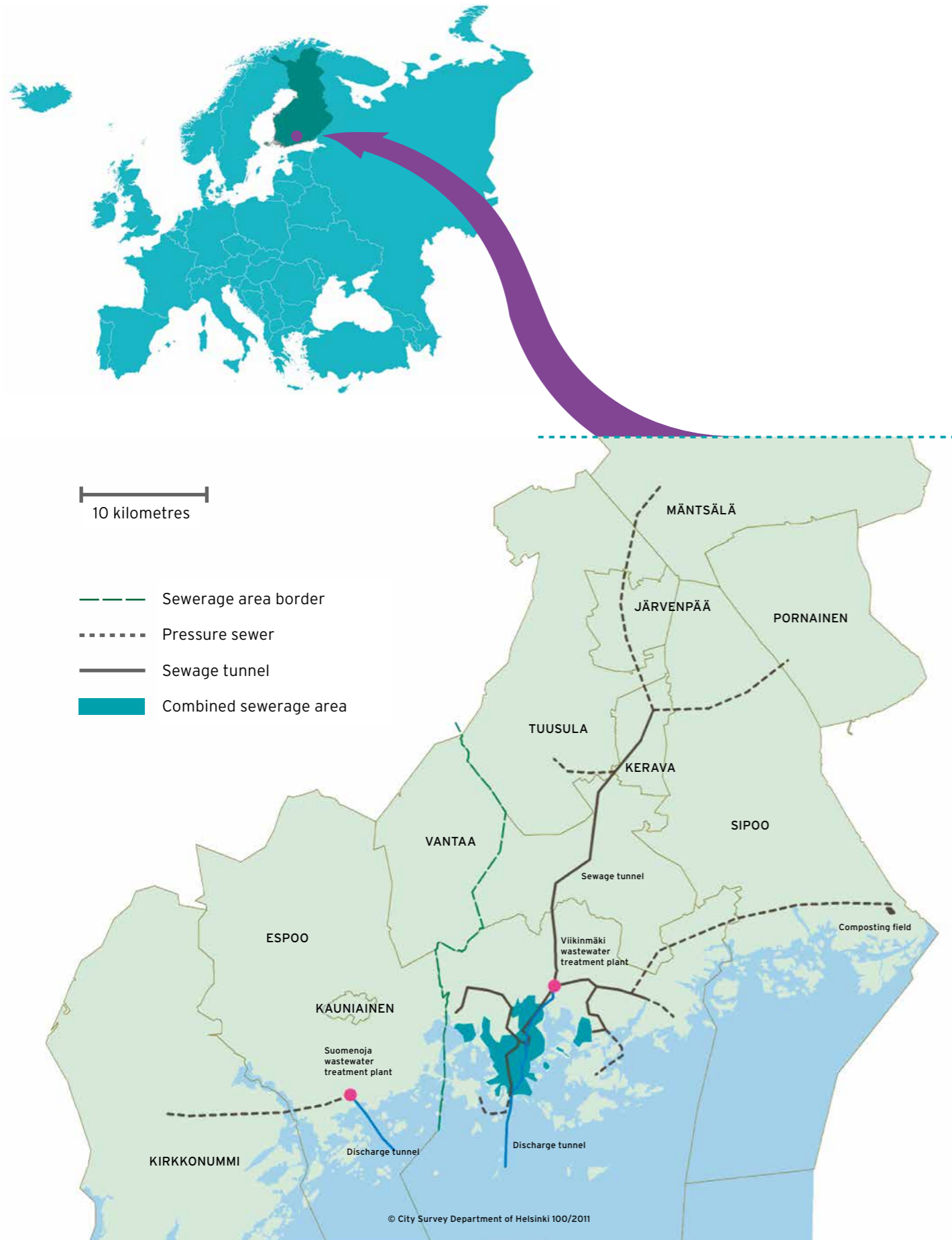


Viikinmäki wastewater treatment plant





Viikinmäki wastewater Treatment Plant

Based on the load, the Viikinmäki wastewater treatment plant in Helsinki is the largest in Nordic countries. The wastewater treatment plant processes wastewater from industry and 800,000 people in Helsinki and its seven neighbouring municipalities. The average wastewater flow is 280,000 m³/day and the peak flow is 700,000 m³/day. Of the total flow into the plant, approximately 85% is domestic wastewater and 15% is industrial wastewater. In the treatment process at the activated sludge plant operating with the simultaneous precipitation method, the wastewater is treated mechanically, chemically and biologically. The treated wastewater is fed through a 16-kilometre discharge tunnel into the sea sufficiently far from the coastline. The sludge separated from the wastewater is digested, and the biogas generated in the digestion process is used to produce heat and electricity for the wastewater treatment plant. The dried and digested sludge is processed into garden soil in the compost-

