

Integrated Management System for the Wastewater Treatment Plants of the City of Cologne, Germany

1 Wastewater Treatment in Cologne

The Cologne Wastewater Company

The one million city of Cologne is the fourth largest city in Germany. The size of the city requires a well-functioning wastewater treatment to protect both people and the environment. The Cologne Wastewater Company (*Stadtentwässerungsbetriebe Köln – StEB*) was established in May 2001 as it took over the previously publicly owned Office for Wastewater Treatment with its five treatment plants, to coordinate wastewater management in an area of 405 km², serving close to one million people and several industries (see Figure 3.1).

Wastewater treatment in Cologne is, however, already more than 100 years old. Modern dewatering of the area began at the end of the 19th century, when Carl Steuernagel, the most prominent planner at the time, built sewers, even using some remains of the old Roman cloaks. The first wastewater treatment plant was built in the suburb of Niehl in 1905.

As environmental concerns became more important in the 1970's several more wastewater treatment plants were built. The 1980's saw further changes to a more environmentally friendly system of wastewater treatment and disposal, as the project "Waste Water 2000" was initiated. The innovative character of the project was recognized in an exhibit at the World Exhibition EXPO 2000.

The creation of StEB led to a process of restructuring, deregulation, liberalisation as well as improved economy of waste-

water management in Cologne. Environmental and economic sustainability were the guiding principles. Huge investments, made under the "Waste Water 2000" Programme, created a good market position of the new company. Today StEB has a very high standard even in European or international comparisons.

During the period 2001–2004 the company introduced an Integrated Management System (IMS). The IMS consists of three components: an environmental management system (EMS), a Quality Management System (QMS) and a Risk Management and Work Safety System. The introduction of the Management Systems has resulted in clear improvements for the environmental situation in the sewer systems and wastewater treatment plants as will be described below. Further information on Cologne Wastewater Company can be found at <http://www.steb-koeln.de>.

The Organisation and Activities

The creation of Cologne Wastewater Company StEB in 2001 was followed by a re-organisation, a process completed in 2004. Today Cologne Wastewater StEB is divided into two main departments, Technology and Management (see Figure 3.2). The Management Department is responsible for administration, purchase, legal issues, and finances and controlling as well as IT-tasks. The Technology Department on the other hand is responsible for all planning and construction processes within the sewer system, operation of the sewer system and the

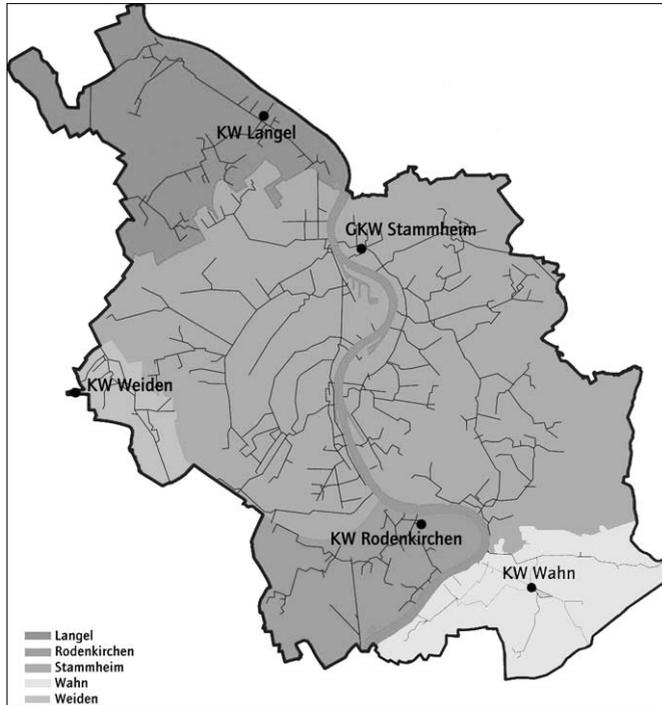


Figure 3.1 Wastewater Treatment area of Cologne StEB.
 The area served by the company is about 405 km². The five wastewater treatment plants are, from top, KW Langel, Stammheim, Weiden, Rodenkirchen and Wahn. A special challenge is the high amount of water protection areas (about 46%), which make the treatment of wastewater more difficult.

wastewater treatment plants, the wastewater institute (laboratories), and surveying as well as property drainage. A number of administrative departments support the work. As will be described below, an Environmental Management System Office, working under the Technology Department, is responsible for the entire Integrated Management System, IMS.

