



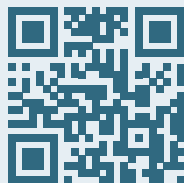
multiplicity

  
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# Extension of the Beggen water treatment plant

[stepbeggen.vdl.lu](http://stepbeggen.vdl.lu)

More information on this project at  
[stepbeggen.vdl.lu](http://stepbeggen.vdl.lu)



#### Project owner



#### Partner



LE GOUVERNEMENT  
DU GRAND-DUCHÉ DE LUXEMBOURG  
Ministère de l'Environnement, du Climat  
et du Développement durable  
Fonds pour la gestion de l'eau

#### Project management



#### Planning



#### Building experts



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# Forewords



**Carole Dieschbourg**

Minister for the Environment, Climate  
and Sustainable Development

## Extension of the Beggen water treatment plant

The Alzette is a waterway  
that shaped the emergence of  
Luxembourg City, and it still  
continues to play a significant  
role in its evolution today.

Water is a source of life, but today human activities are placing it under increasing pressure. As carriers of nutrients such as phosphorus and nitrogen, but also micropollutants such as pharmaceuticals and pesticides, and microplastic pollution, waterways mirror the development of our societies. Today more than ever before, it is vital to protect our waterways, be it by giving them more space to flow as naturally as possible, or by implementing effective wastewater treatment systems. As part of its commitment to help protect the local waterways, the City of Luxembourg has decided to take the major step of enlarging and modernising the Beggen water treatment plant.

Water treatment plants are a potential source of many polluting substances in our environment that come from household wastewater. As the Beggen water treatment plant is the largest such facility in the Grand Duchy of Luxembourg, its potential impact is all the more significant. The planned extension will more than double the plant's treatment capacity – to 450,000 population equivalents – allowing it to accommodate the growing needs not only of Luxembourg City but also of the neighbouring municipalities of Bertrange, Leudelange, Sandweiler and Strassen. In addition to gaining greater treatment capacity, the

Beggen water treatment plant will be modernised through the addition of a fourth treatment stage designed to remove micropollutants and, in doing so, ensure greater protection of the Alzette.

I would like to thank and commend the City of Luxembourg for initiating this important project, and I encourage the City's authorities to continue collaborating with the relevant national authorities. The Ministry of the Environment, Climate and Sustainable Development (Ministère de l'Environnement, du Climat et du Développement durable) supports the municipalities in these endeavours with funding from the Water Management Fund (Fonds pour la gestion de l'eau). For the Beggen water treatment plant project, the State is covering 50% of the cost of the works to bring the existing facilities in line with current standards and to increase treatment capacity, and 75% of the cost of building the fourth treatment stage.

I also want to thank all the staff members of the municipal administration, government authorities and businesses involved for their efforts in executing this project. I am certain that their work will inspire others and that their wholehearted dedication will help us go a long way towards protecting our waterways for years to come.



**Lydie Polfer**  
Mayor of  
the City of Luxembourg

## As a capital city, Luxembourg City is highly attractive as a business, tourist and residential destination.

Over the last decade, the resident population of Luxembourg City has changed considerably: today, the population is some 126,000, whereas in 2011, it was 96,000. This number more than doubles during the day, when large numbers of commuters and cross-border workers come into the city to work.

The population explosion experienced over the past decade presents a challenge for the city, but also an opportunity, in that it drives development, with the very latest technologies being used to cater for the needs of the populace. As stipulated in the Decree of 14 December 1789 on the establishment of municipalities (décret du 14 décembre 1789 relatif à la constitution des municipalités), one of the primary duties of municipal authorities is to ensure that residents enjoy the benefits of a strong public order, notably with respect to cleanliness, hygiene and peace in public streets, places and buildings. That extract from a legal text dating back to the 18th century still holds true today. It is still one of the municipal authority's primary duties to ensure the public space is kept clean and tidy, and that its citizens have a safe environment in

which to live. Alongside waste collection and the supply of drinking water to all households, wastewater disposal is also a key responsibility.

After several years of planning and preparation, we are proud to present the project to extend the water treatment plant in Beggen. The project meets all currently applicable European standards and, with a treatment capacity of up to 450,000 population equivalent, will serve the needs of a constantly growing city.

The new treatment plant, incorporating a fourth stage of filtration, will be one of the most modern plants of its kind in Europe, and will help further improve the quality of water in the Alzette.

We would like to thank all the municipal departments, the Minister for Home Affairs (Ministre de l'intérieur), the Minister of the Environment, Climate and Sustainable Development (Ministre de l'Environnement, du Climat et du Développement durable) and the Water Management Agency (Administration de la Gestion l'Eau) for their commitment, their outstanding cooperation and their invaluable support in getting this huge project off the ground.



**Simone Beissel**  
Alderwoman for infrastructure and  
new construction projects, as well as  
water, energy and sewerage policy

# Extension of the Beggen water treatment plant



## Objectives of the City of Luxembourg

The Beggen treatment plant collects wastewater from the municipalities of Strassen, Bertrange, Leudelange, the locality of Roedgen, Luxembourg City and the area to the west of the airport. As all of these are high-growth areas, in terms both of the number of residents and the volume of economic activity, the Beggen water treatment plant has reached its maximum capacity of 210,000 population equivalent. The capacity of the plant will be upgraded to satisfy a requirement of 450,000 population equivalent by 2047.

Additionally, as the plant discharges large quantities of water into the Alzette – a stream that is relatively small compared to the size of the plant – the Ministry of the Environment, Climate and Sustainable Development (Ministère de l'Environnement, du Climat et du Développement durable) and the Water Management Agency (Administration de la Gestion de l'Eau) have imposed very strict standards.

According to legal requirements, the 24-hour average concentration of ammonium nitrogen ( $\text{NH}_4\text{-N}$ ) must be reduced from 5 mg/litre to 1 mg/litre. The City also intends to significantly improve the removal



of pharmaceutical residues (drug residues, hospital waste and radiological examination waste) and metallurgical residues, reducing concentrations to only a few nanograms per litre. To achieve this target, a fourth stage of treatment will be introduced.





## The project

As the plant's operation cannot be suspended and all standards must be adhered to at all times, the plant will remain operational while the extension works are carried out.

These works include the addition of a new primary sedimentation stage, with four parallel channels, downstream of the existing mechanical treatment stage. After this stage of the treatment process, the City of Luxembourg has opted to add a biological treatment, using sequencing batch reactor (SBR) technology, which is both highly effective and compact. This will be followed by a fourth decontamination stage in which the water is treated using ozone and granular activated carbon.

This technique has been tried and tested, especially in purifying drinking water from natural springs

On account of the growth of the municipalities in the plant's catchment area, initial construction work – referred to as the «DELTA extension» phase – will be needed to ease pressure on the existing biological treatment facility. The reason for partially extending the biological treatment stage is to relieve pressure on the existing installations until the extension works are completed, ensuring the plant can continue to meet all currently applicable legal standards until 2030.



## The project in figures

Budget

**295.314.228,24**  
€ incl. VAT

Site surface area

**~8.8**  
ha

Capacity

**450,000**  
population equivalent

Average daily flow rate

**51,271**  
m<sup>3</sup>/h

Peak hourly flow rate during rainy weather

**9,900**  
m<sup>3</sup>/h

Daily primary sludge flow rate

**20,993**  
kg/d

Daily excess biological sludge flow rate

**15,968**  
kg/d

Daily biogas flow rate

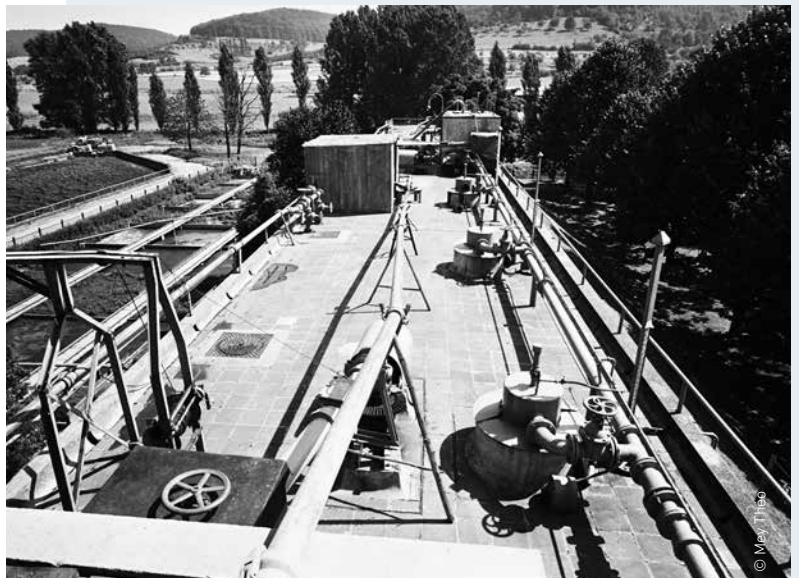
**8,100**  
Nm<sup>3</sup>/d

## Background

Construction on the Beggen water treatment plant began in 1920. Beggen was selected as it is the lowest point in the capital, meaning that waste water would flow towards that point under the influence of gravity.

