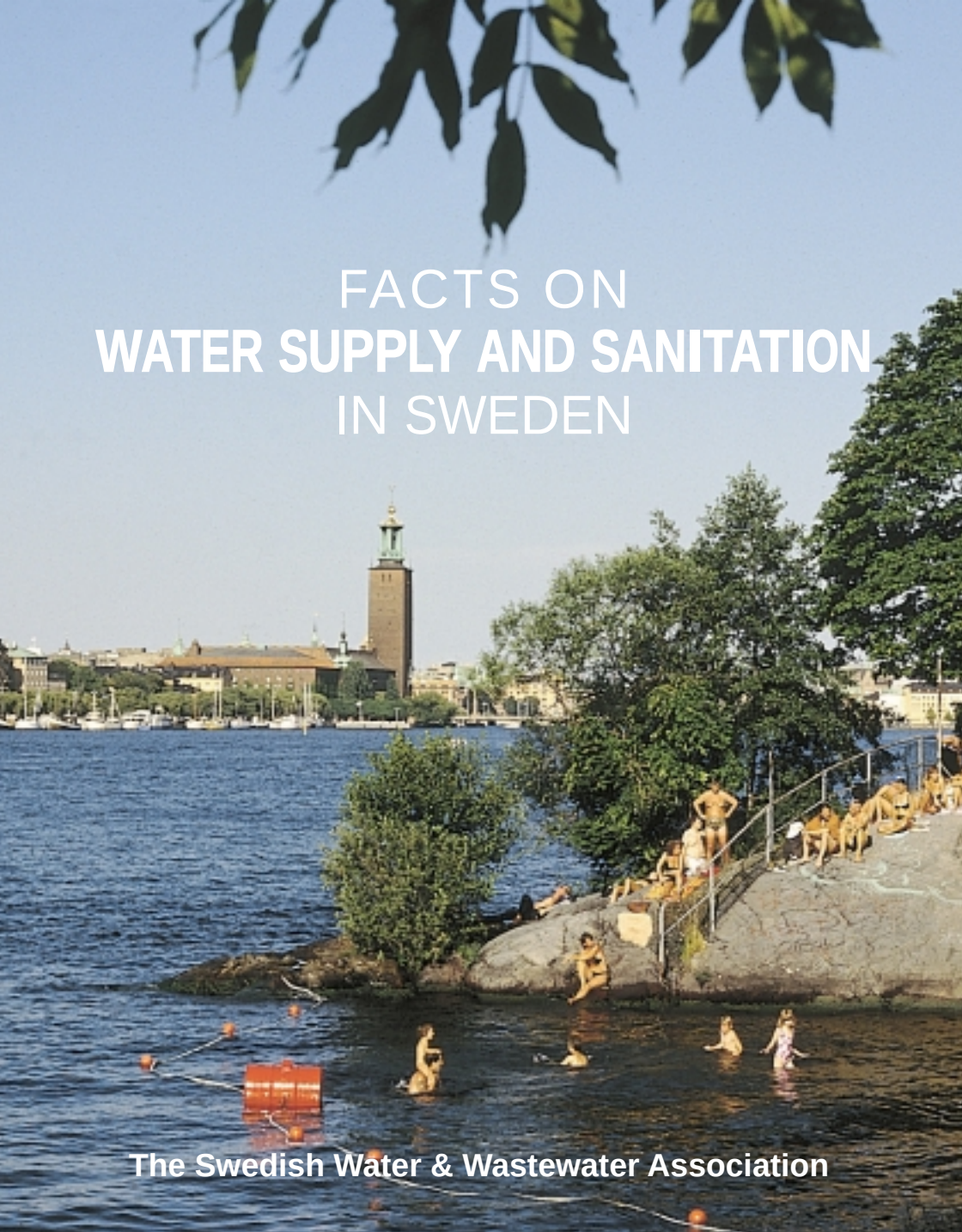
FACTS ON
WATER SUPPLY AND SANITATION
IN SWEDEN



The Swedish Water & Wastewater Association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Introduction

Sweden is one of the world's northernmost countries, on about the same latitude as Alaska and North Siberia. One tenth of Sweden is north of the Arctic Circle. The distance from north to south is nearly 1 600 km and the maximum distance in an east-west direction is 500 km. The total area of the country is 450 000 square km, which is approximately the same size as California, Spain or Thailand. Less than 10 % is farmland and the majority is forested. Sweden is mostly rather flat apart from the mountains in the north-west, which reach heights of up to 2 000 metres.

The climate is mild in spite of the location. For Stockholm the average temperature is 18°C in July and only just below freezing in January and February. These figures are valid for the southern third of the country where most people live. The northern part is characterised by considerably colder winters.