Cologne Wastewater Company StEB has today (January 2005) about 550 employees. Since the company offers most services concerning wastewater treatment, employees with all kinds of professional competencies – chemists, engineers, technicians etc. – are found in the organisation. Table 3.1 shows the operational facilities under the responsibility of StEB in 1987 and 2003. The table demonstrates the considerable expansions made during the time period, especially concerning the amount of rainwater basins and pump stations, which had the highest relative increase.

Within the area of Cologne, the company is responsible for all tasks concerning wastewater disposal, both for public and private customers. Annually about 40 million Euro are invested into improvement and renewal of the sewage network. The know-how gained over years is also offered to other organisations and local authorities. This includes consulting tasks as well as implementation measures. In detail the services for the public sector include:

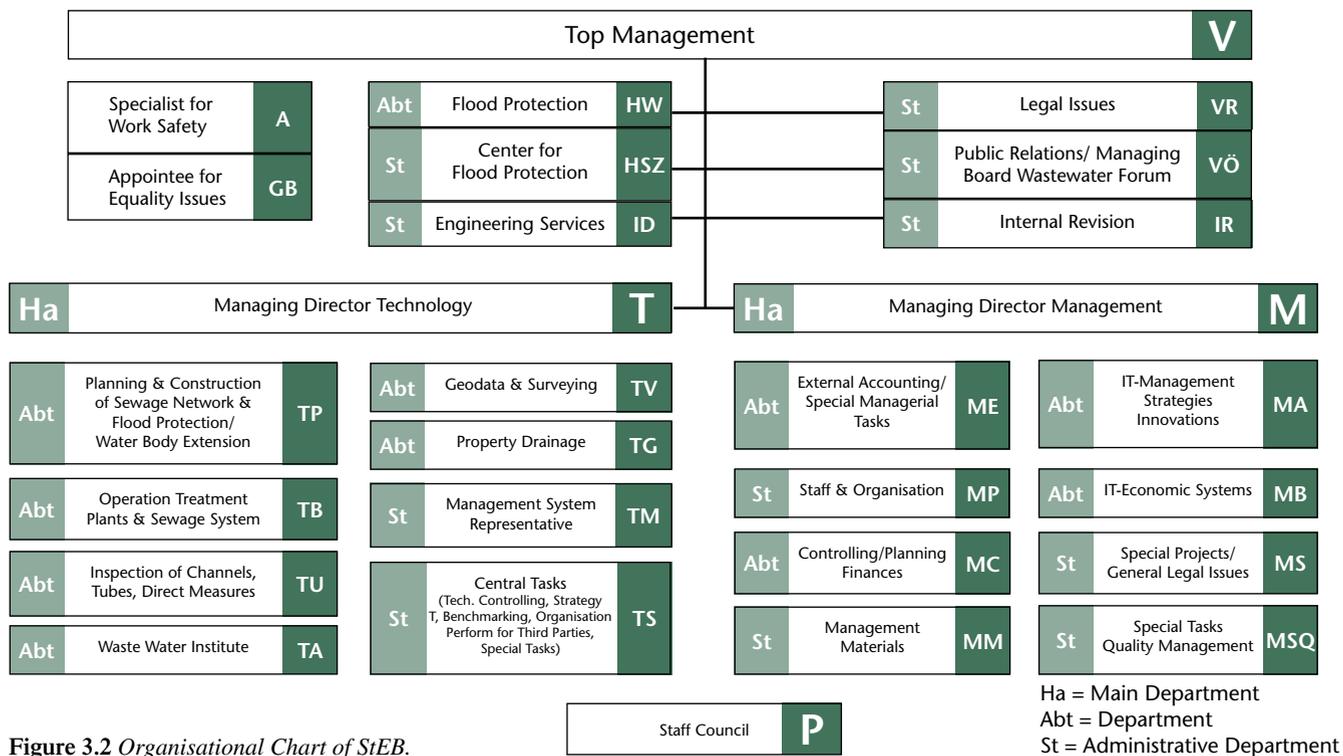


Figure 3.2 Organisational Chart of StEB.

- Drainage and collection of wastewater through the sewage network to the wastewater treatment plants.
- Cleaning of wastewater in wastewater treatment plants.
- Re-feeding of cleaned wastewater into water bodies.
- Disposal or recovery of residues from wastewater treatment and cleaning of sewers.
- Differentiated collection, drainage and treatment of rain-water.
- Construction, maintenance and renewal of sewer networks and wastewater treatment plants.