To meet the needs of its growing population in the 1930s, the City of Luxembourg had a second water treatment plant built in Bonnevoie, which was commissioned in 1936. At around the same time – in 1939 to be precise – the Beggen plant underwent its first extension, and was extended again in 1974.

In the early 2000s, with the entry into force of new legislation, the City decided to centralise all waste water treatment at the Beggen plant and to close down the Bonnevoie plant.



Beggen 1965





Beggen 1970



Beggen 1969



Beggen 1965

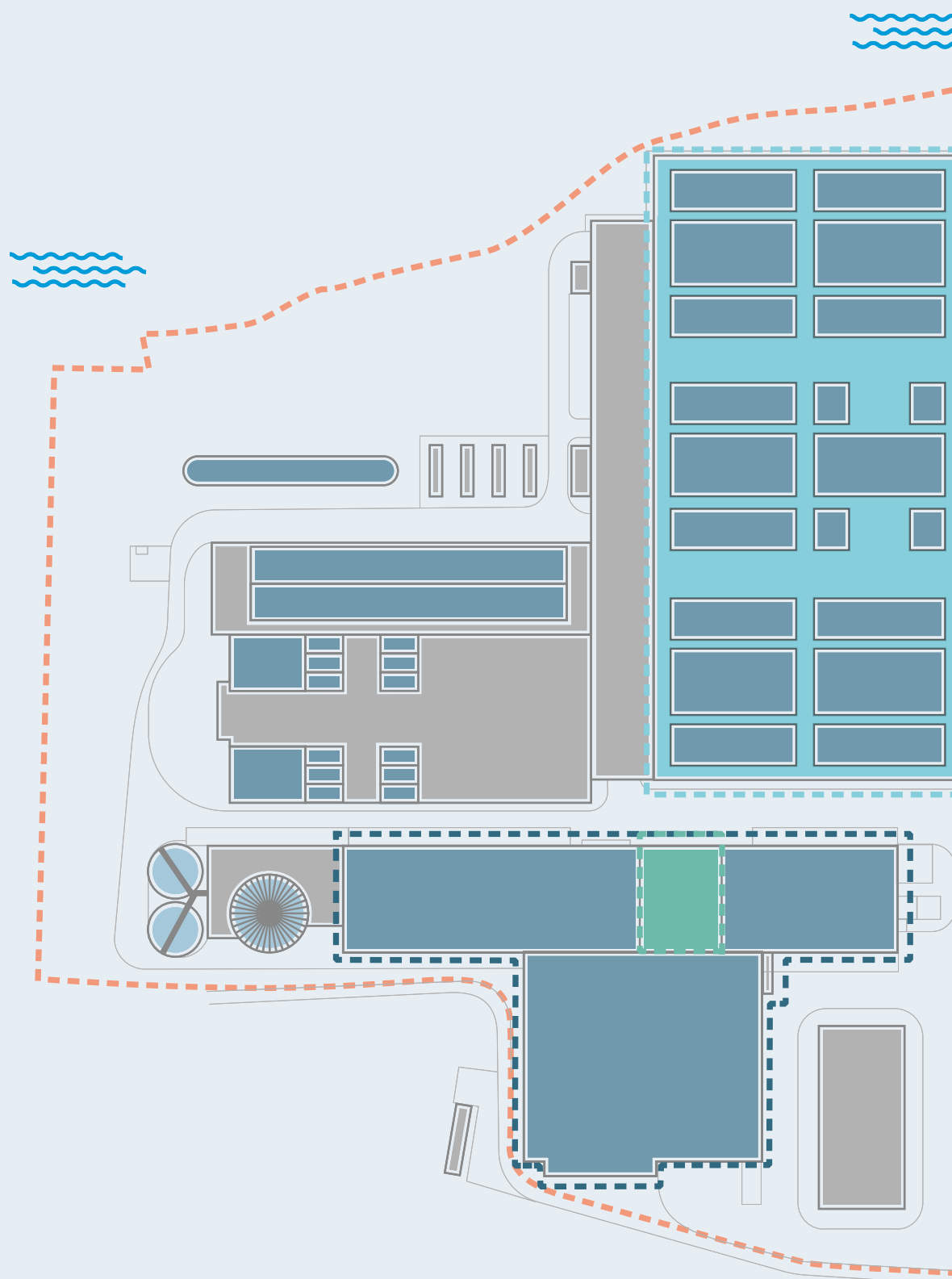


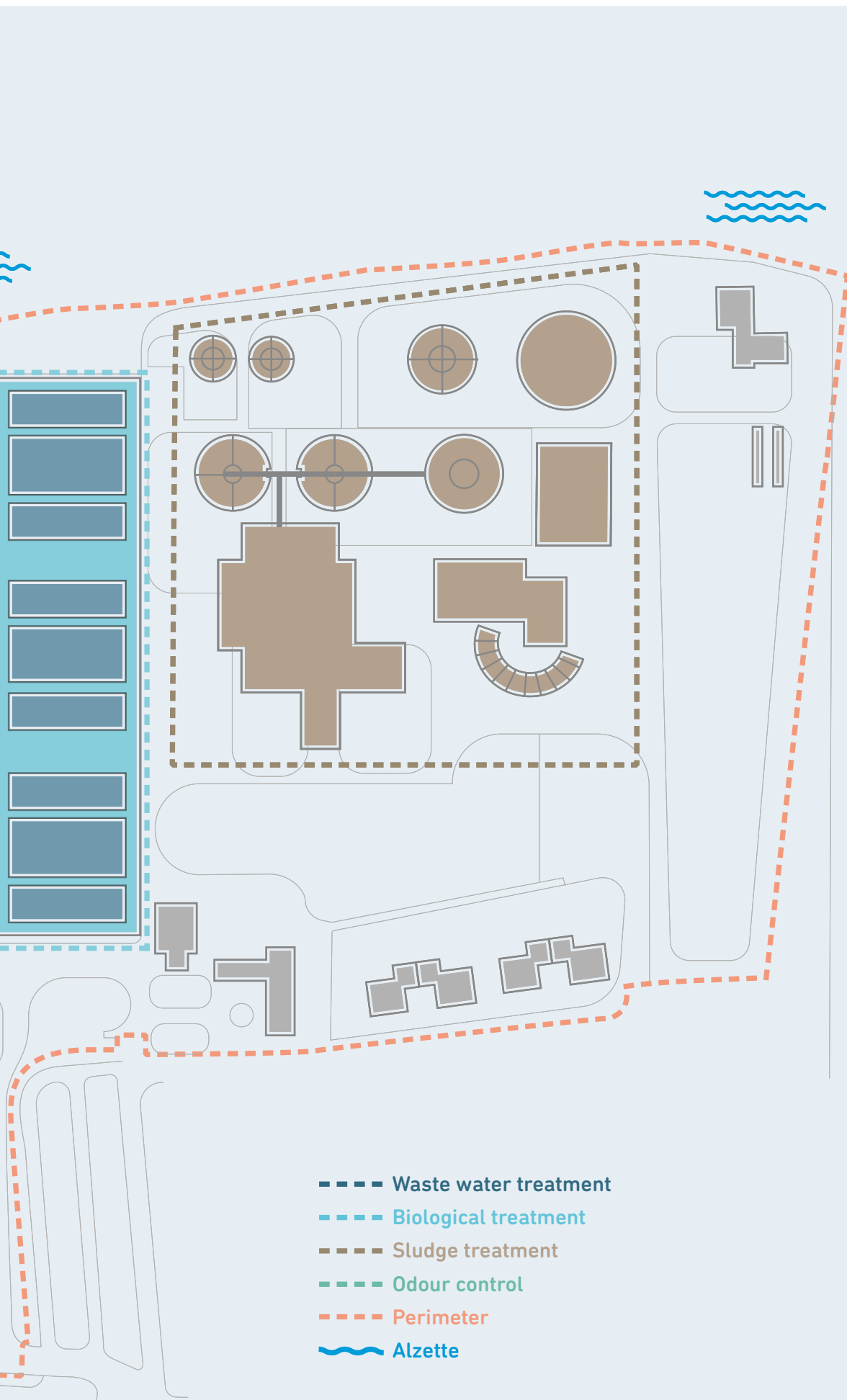
Bonnevoie 2002

From 2007 to 2012, further modernisation and extension works were carried out to meet the population's sewerage needs, and to meet the European standards in force at the time.

