Water Industry in Berlin-Brandenburg

Report 2008

Research
Technique
Consulting
Fresh water
Waste water
Rainwater
Wells
Network
Berlin-Brandenburg
Water
Water Expertise
Water
Technique

TSB TECHNOLOGIESTIFTUNG BERLIN

KOMPETENZZENTRUM WasserBerlin

Welcome

The creation and maintenance of networks linking science and industry and the promotion of technology transfer are the core tasks and competencies of the Technology Foundation Berlin Group, which consists of the Technology Foundation Berlin (TSB), the TSB Innovation Agency Berlin and its strategic initiatives, and the support association Förderverein Technologiestiftung Berlin e.V. The foundation concentrates on Berlin's centres of excellence in the fields of biotechnology, medical engineering, transport & mobility, information and communication technology, and optical technologies. All of these have succeeded in growing through strategic initiatives over the last ten years. The goal of TSB's work is to develop sustainable and growing clusters of innovation within the framework of the coherent innovation strategy outlined by the Senate. The TSB also supports traditional fields of technology such as mechanical engineering, electrical engineering and craft trades.

Technology Foundation Berlin has likewise promoted the development and advancement of the water industry, an important field of competence, from its inception in order to harness the great potentials of water research for innovative developments made in Berlin. This report describes these potentials and ensures their visibility for national and international parties outside our region.

TSB regularly publishes industry reports from other Berlin fields of competence, and they are very well received and frequently cited. These reports raise awareness of these competence fields far beyond the regional borders. Their regular publication makes it possible to follow trends and developments over a long period of time. The foundation expects similar positive effects from "Water Industry in Berlin-Brandenburg – Report 2008".

Berlin water research is full of application-specific potentials that can provide innovative impetus for the entire region. Technology Foundation Berlin will continue to provide strong support for this field of competence in the future. The goals are the successful advancement of water research and networking with the regional economy.

Dr. Bruno Broich, CEO Technology Foundation Berlin (TSB)

Stralau peninsula

Content

Introduction

Water Industry in Berlin-Brandenburg – Report 2008, which now lies in front of you, is the first systematic description of the water industry in the German capital region. Numerous companies participated in the survey by the Berlin Centre of Competence for Water that served as the basis for this report. Technology Foundation Berlin proposed the making of this report along the lines of its report series for other industrial sectors and also provided a substantial portion of the funding.

Water is a substance with diverse properties. No less diverse are the human activities associated with water. The processing and utilisation of water for various purposes is one of the first major technical and cultural achievements of humanity. In today's technological society, these activities go largely unnoticed and unappreciated.

The diverse players involved in water and water utilisation operate within a close network of economic, professional and administrative relationships. Berlin's long tradition of technology and science has produced a dense concentration of scientific knowledge out of which innovative strategies and methods continuously develop.

Water Industry in Berlin-Brandenburg – Report 2008 sheds light on the main players in this field and their networks in the german capital region, which includes the State of Berlin and the surrounding greater Berlin area in the State of Brandenburg. It places particular emphasis on the economic ties between these players and the innovation potentials of the companies in this market sector. Since the tasks of public agencies, municipalities and private companies are intertwined, the report will begin by defining the different sectors and describing their fundamental economic relationships. The subsequent chapters describe the research potentials of the region, the innovative power of regional companies, and the economic significance of the water industry in Berlin-Brandenburg. The report will highlight some of the institutions and companies in the region.

Berlin, April 2008

Markus Müller

Berlin Centre of Competence for Water (KWB)
Coordinator, WaterPN Berlin-Brandenburg

1. Water Management Definition

Numerous organisations are involved in the utilisation of water, and the range of different actors can vary greatly. However, the fundamental tasks and coordination efforts – if not executed by them – are controlled by public institutions.