Sweden has a population of 9 million. Northern Sweden is thinly populated with some few exceptions for certain coastal areas. The highest population density is found in a belt extending from Stockholm on the east coast to Gothenburg on the west coast and to the southernmost parts of the country. About 83 % of the population live in towns with more than 5 000 inhabitants. Including its suburbs, the capital Stockholm has about 1.5, Gothenburg 0.7 and Malmö 0.5 million inhabitants.

Sweden has a constitutional monarchy with a parliamentary form of government. The parliament consists of one chamber and the members are elected every fourth year. In 1995, Sweden became a member of the European Union.

Local self-government a basic principle

The administration in Sweden has three levels. On the central level there is the Parliament (Riksdagen) and the Government and the various Ministries. On the regional level there is the County Administration that has an examining, supervising and co-ordinating function. On the local level there are 290 municipalities, which are responsible for planning, construction and operation of the facilities for water and wastewater. The municipalities also own these facilities. The median size of a municipality is only 16 000 inhabitants. The largest, Stockholm, has more than 700 000 inhabitants and the smallest, Bjurholm, less than 3 000.

Over the past 50 years, responsibility for several major public services such as social care and elementary schools has been shifted from the state to municipalities. This important structural change has coincided with a drop in the number of local authorities in Sweden from 2 300 to 290. The aim of this consolidation process has been to improve the financial situation in each local authority. It was also considered that municipal administration could be rationalised in larger authorities with greater financial resources, while local authority autonomy would be strengthened. Furthermore consolidation was seen as a way of precluding differences in service between rich and poor municipalities. The overall effect has been that local authorities now enjoy a stronger status in society due to their extended area of operations.

Local authority elections are held every fourth year in tandem with parliamentary elections. The electorate consists of all Swedish citizens aged over 18 who are registered with a local

authority, as well as non-nationals who have been registered in Sweden for three years. Most of Sweden's 42 000 local council politicians, of whom 41 % are women, work only part-time in this capacity. In 1930 only 3 and in 1950 only 10 % were women. Only 1 % of these politicians have a full-time commitment.

The total expenditure of the municipalities was SEK 320 billion in 1998. The money was allocated mainly for Social services (35 %) and Education (28 %). Out of a total of 753 000 employees, almost 20 % of the total working population, 58 % worked in these fields.

The local authorities have three main sources of revenue: local income tax, income from services and state grants. The right to levy taxes is a precondition for local authority independence. The fact that local income tax and income from services account for two thirds of municipal revenue means that local authorities retain broad control over the nature of their activities. In 1998 the revenue from state grants amounted to 18 % of the total municipal income and taxes for 56 %. Income from services amounted to 12 %.

Water resources

Sweden is rich in water. Lakes account for 9 % of the total area of the country. There are almost 100 000 lakes, 90 % of which have an area of less than 1 square km. The four largest lakes constitute a quarter of the total lake area.

The average runoff in all rivers amount to nearly 200 cubic km. This means that only 0.5 % of the theoretically available resource is extracted for municipal use. Stockholm uses only 3 % of the average outflow from the third largest lake in the country for supplying the metropolitan area with water. Other users of water in Sweden, such as industry and farming, withdraw approximately three times as much water as the municipal sector.

Apart from the southeastern part of Sweden and the largest islands and the archipelago islands, water supply constitutes no major problems due to the abundance of available resources. However, the quality of raw water varies and thus the level of treatment needed.

The yearly average precipitation varies from 600 mm in the southeast to over 1 500 mm in the mountains in the northwest. An average figure for the southern part of the country, where most people live, may be set at 700 mm.

The water administration

Water supply and sanitation including the management of storm-water is the task of the local government or municipality. The municipality owns the facilities and is also responsible for running them. There is a long tradition in connection with this management.

Each municipality determines the fees for these commodities. Two thirds of utilities cover their costs by means of the fees. Smaller municipalities may subsidise by means of local tax. Altogether 99 % of the costs of capital and running are retrieved by means of the tariffs. This means that the business of water supply and waste-water management can be regarded as self-reliant.

As stated above, the local authorities also operate all the assets providing water supply and wastewater services. However, this is not quite the truth. According to an investigation reflecting the situation, 252 municipalities reported that they were organised as a unit within the municipality, whereas 39 were running water supply and sanitation as a municipally owned company. Eight utilities were organised in inter-municipal companies co-operating over municipal borders but still owned by the participating municipalities and finally 7 had a management contract with a non-governmental company.

The latter is rather new to Sweden; the first management contract was signed only some few years ago. Most of these contracts are for small municipalities and the contract periods are short, typically three plus three years. The question of delegated management has been the subject of intensive discussion in Sweden. However, the situation concerning water supply and sanitation in the country is very well in hand with the management of today. The concepts proposed, especially by foreign organisations, have so far not been attractive enough. The investigation referred to above

does, however, indicate that a state of change may be approaching because 44 municipalities indicated that their organisations were now working on the basis of the client – contractor concept. This is a first step in allowing other bodies in as contractors, for example non-governmental companies.