The Beggen water treatment plant was inaugurated in October 2011 and began operations in March 2012. At the time, its capacity was 210,000 population equivalent.

## Site map showing various buildings







## Timeline

### Spring 2020

Commencement of work on the «Delta-Extension» phase \*

The following works have already commenced:

- Demolition of the old basins
- Earthworks for 3 SBR \*\* basins and a pumping station
- Structural works for the 3 SBR basins and pumping station

At the same time, the final version of the project proposal was being prepared.

### Summer 2020 – Summer 2022

Application for permits and grants from the various bodies involved in the project (the Ministry of the Environment, Climate and Sustainable Development, and the Water Management Agency)

### July 2021

The municipal council approved the final version of the project proposal

### Summer 2021 – Summer 2022

Detailed design, invitations to tender and public tenders

### 2022 – 2023

Awarding of contracts

(\*) Delta-Extension: initial extension works to cover the needs of a 50,000 population equivalent until the treatment plant is fully operational.

(\*\*) SBR: basins for biological treatment

## 2030

Completion of works and final commissioning of all new infrastructure

## 2028

Construction of infrastructure for the fourth stage of treatment

## 2026

- › Construction of the 3 SBR basins on the Beggen side of the site
- › Commissioning of the biological and mechanical treatment facilities

## 2025

- › Demolition of the existing office building
- › Construction of the 3 SBR basins in the middle of the site

## 2023 – 2025

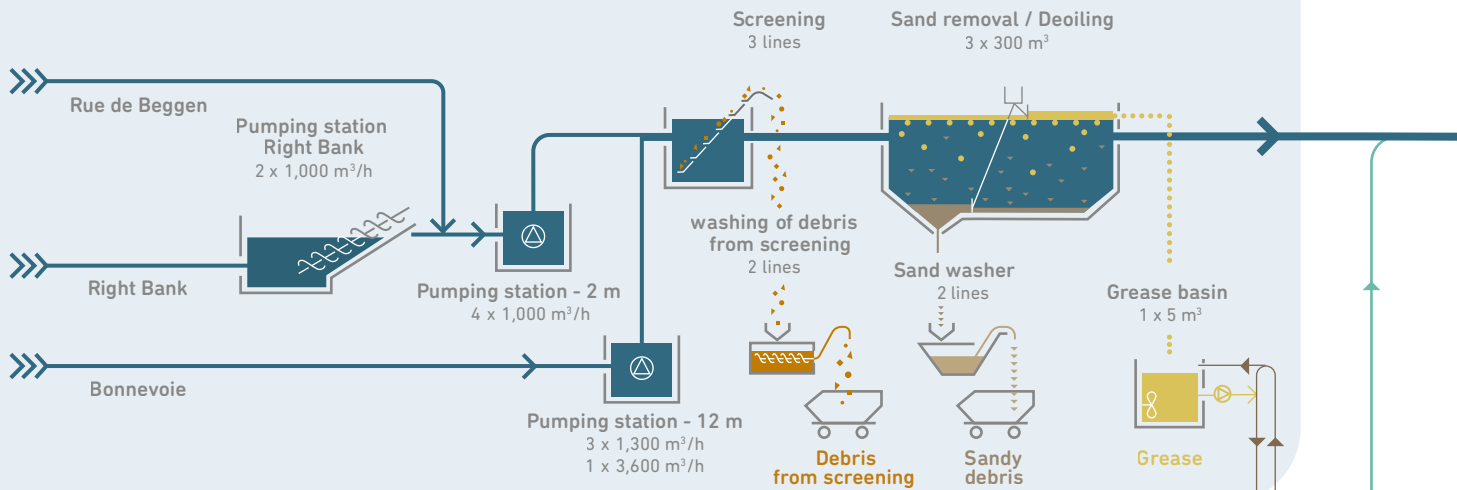
- › Construction of the office building and the new primary clarifier with workshops and storage areas
- › Construction of the 3 SBR basins along the banks of the Alzette
- › Construction of the mechanical sludge-dehydration treatment facility

## 2023 – 2028

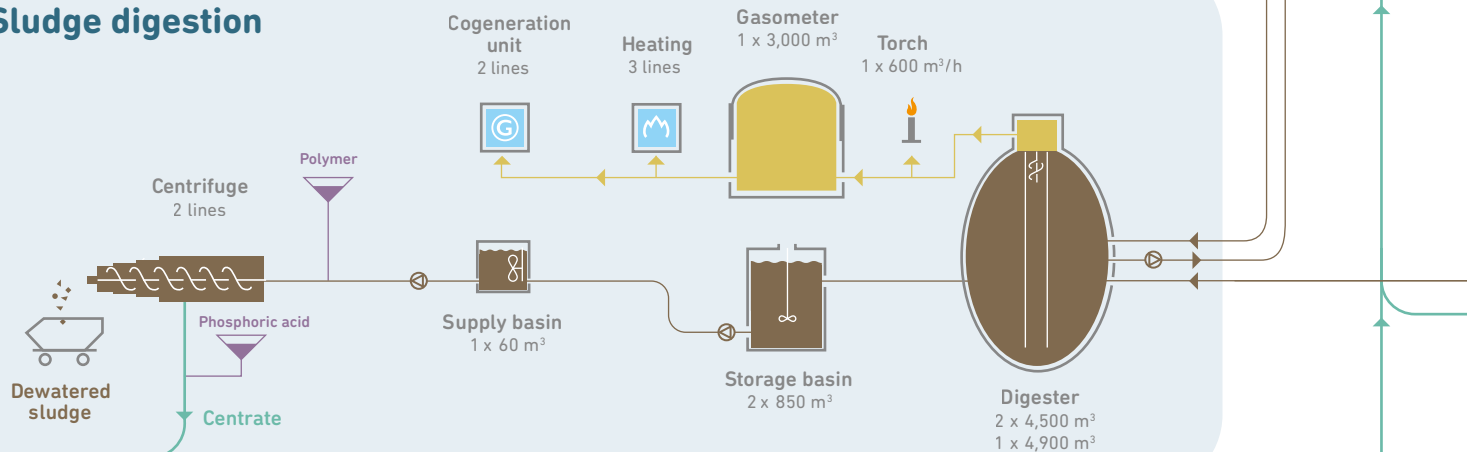
Construction of digester no. 3 and conversion of the two existing digesters

