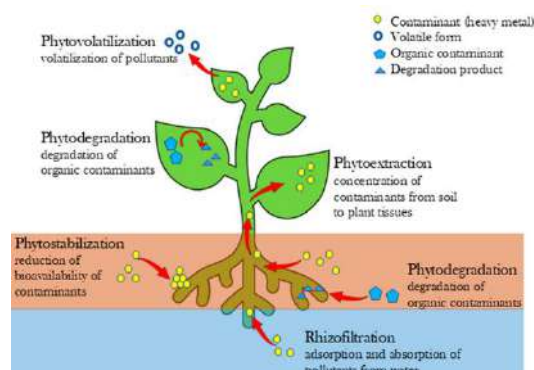


Figure 5. Schematic representation of different phytoremediation approaches by plants. Figure from Applied Sciences.

Phytotechnology is an applied science that leverages the **natural capabilities of plants and associated microbes** to solve environmental problems, often in conjunction with engineered systems. As an NBS in urban design, **phytotechnology involves strategically integrating engineered green systems into both interior and exterior landscaping to perform critical ecological functions.** This approach is used to manage stormwater runoff, filter air and water pollutants, regulate microclimates, and even remediate contaminated soil, effectively transforming previously separate urban challenges into integrated, resilient, and aesthetically valuable green infrastructure.

Biopolus applies its phytotechnology expertise in its advanced biological MNR water treatment systems and through its innovative biofilter solution, whereby a biofilter green roof prevents odors, enhances air quality, provides thermal insulation, while also creating additional habitat for increased urban biodiversity. **Phytotechnology expertise is integral to successful NBS design and application, requiring additional skill to create the resilient and sustainable metabolic flows essential for long-term plant and green space health.** Biopolus addresses this need through its specialization in circular water management and nutrient recovery, ensuring the reliable supply of sustainable water and nutrient flows.