This leads to the general distinction between water management and the water industry or water sector. "Water management" is generally defined as all activities relating to the handling of water to achieve the quantity and/or quality required for human purposes. The terms "water sector" and "water industry", on the other hand, refer to enterprises that deal with water for commercial reasons (see below).

Water management comprises the following elements:
- Supply of drinking water, service water and process water
- Wastewater and stormwater collection and treatment
- Water pollution control, surface water and ground water restoration
- Surface water management (shipping and navigation, flood control, drinking water production, irrigation, etc.).

A variety of different actors are involved:
- Water and wastewater utilities (public and private)
- Trade and industry
- Engineers and consultants
- Contractors (construction, cleanup of contaminated sites and other services)
- Mechanical engineers and plant construction companies
- Scientific advisory services (modelling, IT development, etc.)
- Research and development institutions (university, public and private)
- Public agencies/administrations.

Water has essential functions: it is required for nutrition, agricultural and transportation purposes. Consequently, water management is in many ways affected by government actions, whereby the state functions as a player, regulator and standard-setter.

Municipalities therefore have a statutory mandate to supply drinking water and sewerage services. Stormwater management (urban drainage) also falls in their obligations. Surface water management is planned, regulated and executed by water management authorities, environmental agencies and associations for water and soil management. Legislative and administrative bodies issue regulations concerning water use and water pollution control. Model urban rainwater and service water management projects are initiated and made feasible with state support. A large degree of fragmentation can be observed by virtue of the different functions of water and the history and origins of water management.

The "Badeschiff" in the river Spree

1.1 Water Industry Definition

The players in water industry differ, as does the degree of entrepreneurial risk assumed by them. They can be divided into three groups according to the type of business activity:

1) Public agencies that provide services to the general public, including those responsible for water protection and management.
2) Water and wastewater utility companies, which are often publicly owned and have various entrepreneurial freedoms.
3) Independent private companies that bear full entrepreneurial risk.

Following this comprehensive definition of water management, this report will discuss the part of the "water industry" subject to competition on markets. State administrations are therefore excluded. However, water and wastewater utility companies subject to public law will be included because they are defined as enterprises and not as administrative units. Research and development institutions, which play a key role in advancing technological developments, are also inseparably linked to the water industry.

Providers of technical house connection services are excluded because their mode of operation and pattern of demand is indistinguishable from that of other tradesman enterprises and because they presumably will not provide any systematic contributions to innovation, although interesting single projects naturally can be expected. Uses such as shipping, fishing, and bathing in swimming pools and natural waters are directly related to water resources management, but when classified according to the branch of economic activity, they are included in the transportation, food and agriculture, and tourism sectors and not here.

Some grey areas must necessarily remain due to the diverse nature of inter-relations and the degree of abstraction of some segments (e.g. in measurement and control technology, software, special concrete construction, etc.). However, this has to be accepted if a meaningful definition is to be achieved.

1.2 Water Market Structure

1.2.1 Demanders

Water industry services are demanded by actors with very different modes of action.

Private citizens are the actual consumers of water and wastewater services but, due to the regional monopoly of water and wastewater utility companies, their buyer power in most cases is exerted only in a very indirect manner. Local water and wastewater utilities generally act as the representatives of private citizens on the water market. But for some domestic purposes like irrigation of gardens, rainwater use, or decentralised waste water techniques private citizens are direct demanders.

Water and wastewater utilities are the players with the largest economic stake in the water market. Their underlying basis of operation derives from the obligation of municipalities to ensure adequate water supply and sewerage services. The regional monopoly of the utility companies (drinking water and wastewater) is a direct result of this municipal mandate. On the one side – towards its private and industrial customers – utility companies act as suppliers. Since this occurs within the framework of a regional monopoly, this relationship will not be considered here. When analysing the basic structure of the water market, one can say that the function of utility companies is to bundle up the demands of their private and industrial customers. The greatest demand for water and wastewater services and technology is therefore generated by the utility companies.