## The various stages in the water treatment process

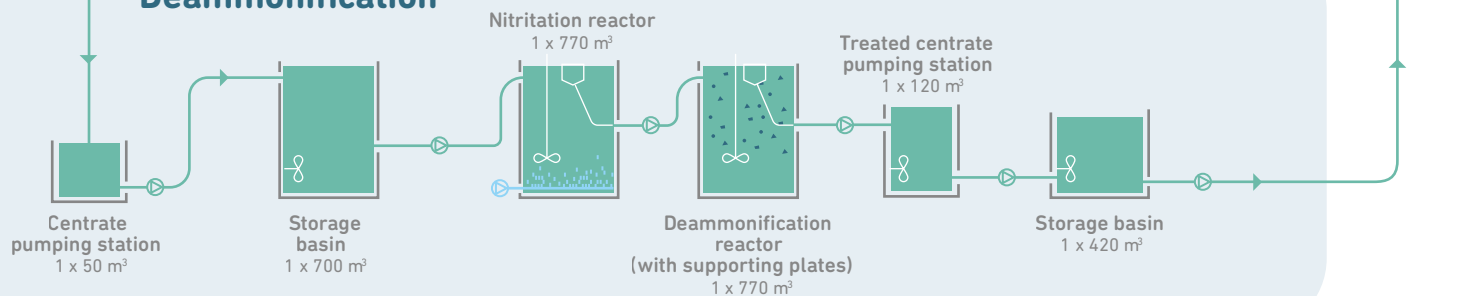
## Mechanical treatment



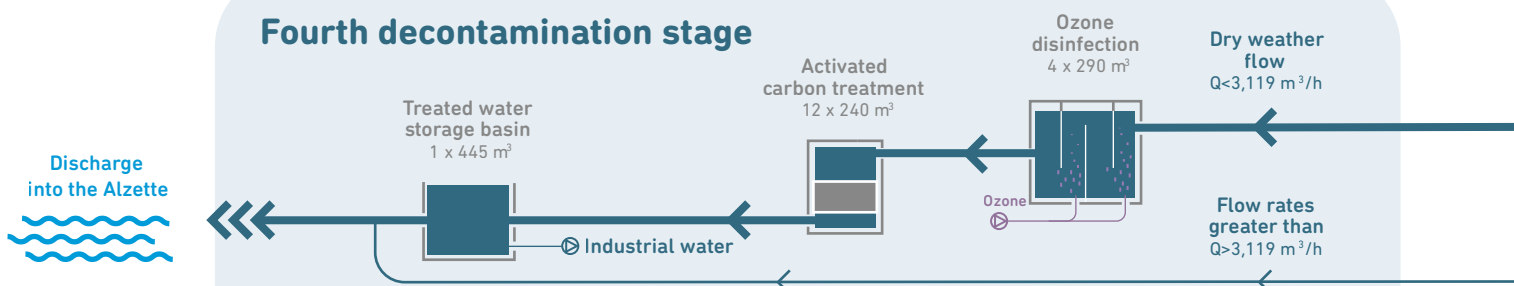
## Sludge digestion



## Deammonification

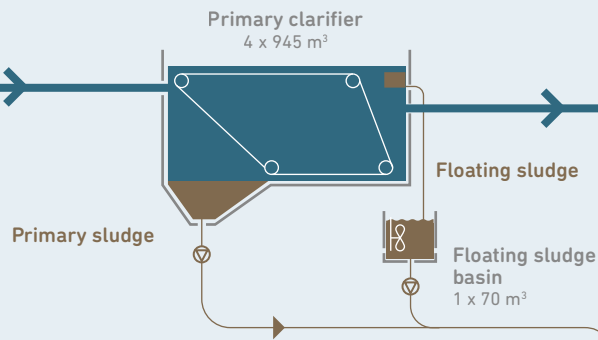


## Fourth decontamination stage

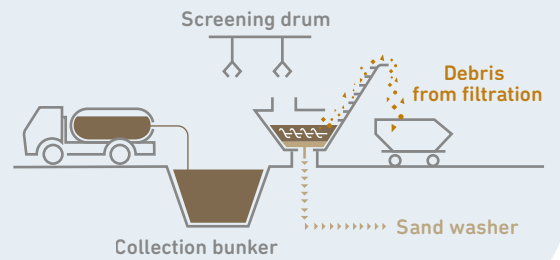




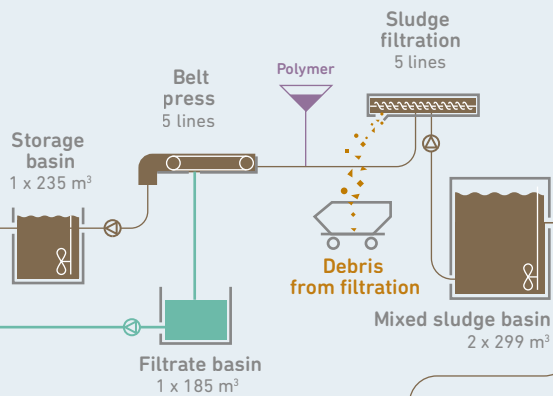
## Primary sedimentation



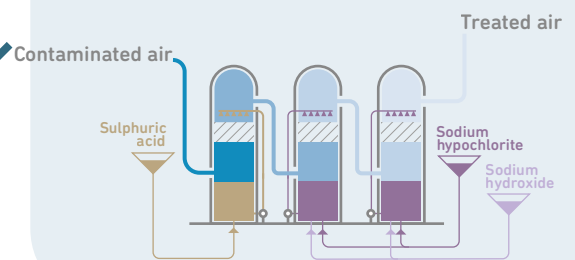
## Collection of sludge from cleaning out collector sewers and drains



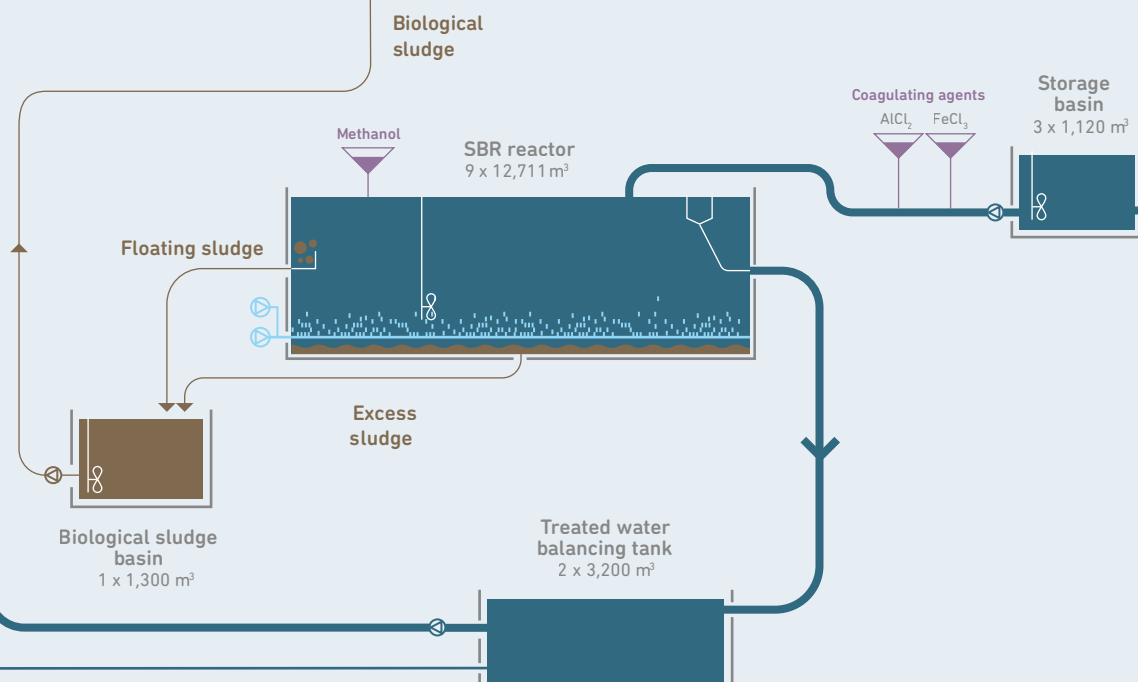
## Sludge dehydration



## Odour control



## Biological treatment



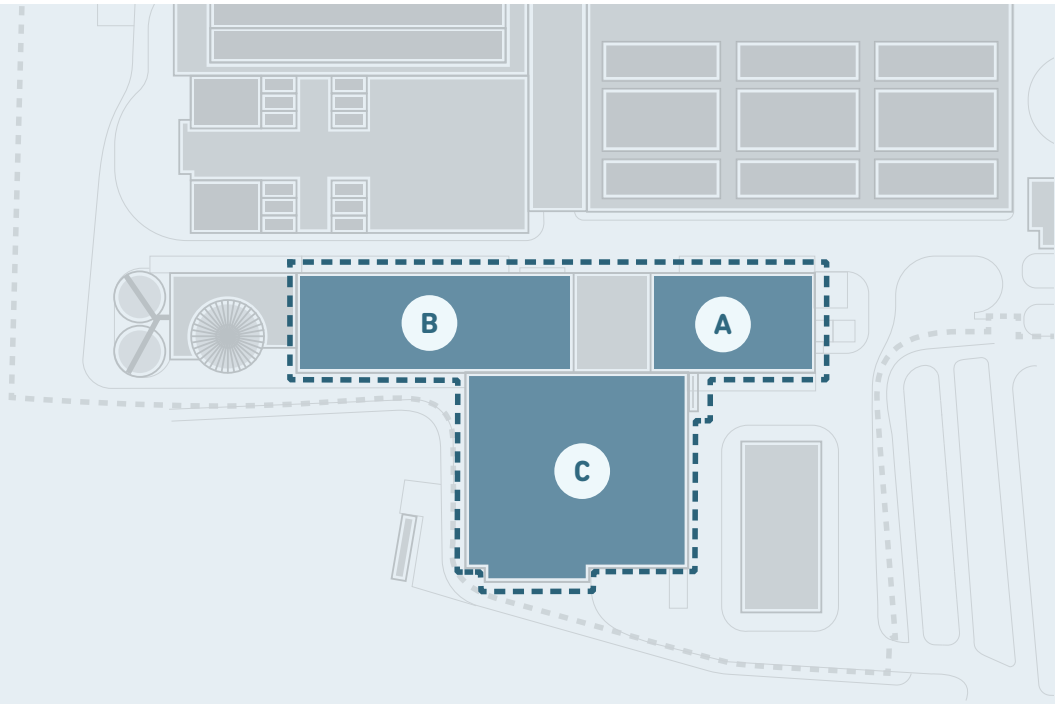
# Waste water treatment

This chapter provides a detailed look at how our water treatment plant works.