- Optimization of sewer systems with respect to environmental, technical and economic issues.
- Disposal of excrements of all types (e.g. from small treatment plants, pits or chemical toilets).
- Sampling and analysis of wastewater and residues from wastewater cleaning.

And for the private sector:

- Planning and advice of all types concerning wastewater disposal.
- Disposal of fats and fat-containing food residues.
- Management of private dewatering systems (home connections and lines).
- Operation control of private wastewater drainages and wastewater treatment plants.
- Sampling and analysis of wastewater and residues from wastewater cleaning.

These services are offered through the different sections of responsibility presented in Figure 3.2. One of the major objectives of StEB is reductions of the fees that the customers are charged. A series of large investments has made this possible. Figure 3.3 shows that the fees could be lowered and stabilized at about the same level as in 1993.

Table 3.1 Operational Facilities StEB.

Type	1987	2003	Unit
Sewer network	2,160	2,400	km
– accessible	565	630	km
– not accessible	1,595	1,770	km
Dewatered area	n. a.	155	km ²
Area of the City of Cologne	405	405	km ²
Share of water protection areas of city area	n. a.	46	%
Share of people connected	n. a.	980,000*	number
Connected plots (estimated)	n. a.	130,000	number
Not yet connected plots	n. a.	550	
Pump stations	91	134	number
Rainwater basins	4	77	number
Flood gate valves	490	570	number
Operating gate valves	140	270	number
Waste water treatment plants	6	4 (5 incl. Wahn)	number

* 99.7% of Colognes population.