ing field. The designed capacity of the biochemical section of the Viikinmäki wastewater treatment plant is 310,000 m³/day. The design value for the BOD_{7(ATU)} load is 69,000 kg/day, 2,100 kg/day for the phosphorus load and 15,500 kg/day for the nitrogen load. When calculating 70 g BOD_{7(ATU)}/inhabitant, the resulting population equivalent is 840,000.

After the wastewater treatment plant was commissioned in 1994, the process has been made more efficient and the capacity of the plant has been increased several times. At the start of 1998, denitrification was made more efficient by changing over to the DN process. The effectiveness of denitrification was increased further when the after-filtration unit was introduced at the end of 2003. At the start of 2004, the eighth activated sludge line was started in order to increase capacity. The maximum capacity of the plant was reached in 2014 when the 9th biological treatment line was introduced.

Solar panels were installed on the roofs of Viikinmäki wastewater treatment plant in summer 2016.



100 years of wastewater treatment

The first wastewater treatment plants in Helsinki were built in the 1910s to save the Töölönlahti Bay. At first, wastewater was treated with crushed stone filters and septic tanks but, as early as the 1930s, the first active sludge plants in the Nordic countries were commissioned in Helsinki. Before the Viikinmäki wastewater treatment plant was commissioned in 1994, a total of 12 wastewater treatment plants had operated in the Helsinki area.

VIIKINMÄKI WASTEWATER TREATMENT PROCESS

Pre-treatment

Screening: 4 screens, screen size: 10 mm
 Sand removal: 4 tanks, total tank volume 2,144 m³, retention time: 13 min.
 Preliminary aeration: tank volume 8,800 m³ in total, retention time: 52 min.

Preliminary settling

7 lines, 14 tanks
 Total tank volume: 34,850 m³
 Retention time: 3.5 hours
 Surface load: 1.4 m/h

Aeration

DN Denitrification-Nitrification process: 9 tanks, with 6 sections each
 Total tank volume: 103,500 m³
 Retention time: 8.0 h

Secondary settling

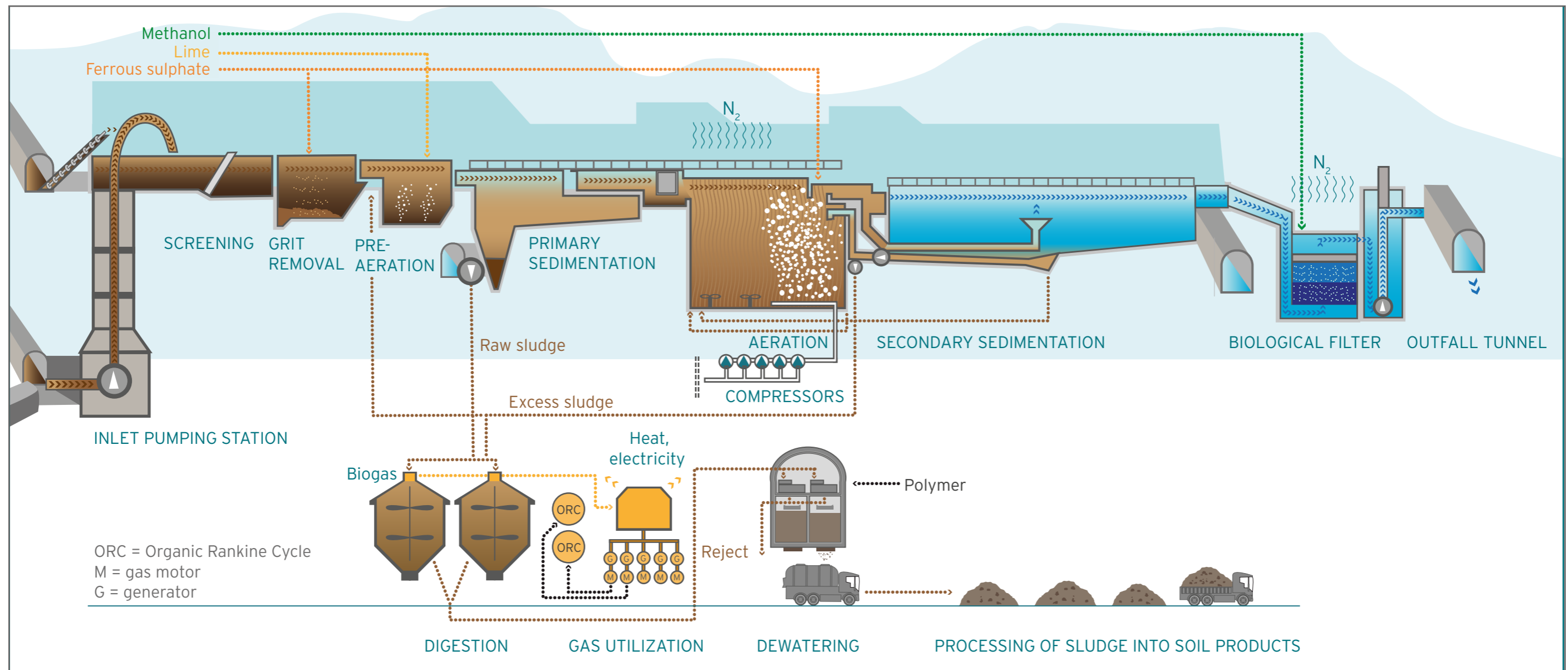
9 lines, 18 tanks
 Total tank volume: 118,260 m³
 Retention time: 9.0 h
 Area: 18,450 m²
 Surface load: 0.7 m/h