## Pumping

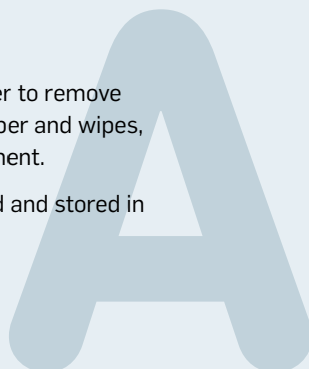
The wastewater comes from collectors located on the right bank, in Rue de Beggen and along the connecting pipe between Bonnevoie and Beggen, and flows into two sumps. The sumps serve to raise the water level so it can flow down to the plant by force of gravity.



## Screening

The first phase is to screen the wastewater to remove waste exceeding 4 mm in size, such as paper and wipes, which could block and damage the equipment.

That waste is then taken away, compacted and stored in bins for removal to the incineration plant.



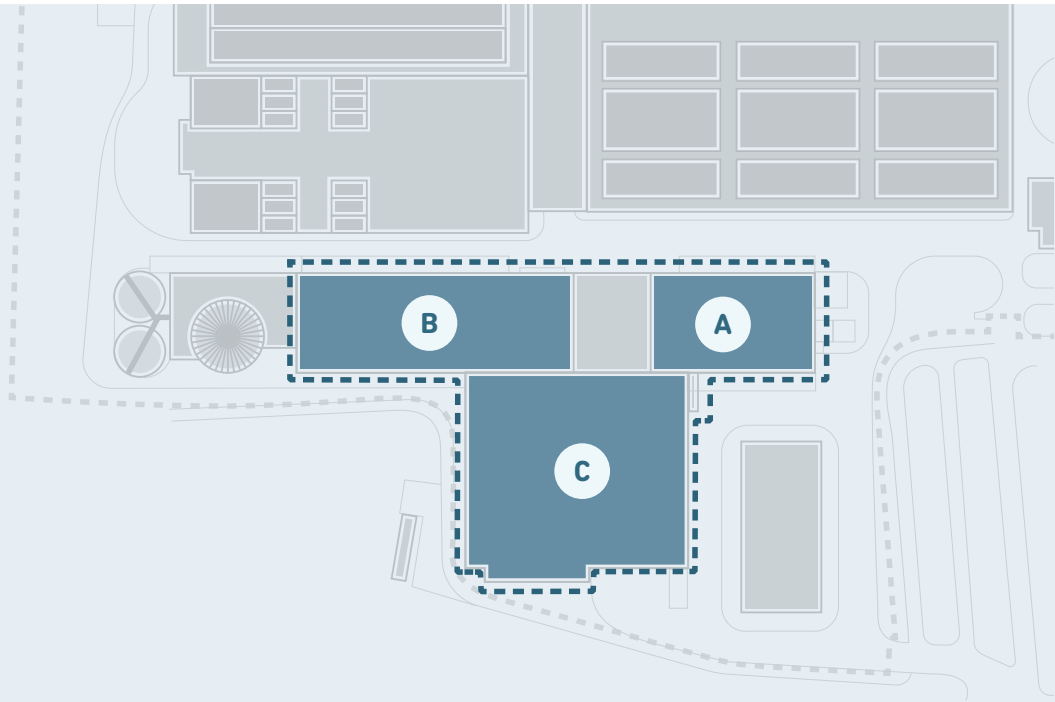


### Degritting/degreasing

The next step in the treatment process is to remove sand (degritting) and grease (degreasing) contained in the water. During the degritting phase, the water flows at a slower rate, allowing the particles of sand to settle to the bottom of the basin. The sediment is then suctioned off, washed and recovered.

Degreasing removes any fats, oils and grease (FOG) in the water. Due to the slower flow rate, greases and other lightweight particles float to the surface, where they are routed by grease collection panels to a new grease collector well. This new collector well will be covered.





## Primary sedimentation

The existing primary sedimentation system will be replaced by a new building in the western part of the site, housing a new pre-treatment system with four treatment lines.



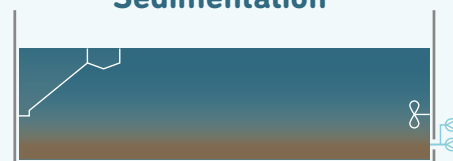
Treated water  
balancing tank



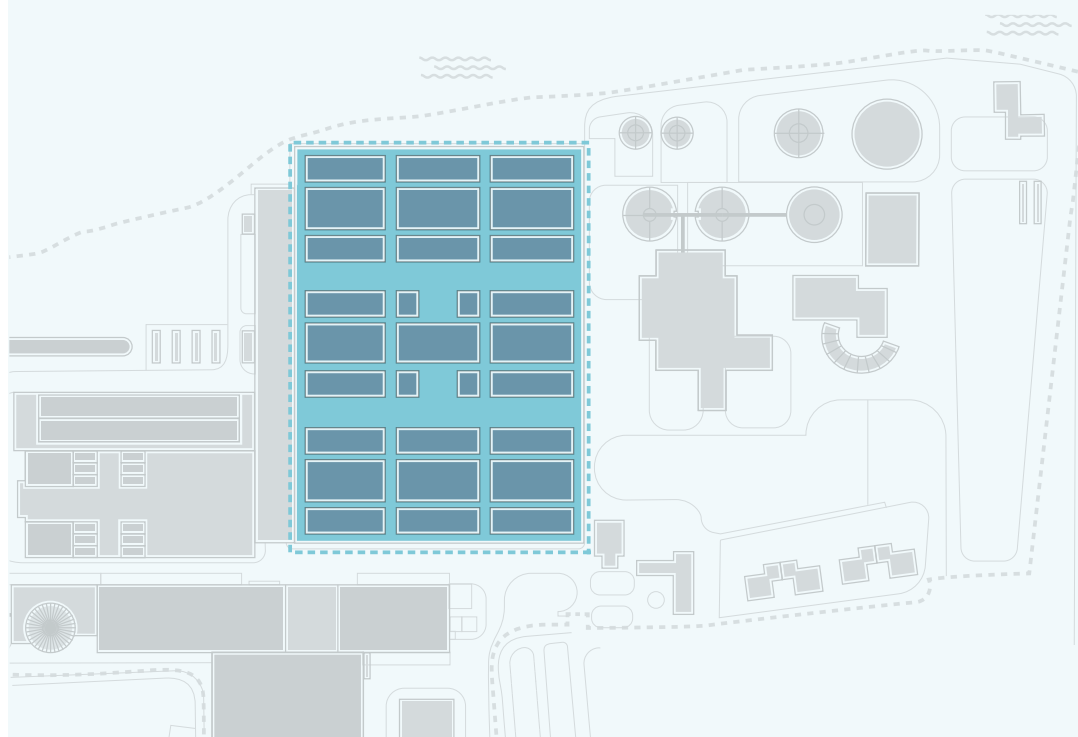
## Biological treatment

To achieve a capacity of 450,000 population equivalent, the biological treatment facility will be equipped with 3x3 SBRs. Whereas in the existing BioStyr® system, nitrification and denitrification take place in sequence at two separate locations, with the SBR system, these treatments can be carried out in succession in a single basin over so-called «cycles». A cycle, which comprises 4 successive phases, can last from 5 to 7 hours.