The effluent from municipal wastewater treatment plants is subject to the licensing rules as expressed in the new Environmental Code that succeeded the Environmental Act in 1999. The Code is a framework covering most of the legislation relevant to the environment. Other major legislation within the field is the Health Act, the Public Water and Wastewater Plant Act, and the Food Act.

Drinking water quality is the responsibility of the Ministry of Agriculture with the National Food Administration as the central supervising agency. On a local level the municipal committee for environment and health exerts the supervision.

The Ministry of the Environment is responsible for water protection. The supervision is provided by the Environmental Protection Agency on a central level, the county administration on a regional level and the municipal committee for environment and health on the local level.

Permits for the discharge of treated sewage are granted by the Regional Environmental Courts for the largest plants. A Supreme Environmental Court deals with appeals. The County Administrative Board issues permits for most plants, and for the smallest plants the municipal environment and health committee may give its approval.

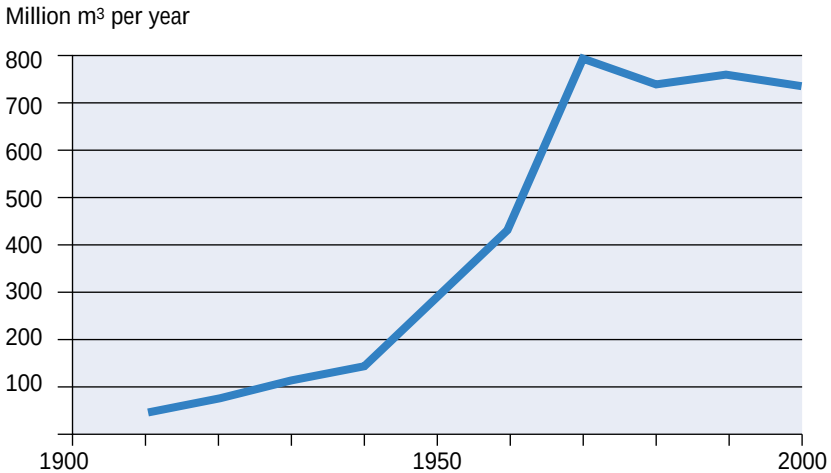
The Swedish Association of Local Authorities is an interest organisation that covers the whole scope of municipal activities. It also takes an interest in the water sector especially when the political and policy issues are on the agenda. A specialised organisation within the field is the Swedish Water & Wastewater Association that will be further described below.

Water and wastewater – a historical introduction

Up to the mid and late 19th Century, the prime reason for water supply in the urban areas was its use for combating fire. During the middle of that century some bad outbreaks of cholera in Stockholm and Gothenburg killed a large number of inhabitants. This prompted the construction of networks of water mains conveying good quality water to the consumers for health reasons. The use of water in the urban areas then increased almost continuously until 1970. From then on, the demand has been constant or has even decreased.

Once the problems of fire fighting and water supply had been solved, an environmental problem emerged. The introduction of bathrooms and WCs led to severe conditions in the receiving waters with oxygen depletion, odour and health risks. In the late 1930s, the popular swimming contest held in downtown Stockholm had to be discontinued due to health risks on the part of the competitors. Sewage treatment plants were introduced. Mechanical treatment was followed by biological treatment in the 1950s and chemical treatment by means of precipitation in the 1970s, thereby reducing discharges of the nutrient phosphorus. During the final decade of the century, nitrogen reduction was introduced for all major coastal plants.

The main reason for constructing sewers was for drainage purposes. A town must be drained to protect buildings. Stormwater was initially conveyed in gutters together with the small amounts of sanitary sewage and solid waste that were produced. Already in the mid 16th Century king Gustav Wasa stated that all property owners must keep a barrel containing 200 litres of water close to



Water use in urban areas – development. The water production is 20 % higher. The differences are due to leakage in the network

the street. When the mayor decided, due to odour, the upstream barrel was emptied in the gutter followed by the others in due order, thus exporting the problem to the receiving water.

The introduction of WCs led to the construction of sewers to convey the effluents, stormwater and drainage directly to the closest body of water. The construction of interceptors during the first half of the 1900s permitted the collection of wastewater and conveyance to the treatment plant. Up to the mid 1950s this combined sewerage system was used in most places. Since that time, a separated system with one foul sewer and one stormwater sewer has been preferred for new developments. Several combined systems have been rebuilt into separate systems, but still some 20 to 25 % of all urbanised areas are served by combined systems. These systems are most commonly situated in the old downtown areas.

