TALLINN WATER TREATMENT AND SEWERAGE

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Tallinn is the capital of Estonia. It has approximately 450,000 inhabitants and the town area is about 150 km^2. Tallinn Water Ltd., owned by the City of Tallinn, maintains water supply and sewerage systems. In 1998 it provided water and sewerage services to 2563 companies entities and 10,279 residential customers. Real estate maintenance companies that are responsible for apartment buildings are included among these companies. The number of employees in the whole company is about 900. The company is financed with the income from the sales of drinking water supply and sewerage services in Tallinn and its vicinity. The company has also received EBRD (European Bank for Reconstruction and Development) loans for reconstruction and repairs. In future the main investments are going to be directed into improving technical standards and meeting the environmental requirements of the European Union.

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I Water supply system

System characteristics (1998)

Water tariff	15 EEK/m^3	For customers
	35 EEK/m^3	For companies
Capacity of water treatment plant	120,000 m^3/d	
Water conducted to the network	40,817 Mm^3	
Water sales	27.3 Mm^3	
Flow rate for the surface water system	235,000 m^3/d	

Water sources

The waterworks receive approximately 90% of the raw water from surface water resources. The main sources are Lake Ülemiste and Paunküla Reservoir. A typical feature of Lake Ülemiste is the fine thick sediment that has accumulated for decades on the bottom and causes problems, especially in windy weather.

Other sources are Pärnu, Jägala, Pirita and Soodla Rivers. The remaining 10% of capacity is pumped from ground water resources, mainly from 100-200 metres depth in the Nõmme area. There are plans to build a new intake pipe around Lake Ülemiste and to use only the purer river water, which would reduce the water treatment costs.

Water consumption

27,304 Mm^3 of water were sold in 1998. Water consumption has decreased constantly in recent years due to reduced household water consumption, the lack of industrial growth and changes in measuring water consumption. As water meters have been installed in each apartment, people have started to economise their use of water. Tallinn Water clients are: residential customers 77% and companies 23%.

Water supply network

The water pipelines are old, the oldest pipes dating from the 1860s. The mean age is 30 years, but 18% of pipes are older than 60 years. Up to 25% of pipelines are so fragile that they should be renewed immediately. The most common material is cast iron. The total length of pipelines nowadays is about 800 km. The quality of treated raw water meets the legislation and recommendations, but the pipelines reduce the quality considerably. In 1998 there was approximately one leakage per 950 m of pipe, which is a rather high rate. The most common cause is corrosion; 60-70% of breakdowns occur in the steel pipes and 30-35% in the cast iron pipes. Small pipelines (≤ 50 mm) are more vulnerable to leaks than larger ones. Another problem is the low flow rate in pipelines because of over-dimensioned pipe diameters.

Water treatment

The first water treatment plant was taken into use 72 years ago. The plant is located on the shore of Lake Ülemiste, near the Tallinn airport. In 1997 the ozonation facilities were put into operation replacing the prechlorination. The process consists of eight phases.

1. A pumping station takes the water from Lake Ülemiste
2. Microfiltration: membranes (mesh size 50 – 100 μm) reduce 20-50% of the plankton
3. Ozonation plant: in the winter and spring 6-7 mg O_3/l and in the summer 10 mg/l.
4. Contact basin 1. coagulant, $Al_2(SO_4)_3$, 15-25 mg/l
5. Contact basin 2. flocculant, PAM (polyacrylamid), 0.15-0.2 mg/l

6. Filtration reactor: some of the water from the contact basin is led directly to the filtration reactor in order to create a sludge layer. Water from contact basin 2 is forced through this layer. Before leaving the reactor the water is treated with PAM flocculant again.
7. Sand filtration: flow rate 5 – 7 m/h, after filtration chlorine 0.2 – 2.0 mg/l is added.
8. Water reservoir: 52,000 m^3.

Water quality

Water quality in Tallinn, mean values in 1998		
	Raw water	**Treated water**
Colour	33	2,4
Turbidity, NTU	11.1	0.33
pH	8.14	692
Conductivity, mS/cm	447.3	471
Alkalinity, mval/l	3.5	2.31
Total hardness, mval/l	4.78	4.79
Aluminium, mg/l	0.05	0.11
Calcium, mg/l	76.9	77.7
Ammonium, mg/l	0.06	0.036
Nitrate, mg/l	3.5	3.6
Nitrite, mg/l	0.014	0.0008
Fluoride, mg/l	0.13	0.07
$COD_{Mn,}$ mgO_2/l	11	3.3
Total organic carbon, mgC/l	13.2	6.4
Iron, Fe, mg/l	0.17	0.009
Coliform. bacteria no/100 ml	21	0
Therm. coliform. bact. No/100 ml	7	0

II Sewerage System

The first mechanical wastewater treatment was taken into operation in 1980. Chemical precipitation was implemented in 1983 and the biological treatment unit was completed in 1991. The plant was considerably improved in 1997. Thereafter some enlargements, modifications and adjustments have been made to achieve the maximum capacity. The wastewater treatment process consists of mechanical, chemical and biological stages and has not been further modified since 1998. To meet the requirements of the European Union, Tallinn Water is reconstructing the pipelines and centralising the sewerage system.