Biological filter

Denitrification filter (Biostyr)
 Retention time: 25 min.
 10 filter units
 Methanol consumption 8,000 kg/day

Chemicals used

Ferrous sulphate: 8,200-9,400 t/year
 Lime: 2,000-2,500 t/year
 Methanol: 2,700-3,200 t/year
 Polymer: 90-130 t/year



Incoming wastewater

Q_{ave}: 290 000 m³/day
 BOD_{7(ATU)}: 270 mg/l
 SS: 290 mg/l
 N-tot: 50 mg/l
 P-tot: 6,0 mg/l
 COD_{Cr}: 600 mg/l

Sludge digestion

Mesophilic process
 Retention time: 14-17 days
 4 digestion tanks
 Volume: 10,000 m³ in total
 To be digested: 2,400-2,900 m³/day
 Solids content: 3.4%

Biogas

Biogas produced:
 13.4 million m³/year

Drying sludge

Dried sludge: 65,000 t/year
 Solids content: 29%

Sludge processing

Composted:
 100,000 m³/year
 Reprocessed to soil products:
 80,000 m³/year

Metsäpirtti soil

The digested and dried sludge is transported from Viikinmäki to the Metsäpirtti composting field in Sipoo. The sludge is mixed with peat in a ratio of 1:1. The mixture is composted in stacks for approximately six months, after which sand and bitite are added to it. During the last processing phase, the soil mixture is screened (screen size: 20 mm). In the Metsäpirtti soil products, approximately 580 tonnes of phosphorus and 620 tonnes of nitrogen are recycled annually. The quality of the soil products is monitored by EVIRA.

Treatment process & treatment requirements

All the wastewater treatment processing facilities have been excavated into rock. The treatment is done with the traditional activated sludge method, where the removal of phosphorus is carried out at the same time in two-phase simultaneous precipitation. Ferrous sulphate (FeSO_4) is used for precipitating the phosphorus, and the resulting phosphorus sediment is bound to the sludge. If necessary, the alkalinity of the water is increased using hydrated lime (Ca OH_2). The bypass water is treated in a separate treatment process.

The first phase of nitrogen removal is done during the activated sludge process with the preliminary denitrification principle, and the second phase occurs in the biological denitrification filters. In the aerated sections of the activated sludge process, the ammonium nitrogen contained in the wastewater is oxidised into nitrate nitrogen (NO_3), which is reduced into nitrogen gas (N) in the unaerated sections of the process. The activity that occurs in the oxygen-free conditions of both the DN process in the activated sludge tank and the Biostyr® filter is based on the ability of denitrification bacteria to reduce nitrogen in nitrate form into free nitrogen gas, releasing the nitrogen in the wastewater into the atmosphere. No chemicals or external biomass is added to the activated sludge process, but in the after-filtration phase, denitrification is accelerated by introducing methanol (CH_3OH). The temperature of denitrification processes varies between 9-18 °C.