Water supply

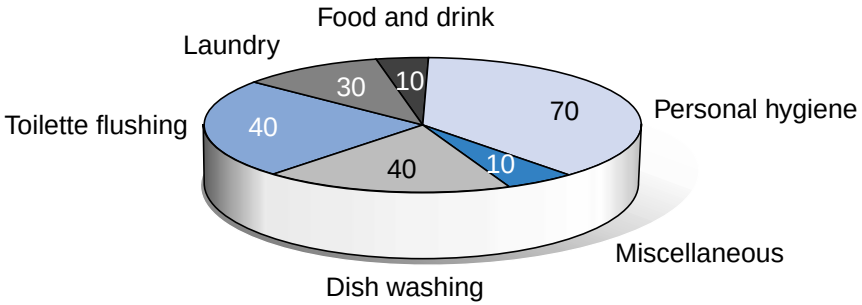
Sweden has slightly over 2000 publicly owned water works, 10 % of which are based on the withdrawal of surface water. These large works serve 51 % of the population. Some 7 % of the works withdraw their water from artificial groundwater and these works serve 23 % of the consumers. The groundwater-based plants (more than 1 700 in number) serve the remaining 26 %.

There are a total of 7.7 million customers, close to 90 % of the total population. The total production may be expressed as 330 litres per person and day. Of this, a little less than 200 litres are used in households. The remaining 130 litres are used in production, industries and for use in official premises, and also includes leakage on the distribution network. This leakage represents on average 20 % of the water produced.

The consumption in households may be apportioned as follows: 10 litres for drinking and food, 40 for flushing the WC, 40 for dish-washing, 30 for laundry, 70 for personal hygiene and 10 litres per person and day for other uses.

Drinking water is classified as food and thus the water works are run like a food production unit. It is possible to produce a good quality drinking water from surface water as well as from groundwater. Groundwater has several advantages compared to surface water due to lower temperature and smaller contents of unwanted organic substances and bacteria. The groundwater resources are not enough to supply the whole country. The trend is to try to implement artificial infiltration and thus gain the advantages of groundwater and at the same time minimise the use of chemicals in water production.

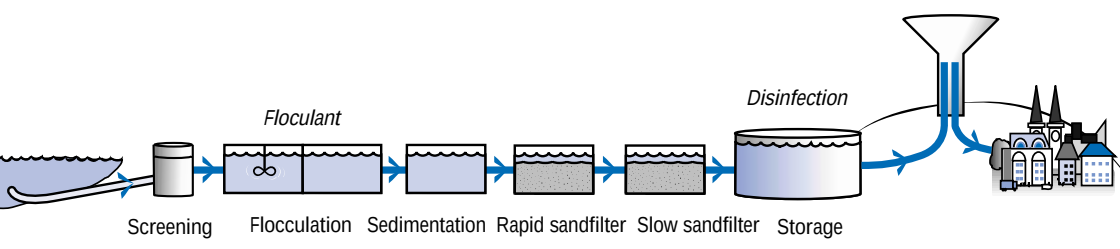
In most parts of Sweden there is no incentive for saving water from a water resources perspective – we have all the resources



The use of water in households

needed. Reasons for saving water may instead be expressed as minimising the flows to the treatment plant and thus optimising the running, minimise the costs for pumping and chemicals. A drawback when saving water is that the flow through the network becomes smaller, thereby prolonging the residence time for the water. This impairs the water quality for the consumers.

Only ten litres per person and day are used for drinking and food, and this could indicate that it may be possible to build a new network for low quality water for all the other uses. This, however, would be a very costly investment as the marginal cost for producing extra water is very small once the resources are there. Furthermore, it would mean a significant lowering of standard with obvious risks of mixing the waters in the households.

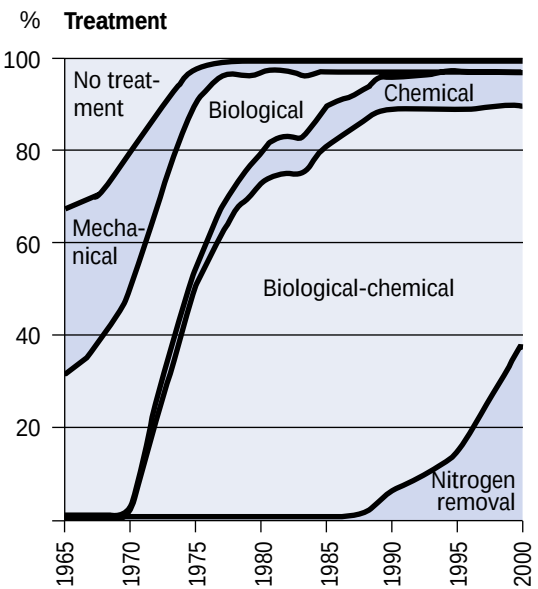


Typical water work for producing drinking water from surface water

Sewage treatment

Sweden has just over 2000 publicly owned sewage treatment plants. The works treat sanitary sewage, stormwater from combined systems, drainage and infiltrated water. The access volumes of water contributed mean that the plants treat almost double the volume of drinking water produced. This means an incoming flow of almost 1.5 cubic km.