Trade and industry are major customers who set specific requirements for process water, service water and special wastewater disposal in accordance with their individual needs. There is an open market in this segment because the solutions and funding needed are entirely subject to private and commercial interests.

Agriculture is worldwide an important demander for water and irrigation techniques. In Germany, however, irrigation is practised only to a limited extend. Nevertheless there might arise an increasing need in Brandenburg if the predicted climate change comes true.

State agencies responsible for water resources management issue contracts for services required to fulfil their mandate within the scope of their allocated budget. The costs of the contract services are not offset by any direct monetary revenue from the achieved effects. Economic effects are generated by their planning services relating to the surface water management and the expansion and maintenance of waterways, etc. Surface water preservation and restoration programmes are other ecologically valued measu- res that produce benefits for the general public.

Last but not least, the **"owners" of contaminated** sites are subject to demands for cleanup services. They have no choice in the decision to clean up the contaminated site, and they may have no choice in the method of clean-up depending on the situation and requirements of the authorities.

These statements on economic value were not intended as a form of valuation. The qualitative and quantitative importance of water is so fundamental that government intervention is required to ensure sustained interregional water resources management. These reflections on the demand structure can, however, provide an indication of the role of public authorities in the development of the water industry.

1.2.2 Suppliers

In accordance with the aforementioned definition of the water industry per se, the group of suppliers is comprised of a large number of small and medium-sized enterprises. Some of these SMEs compete with each other, and some are so highly specialised that they have no regional competitors.

The geographic range of economic activities of these enterprises may be limited to the area in which the company headquarters is located (Berlin-Brandenburg) but, in most cases, it is not. Apart from national companies that operate solely within Germany, a number of companies from this region are successful international corporations – some are even top players in the world market.

The size and ownership structure of these companies ranges from one-person enterprises to subsidiaries of large international corporations; every type of organisational form and size is represented.

A place for culture near the water: Radialsystem V

1.3 Water Industry Structure

Divisions can already be inferred from the market structure. However, the greatly different fields of activity of the water industry make a further division into specialised fields necessary.

Based on the classification according to tasks and organisational structure of the institutions, the private sector companies will be described in more detail since they are often highly specialised.

Research institutions and support institutions such as professional societies and associations that play an important role in the pooling of interests will also be described. Therefore the following classification is used:

- Research institutions
- Private companies (detailed description)
- Water and wastewater utilities
- Associations and support organisations
- Public administration

Precise descriptions of public services (resource planning, waterways, flood prevention, etc.) were intentionally omitted. Regarding the private sector, private companies were classified according to their field of activity (drinking water production, distribution, pumping, etc.) and not their type of business (manufacturing, construction, service, etc.).

This field-based approach was used only in the case of the private sector companies and not for the other players because the economic relationships (see 1.2) would otherwise repeat themselves in the media-based actor groups.

Oberbaum Bridge in Berlin's Friedrichshain-Kreuzberg

2. Players in the Water Industry

Research institutions, private enterprises, utility companies, associations, networks: Who does what? The most important players in the water industry will be described in this section. Selected companies and organisations will be highlighted. Each field of activity will be illustrated using regional companies as examples.

2.1 Research Institutions

Research institutions provide impetus for technological development in addition to developing knowledge about connections between natural and technological systems. Their direct economic significance as customers on the water market is rather low. Their importance for the development of economic power on the other hand, can hardly be overestimated. Universities, in particular, play a prominent role in the development of new technologies and procedures. They continuously secure and maintain technological advantages that are essential for maintaining economic success.

Berlin has three renowned institutions for water management research: the Technical University of Berlin (TU Berlin), the Freie Universität Berlin (FU Berlin), and the Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB). With the establishment of the Berlin Centre of Competence for Water (KWB), Berlin acquired a research network, the projects of which have gained international acclaim. The Science and Technology Park in Adlershof has attracted a number of research-related companies from various specialised fields. Solutions for water management problems have also originated from their expertise. The University of Applied Sciences (TFH) offers studies in water science. The Federal Environment Agency of Germany (UBA) is also present in Berlin with a part of its water research departments.