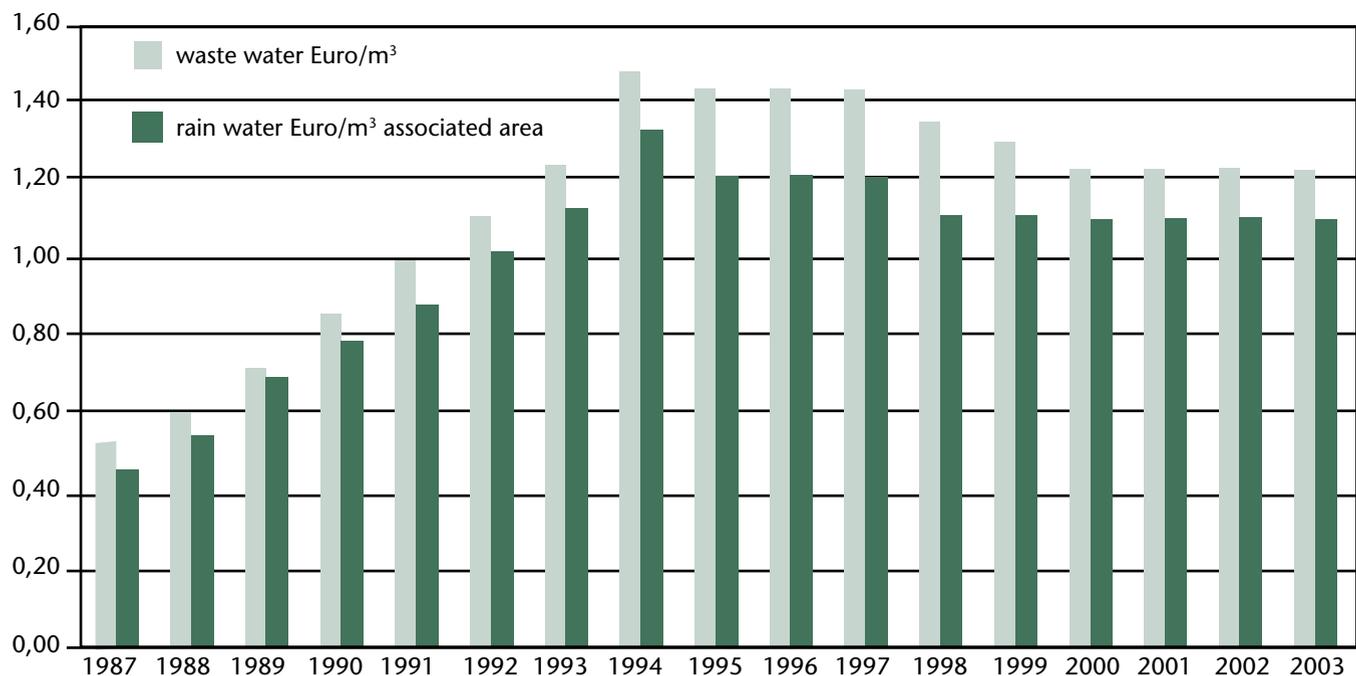


Figure 3.3 Development of wastewater charges in Cologne.

2 Environmental Management

The Environmental Management System

For a long time, environmental issues have had an important role in Cologne Wastewater Company. In the end of the 1990's the company decided to introduce an environmental management system to ensure good environmental performance of their activities. In 1999 four of the wastewater treatment plants (Stammheim, Langel, Weiden and Rodenkirchen, see Figure 3.1) were certified according to EMAS. In February 2003 they were re-certified, this time according to EMAS II.

In 2002 a project was initiated to integrate the existing management systems into one, overall system, an Integrated Management System, IMS. This was achieved in 2004 when the organisation was re-registered according to EMAS and certified according to the Quality Management DIN EN ISO 9001:2000 and Environmental Management DIN EN ISO 14001:1996, as well as introduced risk management and work safety. All systems are integral parts of the IMS. This means that all processes within the organisation are designed with respect to environmental, risk, quality and work safety and health requirements.

Three main requirements are pursued for the management system:

1. Proof of a process of continuous improvement has to be shown regularly to ensure the sustainability of the IMS.
2. Compliance with legal requirements, also part of responsibility of the EMS, has to be ensured.
3. Ensure the use of best available techniques, BAT, in environmental protection, if economically viable.

To achieve these goals a range of targets and objectives were implemented. The most important of these are:

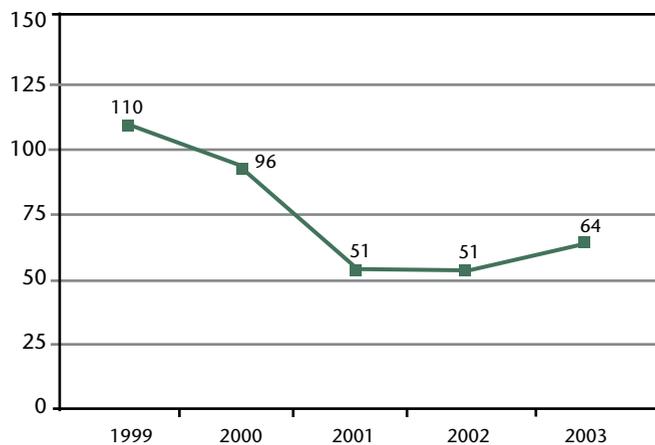


Figure 3.4 Number of complaints caused by odour emission from the Stammheim waste water treatment plant 1999-2003.