All the 7.7 million people living in urban areas are connected to a sewage plant. Sweden started the implementation of wastewater treatment early and the most intensive period for construction was the 1960s and 1970s. Today, plants with biological/chemical and nitrogen removal serve 36 % of the connected population, biological/chemical plants serve 58 % and biological only or chemical only plants serve the remaining population. This investment in building plants has led to a decrease in pollution load on the receiving water. The load is at present down to the level we had at the beginning of the last century.



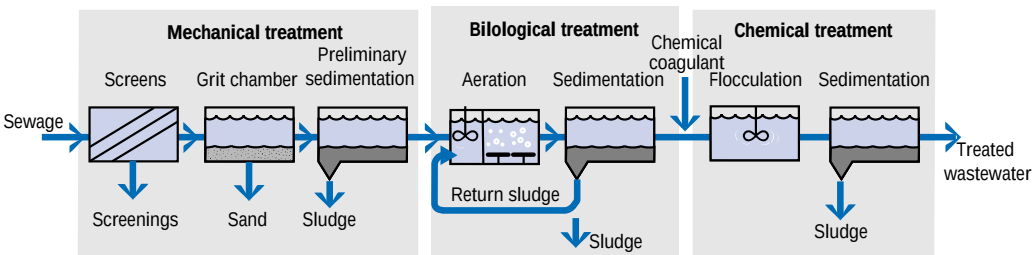
Development of wastewater treatment in Sweden, 1965-2000

Sweden may have the most far-reaching effluent standards in the world for treated wastewater. Licences are expressed

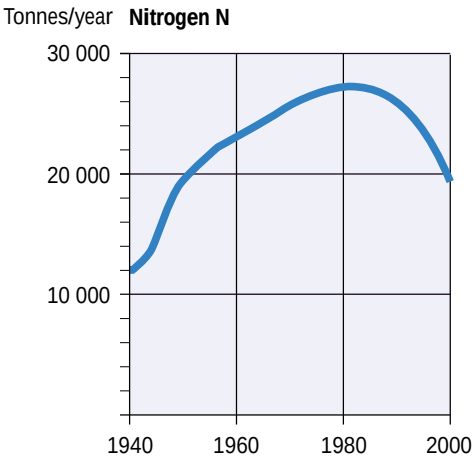
as concentration in the residual water entering the receiving water. Emission standards are not used to any great extent. Typical limit values expressed in mg per litre are for organic matter (BOD_7) 10-15, phosphorus 0.2-0.5 and nitrogen 10-20.

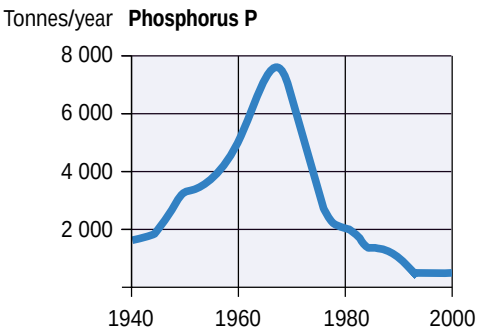
The treatment plants produce 230 000 tons of sludge annually expressed as dry solids. This sludge contains 6 000 tons of phosphorus, which could be used as fertilisers on farmland. The amount of phosphorus may be sufficient to supply up to 8 % of the arable land. However a never-ending debate is in progress whereby the risks of contaminating the soil are disputed. Even though Sweden does have very rigid standards far beyond the corresponding EU directive, only 30 % of the sludge is used in agriculture.

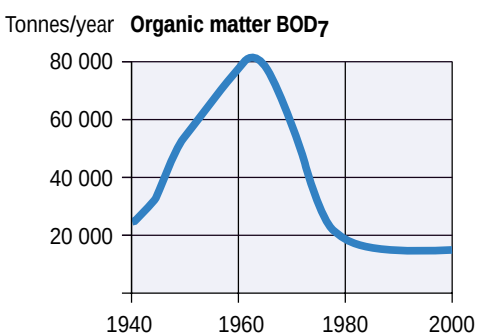
The trends are towards minimising the use of chemicals in wastewater treatment by implementing biological purification methods. As regards sludge management, methods of separating out the phosphorus contents are being tested.



Typical wastewater treatment plant with mechanical, biological and chemical treatment







Discharges of nitrogen, phosphorus and organic matter from all urban areas in Sweden. The peak values may be found according to:

1960 the erection of biological plants starts to diminish organic matter

1970 the building of chemical plants starts to reduce phosphorus

1990 the implementation of nitrogen reduction starts

Water infrastructure

The total length of the water mains is 67 000 km which means 8.8 meters per connected person. These figures do not include the private house connections. If these were to be included the figure could double. The pipe material is 55 % cast iron, 19 % PVC, 14 % PE and the rest other materials. PE is the dominating material in new pipes.

The total length of the sewers amounts to 92 000 km, of which 32 000 consists of stormwater sewers. This gives an average of 12 metres per connected person. The figures here, as well as those for water mains, do not include the house connections. The pipe material is 80 % concrete, 13 % PVC, 3 % PE and the rest other materials.