The sludge generated in the treatment process is processed in digestion tanks. The methane gas generated in the digestion process is utilized in energy generation to produce electricity and heat. The electricity generated corresponds to 70% of the wastewater treatment plant's electricity needs. In 2017 the aim is to achieve 80 % self-sufficiency. The wastewater treatment plant is self-sufficient regarding heat. The digested sludge is dried using a centrifuge; the process is accelerated with polymer. The dried sludge is taken away for further processing into soil products at the Metsäpirtti composting field in Sipoo.

Continuous research and development work is done at the Viikinmäki wastewater treatment plant with the goal of ensuring high-quality wastewater treatment both now and in the future. The growing population in the Helsinki Metropolitan Area and the changes caused by global warming present new challenges to the wastewater treatment plant, as

the amount of wastewater and extreme climate phenomena increase; in addition, the wastewater treatment plant's current capacity is insufficient to achieve the results required by the increasingly strict treatment requirements. In addition to developing the process, increasing the plant's energy-efficiency is also an important development target.

Permit conditions for the Viikinmäki wastewater treatment plant

The treatment requirements in accordance with the currently valid environmental permit are:

Permit conditions	¹⁾ BOD _{7(ATU)}	¹⁾ Kok. P	²⁾ Kok. N	¹⁾ COD _{Cr}
mg/l	< 10	< 0,3		< 75
Reduction %	> 95	> 95	> 80	> 85

¹⁾ as a quarterly average

²⁾ as an annual average

In addition, in accordance to the Government Decree (888/2006), the total nitrogen concentration of the outgoing water may be 20 mg/l at maximum when the water temperature in the biological process is at least 12 °C.

The 9th treatment line was introduced in 2014

In connection with the expansion in 2004, an area reserved for the 9th biological treatment line was excavated in the wastewater treatment plant cave; the line's construction and mechanisation work began at the start of 2013. The factor that started the project involved the treatment requirements set for the plant, which are becoming increasingly difficult to fulfil as the nutrient load in the incoming wastewater continues to grow and the fluctuations in flow are increasing and becoming stronger. The line was introduced in 2014, and increased the biological treatment capacity by approximately 12%.

Technical specifications*

Incoming wastewater

Number of inhabitants	Daily flow	Maximum flow	BOD ₇	Total nitrogen	Total phosphorus
900,000	290,000 m ³ /d	600,000 m ³ /day	266,4 mg/l	48,9 mg/l	6,03 mg/l
			76 106 kg/day	13,552 kg/day	1,673 kg/day

Outgoing wastewater

	BOD _{7(ATU)}	Total nitrogen	Total phosphorus	COD _{Cr}
Limit values	< 10 mg/l	> 80 % reduction	< 0,3 mg/l	< 75 mg/l
Results	4,3 mg/l	4,0 mg/l	0,19 mg/l	40,4 mg/l
Reduction	98 %	91 %	97 %	93 %

Chemical consumption

Ferrous sulphate	Hydrated lime	Methanol	Polymer
8,274 t/year	2,152 t/year	2,677 t/year	133 t/year

Biogas and energy

Production of biogas	Energy consumption in the process	Total consumption	Production of energy	Self-sufficiency in electricity	Self-sufficiency in heat
14,4 milj. m ³ /year	34,515 MWh	40,022 MWh	36,258 MWh	91 %	100 %

Costs**

Operating costs	Personnel costs	Outsourced services	Materials and equipment	Renovation investments
11,6 M€/year	2,6 M€/year	3,6 M€/year	3,6 M€/year	2,0 M€/year