- Complete documentation of all processes within the company to create a consistent and reproducible work standard in all parts of the organisation.
- Further documentation of a large number of supporting activities within these processes (e.g. work instructions, checklists, training plans, inspection instructions etc.).
- Upgrading of a database on environmental legislation, which makes it easy to identify relevant regulations and to connect these to internal processes.
- Establishment of an extensive environment and quality programme with a number of measurable objectives and measures to eradicate weaknesses and to identify optimization possibilities.
- Further development of a training programme for the employees to inform them better about the IMS.
- Introduction of performance figures to measure environmental and quality performance and to control environmental aspects.
- Introduction of an extensive audit programme to measure target completion and performance within the IMS and to enable corrective measures.

Environmental Policy and Environmental Targets

In 2003 the environmental policy was integrated into the mission statement of the company. Since its first certification, technical and administrative processes have been continuously developed to meet the increasing demands stated in the environmental policy.

The environmental policy of Cologne Wastewater Company StEB sets a series of environmental objectives, such as the commitment to prevent or reduce environmental impacts, and the commitment to comply with the environmental legislation, or over-comply, if economically viable. A large number of objectives and targets set in previous years have already been achieved. These include:

- Validation/certification of the entire company according to EMAS 2, DIN EN ISO 14001, DIN EN ISO 9001:2000.
- Reduction of odour emission in waste water treatment plant Stammheim through new constructions (see Figure 3.4).
- Increase of operating safety in the same treatment plant by installing an extra pump station.
- Waste reduction in treatment plant Weiden.
- Reduction of energy consumption in Stammheim with 7% compared to 1999.

The new objectives and targets were set and reached in 2004. These included decreased energy consumption by installing a new ventilation system at Stammheim WWTP. The



Figure 3.5 Sewer inspection and rehabilitation.

other environmental goals are still worked on. The operating safety will be increased by optimizing the pump operations and better inspections of the sewer network (see Figure 3.5) as well as the reduction of the emission of hazardous substances. Noise is to be reduced, as this is one of the major nuisances, by using more noise-reduced vehicles and machinery on construction sites. Environmental protection and work safety will be improved further, for instance, by decreasing the amount of hazardous substances used. Furthermore, environmental awareness of new employees needs to be improved. Special training programmes are introduced to solve this problem.

Environmental Work in the Company

The work on improved environmental performance in Cologne Wastewater Company StEB is varied and far reaching. Both direct and indirect aspects are considered in the EMS.

Direct aspects are dominating in the daily activities. They include:

- Emissions into atmosphere.
- Discharge into water bodies.
- Prevention, usage, recycling and disposal of waste, especially hazardous waste.

- Usage and pollution of soil.
- Use of natural resources (including energy).
- Local disturbances (e.g. noise, odour).
- Dangers resulting from accidents and emergencies.

Indirect aspects play a more important roll in the strategic sector and involve mainly administrative and planning decisions within the company and the environmental performance and environmental behaviour of contractors, sub-contractors and suppliers.

The very nature of the activities of StEB – wastewater treatment – of course is positive for the environment: the water which flows into the wastewater treatment plants is being treated and leaves the plants less polluted. However there are some problem areas. One is transport. Even if most wastewater is transported to the treatment plants through the sewer network (see Figure 3.9), in some exceptional cases it is transported with tank cars. Required materials such as spare parts or chemicals are also transported with trucks to the treatment plants. Another issue which has been receiving special attention in past years is disturbance from odour. Constructions were improved and much research on odour prevention has been carried out to reduce bad smell.

Already during planning and constructing, possible environmental problems are considered, mainly energy consumption and resource use. The main resources needed in the wastewater treatment plants and in the sewer network are:

- Energy (electricity, natural gas, sewage gas, heating oil, diesel).
- Operational resources (aid materials, conditioners, chemicals, water hazardous materials, hazardous materials etc.).
- Fresh water.
- Oils, fats, lubricants.
- Cleaning materials.
- Other consumables.