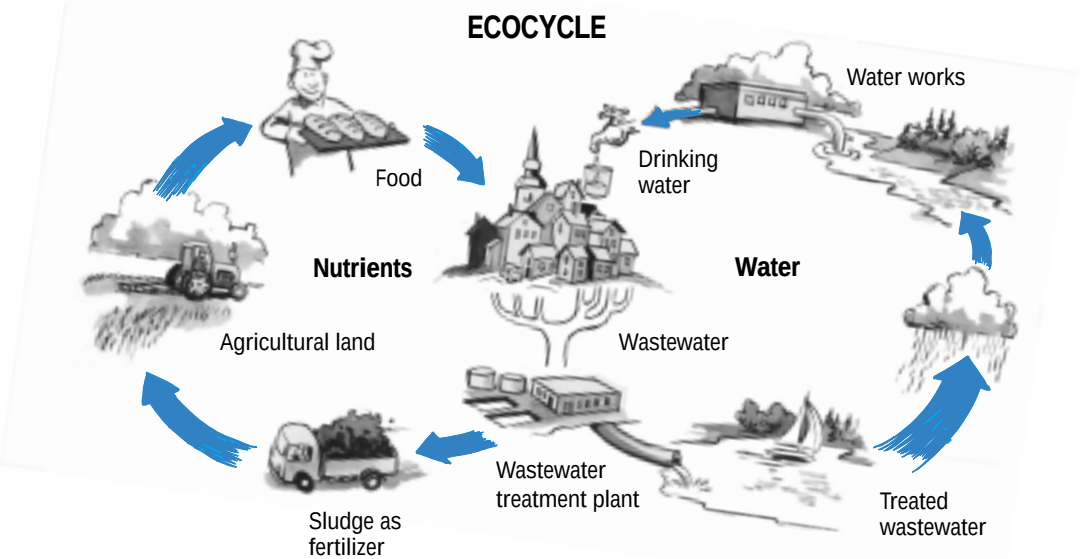
As may be seen above, Sweden is well equipped regarding the technical facilities needed for running a comprehensive service for water supply and wastewater treatment. However, running costs show an increasing trend. A measure of the need for renewal of, for instance, water mains and sewers may be illustrated by the figures for their theoretical renewal intervals, i.e. 225 and 310 years respectively. Then, of course, consideration must be given to the fact that most of the pipes are of a low age. Half the length has been constructed during the past 35 years, and is not due for retrofitting for many years.

One development within the field is that no-dig methods are becoming more common for rehabilitation of the networks. As of today, 25 % of the lengths attended to are using these methods.

As it is very costly to rebuild the old combined system, new methods for overcoming the shortcomings of this system are being implemented. Detention in and off the system and in ponds and local infiltration are much in use. Real time control of the systems makes it easier to operate the treatment plant in an optimal way. In this context, mathematical models are tested on-line.

The Swedish water and wastewater utilities

In Sweden, water and wastewater issues have always been organised as a municipal utility. Some changes have been made lately in this respect as may be seen above. All these utilities are run by approximately 6 000 persons. Of these, 2 000 are technicians at water works and waste water treatment plants, 2 000 work on pipe networks and the rest in the offices. During the last decade, all organisations have experienced extensive rationalisation. Ten years ago, the number of employees was 10 000.



Water supply and sewerage are included in two cycles, the water cycle and the cycle of nutrients. Combined they may be regarded as an ecocycle

The first demand made on the utilities was to secure that healthy drinking water was distributed to all consumers. This task was fulfilled long ago. The second demand was to treat the wastewater properly, thus avoiding deterioration of the receiving waters. The solving of this task is well under way. During later years a third demand, on sustainable solutions, has been formulated. This task currently occupies most of the utilities.

The urban water cycle has worked well for many years. Water is taken from a certain source, drinking water is produced and conveyed to the consumers, wastewater is collected, conveyed and treated and finally brought back to the natural hydrological cycle. Much effort is now being devoted to the question of the nutrients cycle. The idea is for the nutrients to circulate like the water. The crucial issue is the use of sludge on farmland. Despite the strongest regulations in the world, sludge is still regarded as a harmful substance by many farmers and associations.

Costs and tariffs

During 1999, the total costs for running the publicly owned facilities in Sweden were SEK 14.1 billion (SEK1 = USD 0.11) including an additional VAT charge of 25 %. Out of this cost, 42 % may be referred to the production and distribution of drinking water and the remainder to the collection and treatment of sewage. Of the total cost, 37 % is the cost of interest on capital.