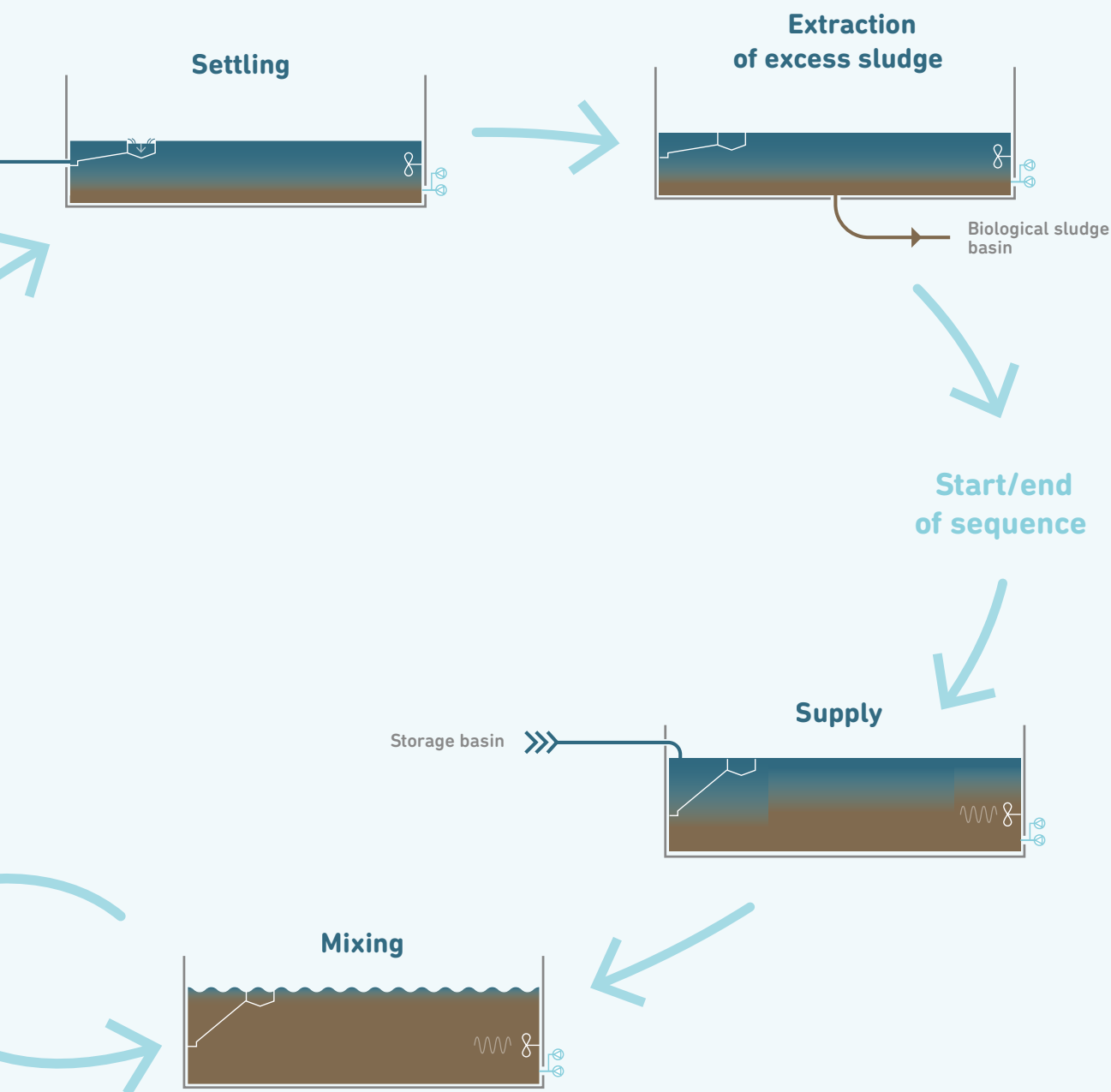
Sedimentation



Aeration







## Supply

The water from the primary sedimentation stage, which is temporarily held in 3 storage basins, is pumped into one of the 9 SBR basins. The already half-full SBR basins are then completely filled.

## Aeration and mixing

The water is mixed by agitators and aerated using membrane aerators to enable the organic matter to decompose the residues.

## Sedimentation

The water is still. Organic matter settles to the bottom of the basin. The water in the upper part of the basin becomes clearer.

## Clear water discharge

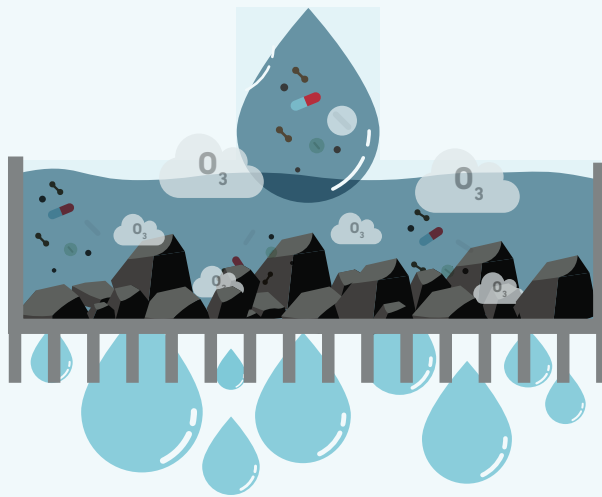
The clear water is discharged into a retention basin. The SBR basin is emptied to half its capacity; the organic matter is not discharged and remains in the basin.

## Extraction of excess sludge

To ensure the level of organic matter remains constant, some of the biological sludge needs to be extracted.

## Treatment with ozone and granular activated carbon

Although many pollutants will have already been removed, there will still be trace amounts of inorganic substances – pharmaceutical or metallurgical residues and pesticides – that will need to be removed. In the fourth stage of treatment, up to 3,119 m<sup>3</sup>/h (maximum flow rate during dry weather) of water is pumped. During rainy weather, the excess is discharged, via a bypass, into the Alzette.



By combining the ozone- and granular activated carbon-treatment stages, a very high rate of pollutant removal can be achieved. Pollutants are removed firstly by oxidation and secondly by adsorption onto the activated carbon particles.

## Sludge treatment

Sludge treatment also entails a number of processes, and requires several buildings and special mechanical engineering. Mainly, these facilities process the large quantities of primary sludge from the primary sedimentation stage, the excess sludge from the SBR reactors, and residual fat. To achieve the target of 450,000 population equivalent, the sludge-treatment infrastructure will be extended, with a new building housing a mechanical sludge dehydration

system. The existing two digesters will be overhauled, and a third one built.

The sludge from the various stages in the purification process is discharged into two basins designed specifically for that purpose.

The sludge is then sieved and thickened mechanically by adding polymers. The residue from the sieving is conveyed to containers for subsequent removal.



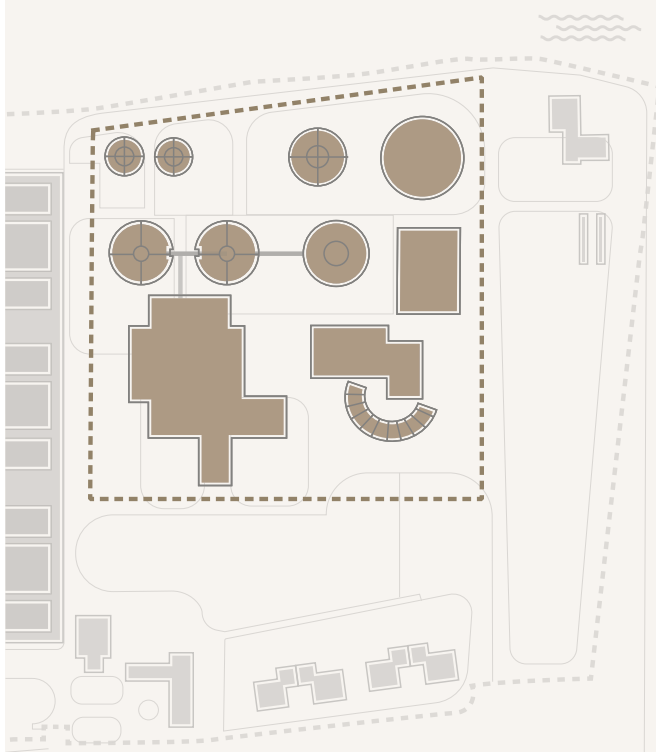
## Sludge treatment

After sieving and thickening, the thickened sludge is then conveyed to the digesters, where it undergoes anaerobic fermentation at approx. 37°C. The resulting biogas is collected in a gasometer. To maintain the temperature required for effective fermentation, each digester has a mixing system, a heat exchanger and a circulation system for sludge used for heating. In these conditions, the fermentation process can be completed in approx. 20 days.