The company has successfully improved its environmental performance on several of the issues mentioned. Figure 3.6 shows the development of sludge treatment. Disposal of sludge on landfills has been completely abolished, as the use for fertilising agricultural land and for fermentation to produce biogas for energy purposes increased.

A negative trend, on the other hand, is the increased specific emission of CO₂ per m³ waste water (see Figure 3.7). This can be traced back to a number of factors. It is not only the energy sources used, the way of producing energy and the amount of mixed water transported, but also other factors such as pollu-

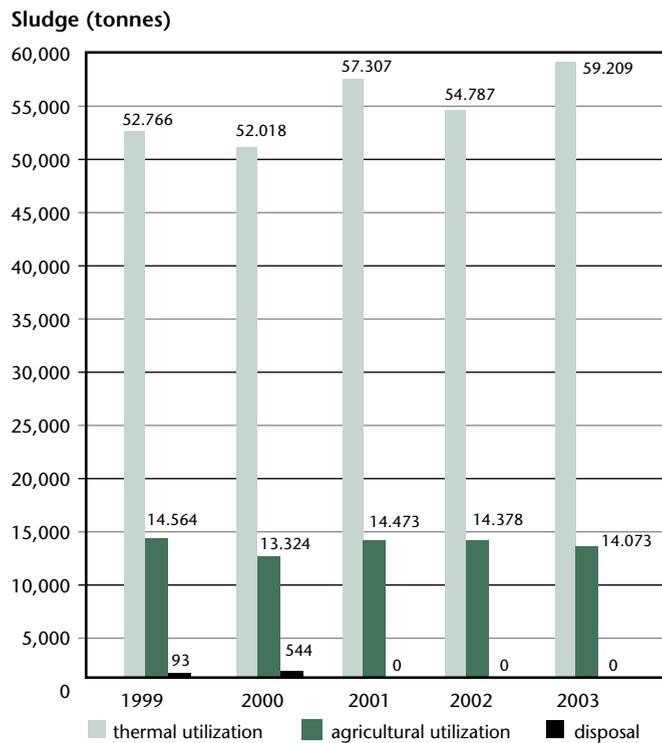


Figure 3.6 Sewage sludge management. Amount of sludge produced and its end usage.

tion load, oxygen need for biological cleaning process, and the amount of sludge. Carbon dioxide emissions is continuously monitored and measures for reduction will be implemented.

The Environmental Management System Office

In Cologne Wastewater, an office for environmental management with one head manager and two personnel is working with both the EMS and the IMS (Risk Management and Work Safety is managed by a different organisation). In addition EMS coordinators are found in each of the individual departments. The office is responsible for maintaining and improving the IMS, and handling the tasks occurring on a regular basis, such as regular internal audits or advice with implementation of improvement. The environmental management office further organizes monthly meetings with the heads of the different departments of the technical branch of the StEB to discuss performance of, and activities within the IMS. The office is also responsible for communicating the management systems within the different departments. They also carry out audits. Four times a year a larger meeting is organised between the management system representative and the coordinators with the aim of updating quality and environmental issues and keeping the IMS functioning.

Communications play an important role in active environmental protection. The monthly meeting are one form of communicating the IMS to the employees, another is the publication of a paper with information on the IMS. Stakeholders have been informed for a number of years, brochures are available in the wastewater treatment plants and visits to the plants can be booked. Other measures include education for school children and adults aimed at increasing environmental awareness.