In 1998 the amount of discharged treated wastewater was 64.7 Mm^3, of which 28.2 Mm^3 was charged to customers. The Tallinn water treatment plant treats all wastewater from the city area and also from the Viims community and two smaller towns (Saue and Saku).

System charasteristics in 1998

Discharged wastewater	64,687 Mm^3
Charged wastewater	28,185 Mm^3
Sludge production	71,900 t
Capacity	350,000 m^3/d
Design data:	
Designed plant maximum flow	750,000 m^3/d
	31,200 m^3/h
BOD_5	63,000 kg/d
Total nitrogen	12,600 kg/d
Total phosphorus	1400 kg/d

Sewer network

The length of the wastewater network today is 880 km, of which ten kilometres is owned by industry. The old wastewater and storm water system was combined, but all reconstructed sewers are separate sewers. The oldest sewers were built at the beginning of the 18th century. Almost half of the pipes are made of concrete, and asbestos cement is the second most common material. Nearly 3000 blockages took place in the sewers in 1998.

Wastewater loads

Wastewater loads in Tallinn, mean values in 1998			
	Influent	**Effluent**	**Reduction, %**
Suspended solids, mg/l	199	10	95
BOD_7	147	3.9	97
pH	7.37	7.51	
Total nitrogen, mgN/l	24.9	14.1	43
Total phosphorus, mgP/l	4.7	1.3	72
NH_4, mgN/l	16.1	0.38	98
Nitrates, mgN/l	0.83	13	
Nitrite, mgN/l	0.13	0.1	23
$COD_{Mn,}$ mgO_2/l	279	32	89

Wastewater treatment plant

Tallinn Wastewater treatment plant is situated on the Paljassaare Peninsula in the northwestern part of the city.

1. Main pumping station
- leads the water to the treatment plant
2. Screening
- separates large waste pieces
3. Grit removal
- sorts out smaller particles like sand
- after this treatment, $Fe_2(SO_4)_3$ is added to precipitate phosphorus at the next stage
4. Primary sedimentation
- most of the phosphorus is removed in eight basins (size 1250 m^3)
- sludge is transported to the sludge storage basin
5. Aeration phase
- air is forced into the wastewater tank, where aerobic microorganisms eat organic matter
- beforehand, some $Fe_2(SO_4)_3$ is added again to precipitate the rest of the phosphorus
- there are six aeration tanks, each of them 10,500 m^3 large
6. Secondary sedimentation
- the sludge containing microorganisms and phosphorus settle to the bottom
- size of the basin is 5130 m^3
- part of the sludge is returned to the aeration phase to maintain the suitable micro-organism culture
- the rest of the sludge is led to the mud thickening phase
7. Effluent pumping station
- after the secondary sedimentation the water is pure enough to be led into the sea
- the outlet is 2.8 km away from the coast in Kopli Bay.

Overflow of untreated wastewater during heavy rains is still an unresolved problem. This untreated wastewater is led directly into Kopli Bay. However, this is only 0.1% of the total amount. The situation will change after the planned equalising basin is introduced.

Sludge handling

The amount of excess sludge after treatment is appr. 72,000 tons, of which 40% is taken to landfills. The rest is composted and the plans are to build a bigger composting area near the wastewater treatment plant in order to compost all the sludge. Research is being carried out to study the possibilities to use the sludge as a fertiliser.

1. Mud thickening
- some of the mud from the secondary sedimentation is fed to the mud thickening (the rest goes to the centrifuge or back to the aeration)
- the separated water is pumped to the screening phase
2. Centrifuge
- excess water is separated and pumped to the screening phase
3. Mixed sludge storage
- sludge from both earlier phases (1 and 2) is conducted to the storage reservoir
4. Digestion

- sludge is warmed and digested
- biogas (methane) is collected
- methane is used to drive the gas engines of the air blowers

5. Sludge storage and decantation

- digested sludge is stored and the remaining water is decanted and pumped to the screening phase

6. Sludge dewatering

- the water content of the sludge is reduced further

7. Sludge silos

- dry sludge (dry content 17 %) is stored in sludge silos and taken to the dumping ground (39%) or to the composting area