In Brandenburg, the Universities of Potsdam and Cottbus are actively engaged in the field of water research; they are flanked by the Institute of Agricultural Engineering (ATB) in Bornim and the Leibniz Centre for Agricultural Landscape Research (ZALF) in Müncheberg.

Science and research in the capital region is represented by strongly linked institutions that investigate manifold aspects of the natural processes directly and indirectly related to water and water management. The individual institutions have their own individual approach to the problems of water management and distinguish themselves through their emphasis on practical solutions. The bottom line of this evolved and intentional division of labour is comprehensive expertise.

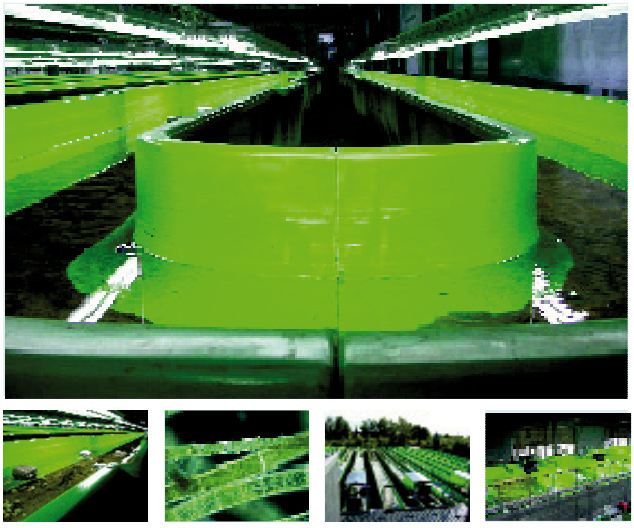
• Technical University of Berlin (TU Berlin)
TU Berlin's large interdisciplinary Centre for Water in Urban Areas is a very successful inter-university network in which 22 departments and 10 institutes work together. The Centre will be discussed in a separate chapter (Section 3.3).

• FU Berlin – Institute of Geosciences
Water management issues are the main focus of the Workgroup Hydrogeology of FU Berlin's Institute of Geosciences. Their investigations start with hydrological analyses of entire catchment areas and extend to interactions between ground water and aquifer rock, the transport and fate of various substances, ground water flows, and the modelling of subsurface chemical interactions. The workgroup's research work contributes to the understanding of factors relating to the production of drinking water and the prevention of ground water contamination. In addition to its geothermal research activities (production of energy from hot ground water layers deep below the surface), the Hydrogeology Workgroup also participated in KWB's large-scale joint study of drinking water production by means of bank filtration, which was conducted in Berlin (NASRI Project); the workgroup will also perform important tasks in the new 2008 research project for optimisation of drinking water well management (WellMa Project, KWB). The workgroup's international co-operations span to projects in Spain, India, Egypt and elsewhere. Last but not least, it has worked together with TU Berlin and Berlin's water utility company Berliner Wasserbetriebe (BWB) at the local level for several years.

• Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB)
The IGB looks back on a more than 100-year history. A precursor of the institute was originally founded as the Institute of Inland Fishery in Berlin-Friedrichshagen in 1893. The mission then was to conduct research on inland fishery in natural waters and to monitor water quality in Lake Müggelsee. Today, the IGB investigates the ecological relationships between inland lakes, shallow lakes and lowland rivers in the Brandenburg region using a solid interdisciplinary approach. The development of concepts for surface water preservation, restoration and management is a main objective. Consequently, the IGB's research focuses on the impact of pollutants in surface waters. Research questions range from nature conservation and resource protection to pisciculture (fish farming).