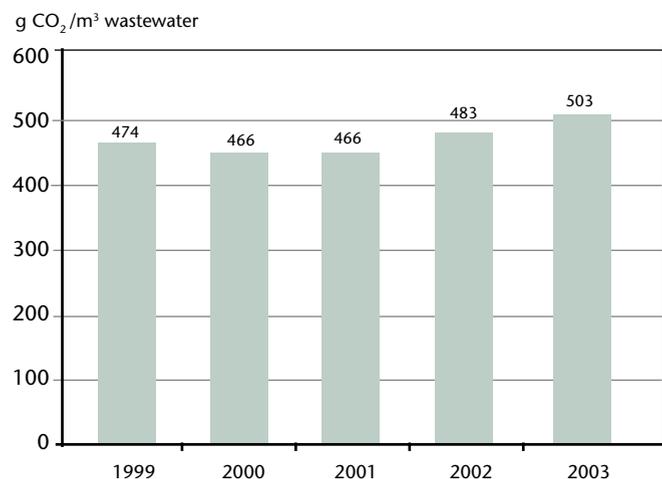


Figure 3.7 Specific CO₂ emissions from the wastewater treatment plant.

Training is performed regularly to increase awareness among the employees. A detailed training plan is updated annually, using comments and statements made by the employees during and after the training sessions. Most training relates to health and safety as well as environmental issues that the employees come in contact with, for example how to handle dangerous chemicals, what to do in case of an emergency or how to prevent nuisances for neighbours of the wastewater treatment plants.

The first audit of the waste water treatment plants, carried out in 1999, led to the development of a number of objectives and measures for improvement of the environmental situation. Internal audits were then carried out in 2000 and 2001 to test the EMS. In 2003 an external auditor was again checking the company. The audit showed a great conformity with the requirements of EMAS and a good performance concerning reaching the set targets.

3 Future Plans

Environmental Innovations – energy recovery

In the past years a number of environmental innovations were introduced in the StEB. One of them is the use of biogas, methane, obtained from fermentation of sewage sludge. The biogas is burned in combined heat and power plants (CHP). The heat generated is enough to completely cover the heating needs of the wastewater treatment plants, while the electricity produced covers 50 percent of their electricity demand. The biogas incineration leads to emission of CO₂ and NO_x, although this CO₂ emission does not contribute to global warming since it is not of fossil origin. The nitrogen oxides are mostly eliminated from the flue gases at least in the largest wastewater treatment plant, Stammheim.

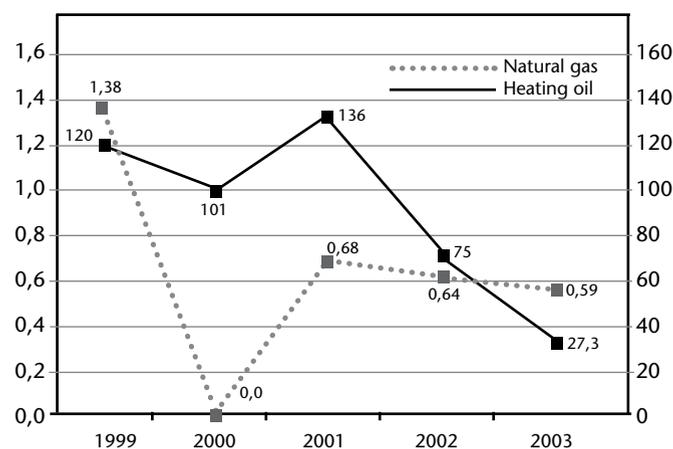


Figure 3.8 Consumption of natural gas and heating oil.



Figure 3.9 Construction of the sewer network.

The wastewater treatment plant Rodenkirchen on the other hand uses a totally different way of producing energy. A fuel cell has been installed here to produce electricity from hydrogen extracted from the biogas.

As a result from energy recovery from sludge the use of fossil (natural) gas and heating oil has been reduced considerably (see Figure 3.8).

Long-term Improvements

The company plans to improve and optimize its IMS further and to improve the environmental performance. One of the main tasks in the future will be to finish the re-organisation process and adapt the IMS to the new structure. A large number of ambitious objectives and targets promises to further increase the efficiency and usefulness of the IMS. One of the focal points will be faster processing of information and tasks within the organisation and an improved operation safety.

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References

This case study is based on information found on StEB's home page as well as material provided by the Management system representative.