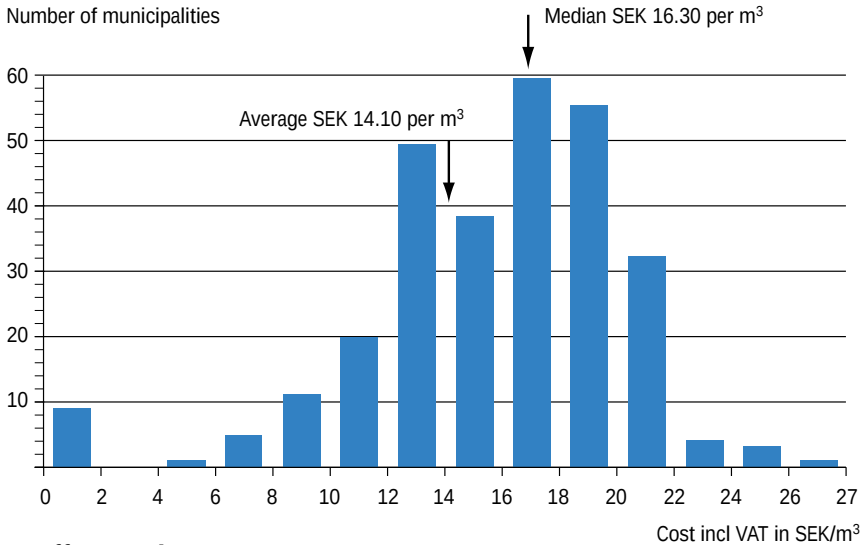
The value of all the assets may be estimated at SEK 500 billion, of which 350 or 70 % is for the infrastructure, i.e. the pipe network.

Connection fees

All customers who want to be connected to water and waste-water services must pay a connection fee, the size of which is decided by each local authority. The fee may be calculated in many different ways, but it is common to include, on top of a basic tariff, fees for connection points for water, wastewater and stormwater as well as for land area or apartment area. In 1999, the connection fees amounted to SEK 71 000 as a median for all the municipalities. The least expensive municipality had a fee of SEK 10 000 whilst the most expensive one charged SEK 126 000 The larger municipalities normally charge a higher connection fee.

Rates for managing water supply and wastewater

Water supply and wastewater management rates normally incorporate two components: a basic price per year and a current price per cubic metre of water consumed. The calculated average current price for a distributed cubic metre is SEK 14.1 including VAT. A basic rate of an extra SEK 9.5 including VAT, when

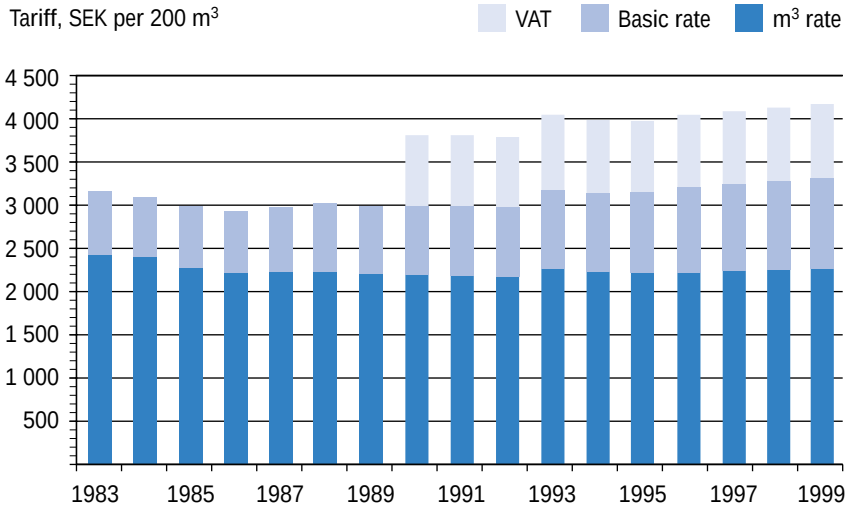


Tariffs per cubic meter 1999

calculated for a family using 200 cubic meters a year, must be added. So altogether the typical price will be SEK 23.6 per cubic metre including VAT. The cost, however, varies between different municipalities, the most expensive charging about three times the rate of the least expensive.

The trend is for smaller municipalities to charge higher current rates. The total rates may be calculated for a single-family house where the consumption of water and thus the production of wastewater is 200 cubic metres a year. A family in Sweden pays on average SEK 4 200 per year. The rates in the least expensive municipality are less than SEK 2 000 whilst the most expensive charge more than SEK 7 000.

The rates for water supply and sanitation have been fairly stable over the past 15 years. Apart from the VAT, see above, that was introduced in 1990 the costs have remained practically unchanged if the effects of inflation are discounted.