The sludge is then mechanically dehydrated in centrifuges, reducing its dry matter content to between 28 and 32%. It is then taken away for incineration.



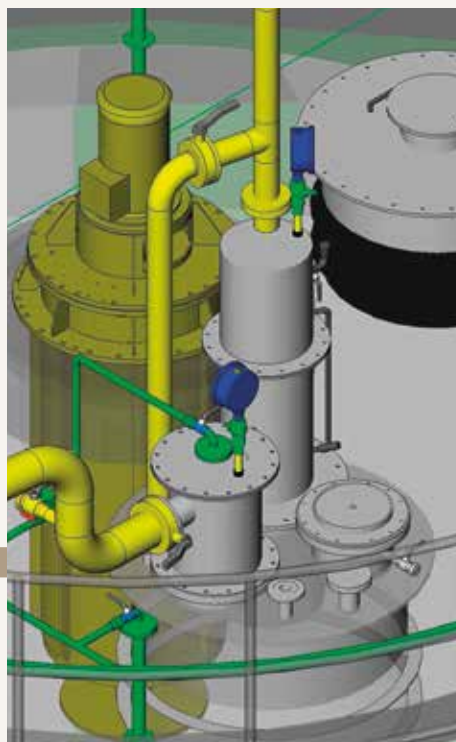
The water from the centrifugation process (approx. 600 m<sup>3</sup>/day), which contains approx. 25% of the ammonium nitrogen recovered by the water treatment plant, undergoes a separate biological treatment known as deammonification (i.e. the elimination of nitrogen).



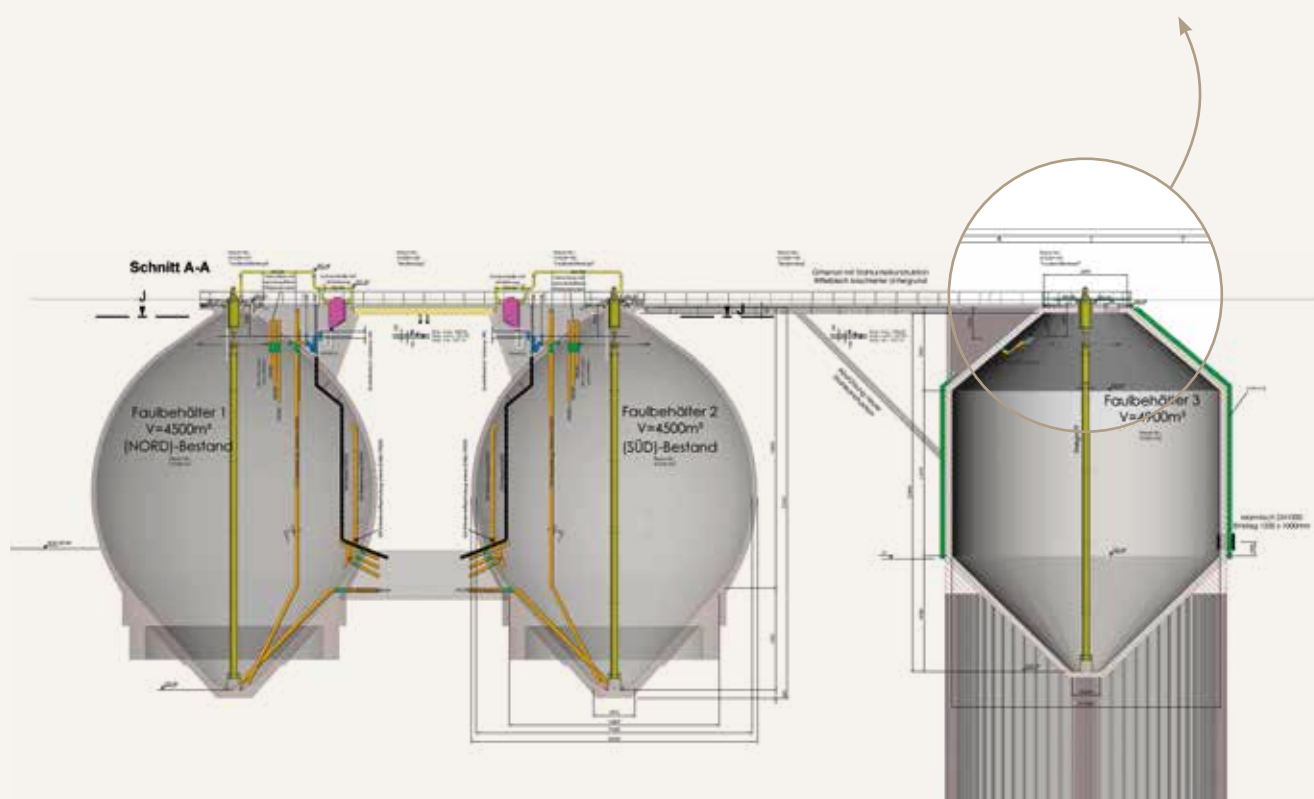


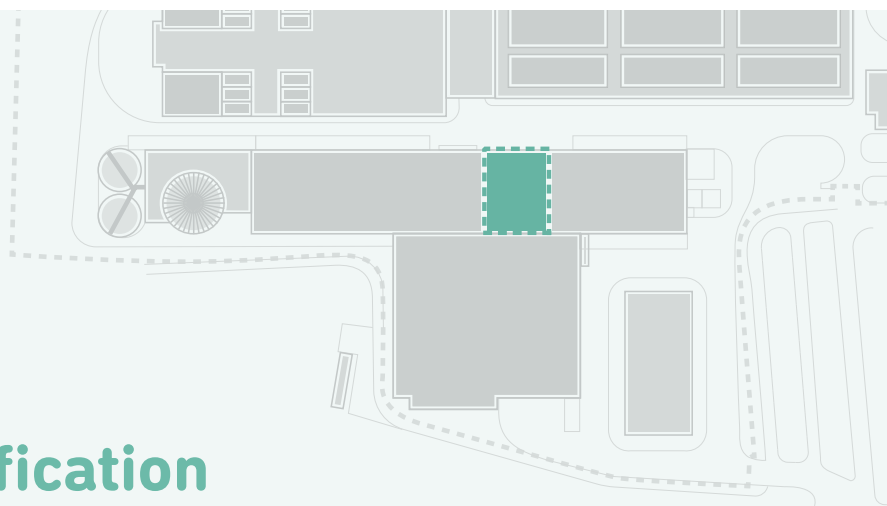
## Biogas

The biogas is stored in a gasometer, until it can be used to produce energy in a cogeneration plant. The electricity produced is fed into the public power grid, and the heat produced is used to heat the digested sludge and the buildings at the water treatment plant.



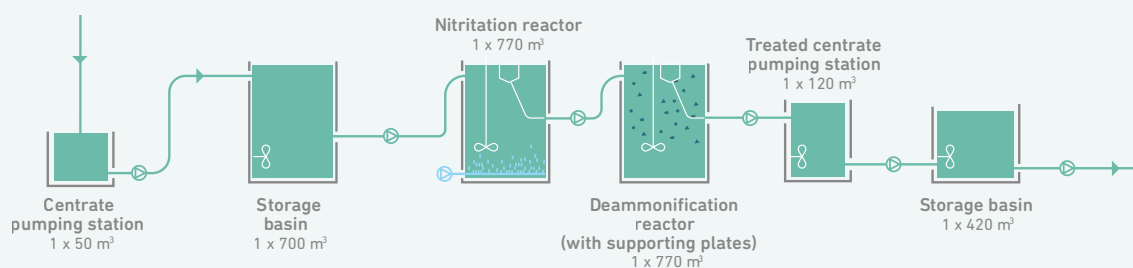
Detailed view of the system for evacuating gas from the digester





## Deammonification

The centrates from the centrifuges (around 600 m<sup>3</sup>/day), which make up around 25% of the treatment plant's ammoniacal nitrogen load, are subject to a separate biological treatment known as «deammonification», or nitrogen elimination.