* Information from 2017

** Does not include the further processing of sludge



Picture: HSY

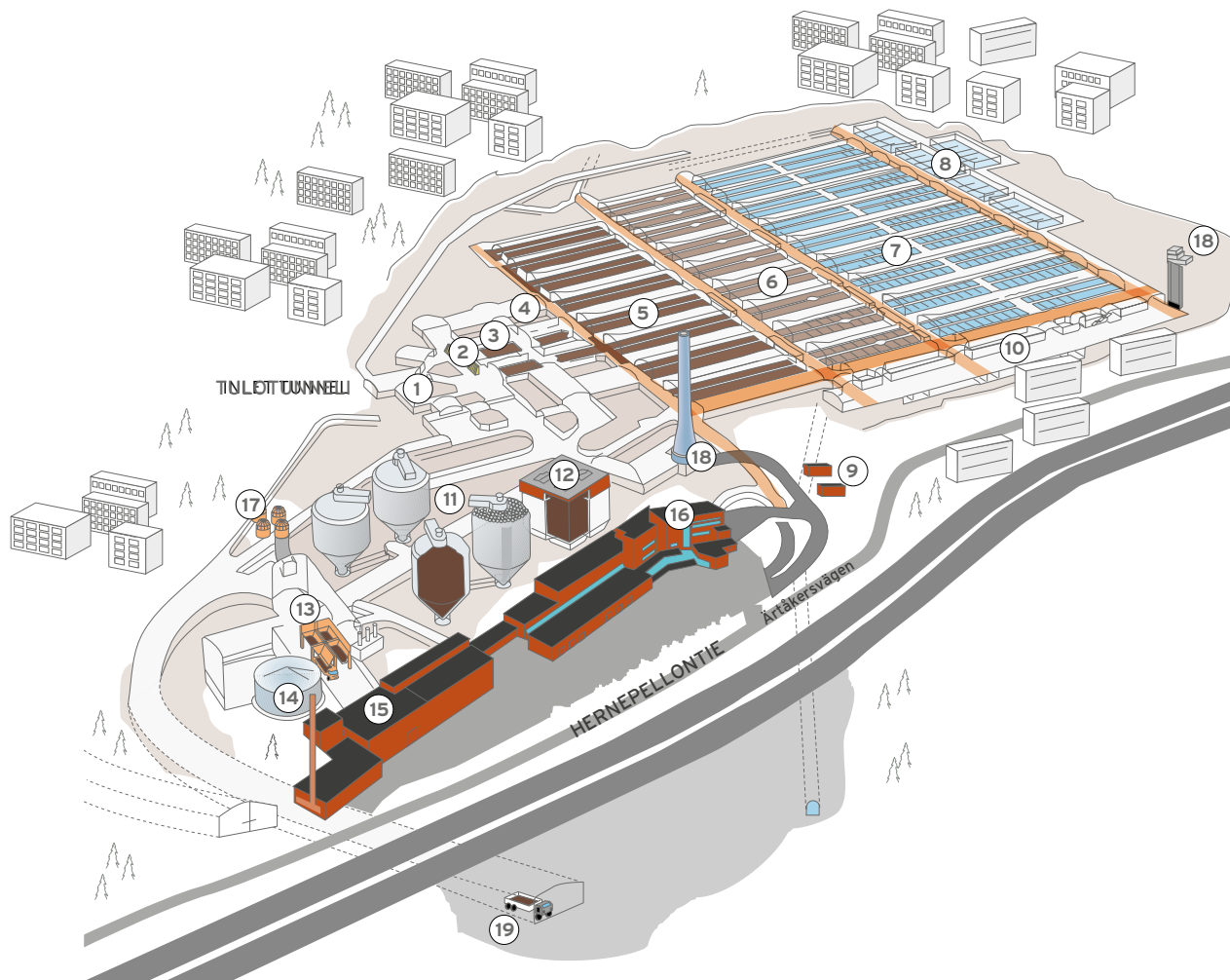


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Printed matter

Wastewater treatment plant area

HSY 8/2018 | Cover picture: HSY / Kai Widell



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|-------------------------|---------------------------------|--------------------|
| 1. Inlet pumping static | 8. Biological after-filtration | 14. Gas holder |
| 2. Screens | 9. Methanol station | 15. Energy station |
| 3. Sand removal | 10. Machine and equipment areas | 16. Main building |
| 4. Preliminary aeration | 11. Digestion tanks | 17. Incoming air |
| 5. Preliminary aeration | 12. Intermediate storages | 18. Outgoing air |
| 6. Aeration | 13. Sludge dryer | 19. Heavy traffic |
| 7. Secondary settling | | |



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