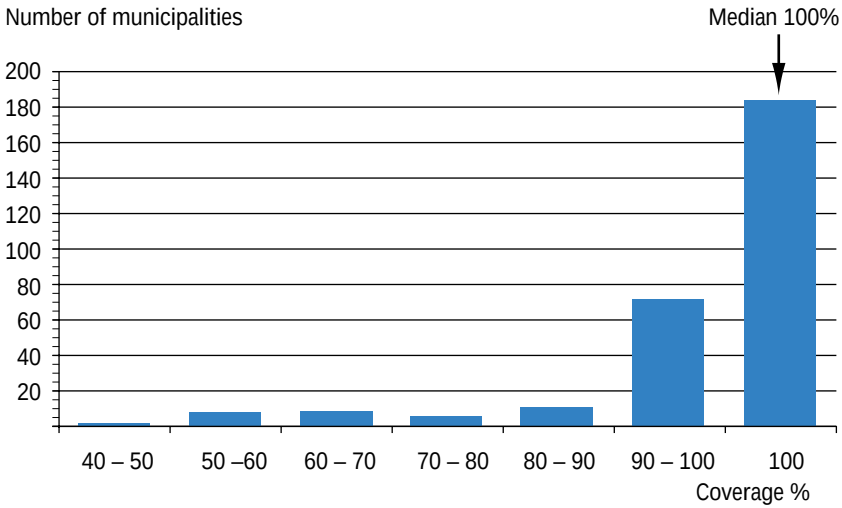


Development of average costs for a single family house using 200 m³ per year

Coverage of costs by means of tariffs

The tariffs cover on average 99 % of the total costs of operation and capital. The remaining 1 % is put on the local authority, i.e. municipal tax. All the large municipalities cover all their costs by means of tariffs. Two thirds of municipalities cover the full cost by tariffs.

To facilitate a fair fee, practically all consumers have water meters. The total number of water meters is 1.5 million. As water supply and sanitation operations cover their own costs, the activities may be claimed to be self-reliant. Swedish law stipulates that you are not allowed to make a profit in this sector and then invest it in another public utility, such as libraries. If you make a profit one year, you must show in your investment plans how you are going to use the money in the future.



Coverage of costs by means of tariffs in 1999

Future development

In the future there will probably be a large variety of solutions for the water and wastewater services. Many local systems with interface to the central system may be developed from the research that is now in progress. The present central system will still be serving most of the population in already existing urban areas. New methods however, such as the separation of urine, may well have a future in new developments and in suburbs undergoing reconstruction.

In water production and wastewater treatment, new methods for biological treatment are being tested and may well be a major issue in the future, thereby minimising the use of chemicals.

Today a large number of water pipes in houses are made of copper. This causes release of copper that is harmful to the user as well as to the sludge. Research has indicated that stainless steel may be an alternative.

The sludge issue must be solved. The general goal is to reuse contents of nutrients, especially phosphorus. This may be done in several ways. The easiest way is through land application, but if so the quality must be approved by all parties concerned. A second way is to incinerate it and extract the phosphorus out of the ashes. A third way is to extract the phosphorus directly out of the sludge. Several of the latter methods are being tested such as, for example, hydrolysis.

In stormwater management, the trend is to use more open solutions such as dams and ponds instead of conveying the water inpipes. Keeping the stormwater above ground also adds to the aesthetic values.

The tendency is to use IT-solutions in all possible applications. This minimises the number of personnel and optimises the use of what has already been built. Plants and networks may then be run in a coordinated way.

Svenskt Vatten, The Swedish Water & Wastewater Association (SWWA)

The Swedish Water & Wastewater Association, SWWA, was set up by the municipalities in 1962 to assist with technical, economic and administrative issues and to represent the interests of the municipalities in negotiations with authorities and other organisations on regulations etc. One of the first duties of SWWA was to collect and evaluate statistical data, most figures above are drawn from regular SWWA statistics. Other obligations are the compilation of recommendations and guidelines and the arrangement of seminars and short courses for the members.

SWWA has several ad hoc working groups with experts from member municipalities covering the whole field of municipal water and wastewater activities. SWWA publishes a journal, newsletters and reports. The association is a member of the European Union of National Association of Water Supplies (EUREAU) and administers the national secretariat for the International Water Association (IWA). At present, SWWA has all 290 municipalities as its members. In other words it is no exaggeration to claim that SWWA well represents the national municipal units for water and wastewater. The membership fees, the size of which depends on the population of the municipality, are the basis for the activities within SWWA and this fee is put on the water tariff, which means that the consumers pay. The office is situated in Stockholm and employs approx 16 persons.

Another of SWWA's obligations is to not only initiate but also to sponsor research and development within the field. On a volun-

tary basis the municipalities have contributed SEK 1.05 per person and year since the start of the research programme in 1990. As practically all municipalities are members, this generates SEK 9 million a year for applied research within the field. Several studies have been undertaken and 230 reports issued. This fee, like the membership fee, is also put on top of the water bill by the municipalities, which means that the consumers or end users of the facilities finance the research and development that is needed.

On an international level SWWA promotes the dissemination of Swedish know-how.

Publisher: The Swedish Water & Wastewater Association, Stockholm
Designed by: Nilsson Design AB
Photo frontcover: Mikael Ullén, Orange AV Produktion AB
Printed by: Karléns Tryck AB, Stockholm, 2000

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