## Odour control



Polluted air is collected from the various buildings through a network of conduits and blown by fans into the duct feeding the air treatment facility. There, the air is chemically scrubbed as it passes through a series of three towers.





New office building



New building for primary sedimentation, with green façade



New building for sludge filtration and thickening



View from the Alzette





## Impact on the environment

### Residents

The Beggen water treatment plant is on the outskirts of Luxembourg City and the municipality of Walferdange, near several residential areas. The City of Luxembourg is committed to protecting the welfare of its citizens and of those who work in the vicinity of large-scale construction sites. Thus, every effort will be made to minimise any nuisance caused. As part of this project, noise from machinery and unpleasant odours will be reduced as far as possible.

As shown in the pictures and diagrams, the new infrastructure comprises several imposing buildings. Mindful of the aesthetic impact of the project, the City was determined to select a project that includes the installation of green facades and roofs, allowing the treatment plant to fit in better with the natural surroundings on the banks of the Alzette.

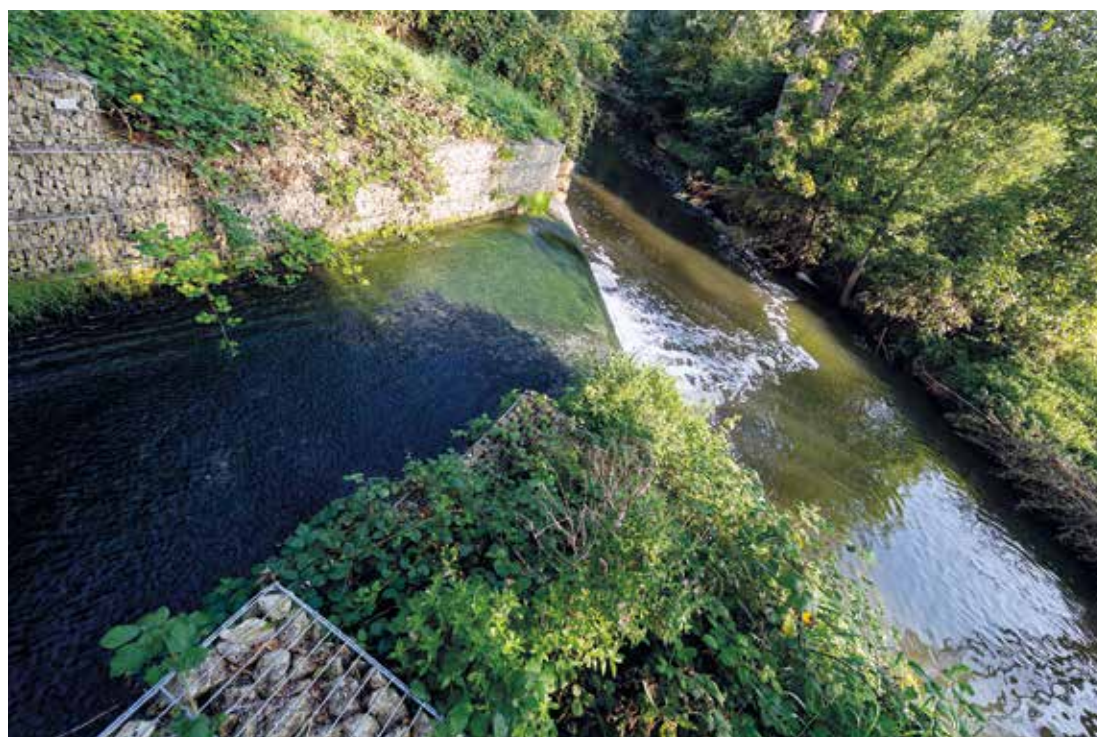
Additionally, in response to requests from local residents, a park will be built near the water treatment plant. As the existing P+R parking area is needed for the new buildings, a new parking zone will be built along *Rue du pont*. A vel'OH! bike station will also be installed, and the site will be connected to the national cycling route network.





## Nature

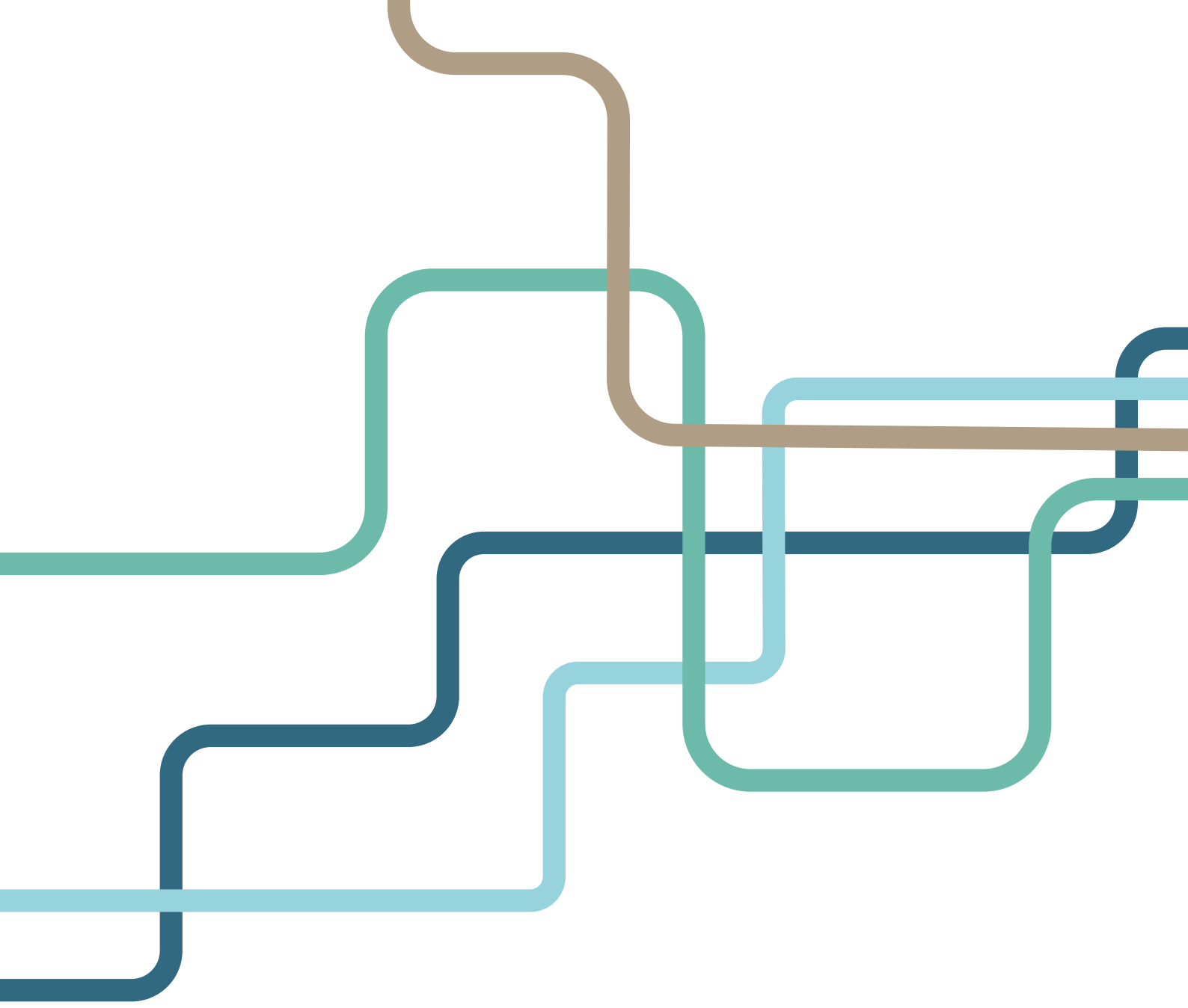
To comply with current legal regulations, and to satisfy the required conditions, the City of Luxembourg will undertake a partial restoration of the Alzette. As similar projects on the Zéissenger Baach and the Pétrusse have done, this will considerably improve water quality and encourage the development of aquatic flora and fauna on the river banks.



**New building for  
sludge filtration and  
thickening**







Ville de Luxembourg | Service de la Canalisation

Beggen water treatment plant  
1 rue du Pont  
L-7245 Bereldange