The IGB collaborates with other universities and institutes, including the TU Berlin, FU Berlin and BTU Cottbus. In addition, it participates in KWB research projects investigating blue-green algae (cyanobacteria) in lakes and works jointly with SMEs to address questions relating to fish farming.

· Federal Environment Agency (UBA)
Even after officially relocating to Dessau in 2005, the Federal Environment Agency (Umweltbundesamt – UBA) still has approximately one-quarter of its employees in Berlin. Its laboratories, in particular, are still located in the capital city. The Federal Environmental Agency has a unique facility in Berlin-Marienfelde: The Artificial Stream and Pond System (Fließ- und Stillgewässer-Simulationsanlage – FSA). This large test facility allows scientists to simulate aquatic lotic (flowing), lentic (stagnant) and flow-through systems ranging from streams, rivers, ponds and lakes to lake-like lowland rivers. The FSA facility is one of the largest model ecosystems (mesocosms) in existence. Mesocosm systems make it possible to create intermediate experimental conditions between those of simple and easily controllable laboratory experiments and more complex and difficult to control field studies. The FSA facility has 16 streams with a total flow length of 1.6 km, 16 ponds, and approximately 5 km of pipe network equipped with pumps, valves and the corresponding sampling and measurement equipment.



The Artificial Stream and Pond System

· University of Applied Sciences (TFH)
Maintenance, restoration and optimised utilisation of existing facilities are increasingly important concerns. The optimisation of infrastructure facilities in large urban areas is a global task. The TFH's new curriculum for "Urban Infrastructure Planning – Transportation and Water" was designed to address these important issues.

· University of Potsdam – Institute of Geoecology
The University of Potsdam's Institute of Geoecology addresses questions relating to water cycles and water balance in complex landscapes and the flows of various substances within them. The main emphasis is placed on streams, rivers and their marshlands: Physical laws and the prediction of runoff and flooding, flood management and nutrient and sediment transport are currently the main areas of research interest.

The Institute of Geoecology has international connections with Europe, South America and South Africa. It has teaching and research collaborations with the Leibniz Centre for Agricultural Landscape Research (ZALF), the Potsdam Institute for Climate Impact Research (PIK), and the German Research Centre for Geosciences (GFZ) in Potsdam.

· Department of Hydrology and Water Resources Management, Brandenburg Technical University (BTU) – Cottbus
The nature and management of water resources is the central focus of the department's work. Basic research in this subject area is conducted to improve the understanding of the related processes, and research concepts are applied to questions relating to dam management. Lignit open cast mining and the recultivation of abandoned mines in the affected landscapes are two main areas of interest. Due to the substantial drop in the ground water level and the subsequent flooding of the mines, the conditions are so severely impaired that their impact on natural waters must be monitored closely. Extreme runoff events, low-water runoff in hot summers as well as flood runoff, are further areas of research interest.

· Leibniz Centre for Agricultural Landscape Research (ZALF)
The Leibniz Centre for Agricultural Landscape Research (ZALF), which was founded as the Kaiser Wilhelm Institute of Plant Breeding Research, looks back on an eventful history. ZALF has a total of 7 institutes, one of which is the Institute of Landscape Hydrology. This institute investigates questions regarding the availability of water in various landscapes in connection with land use and climate change. Water and nutrient flows as well as the preservation of small water bodies and wetlands in the target landscapes are studied in addition to broad research questions. ZALF has numerous contacts and co-operations.

· Leibniz Institute for Agricultural Engineering in Potsdam-Bornim (ATB)
The ATB's main areas of research are agricultural engineering and biological process technology, including the purification of special wastewater from agricultural production. The ATB conducts joint projects with a number of institutions, including Humboldt-University-Berlin, BTU Cottbus and ZALF.

2.2 Private Companies

Private companies that are entirely subject to market competition are responsible for a number of water management tasks. Their customers include public water and wastewater utilities, public institutions and private businesses, especially those in the manufacturing industry. This group of actors is extremely diverse and covers a range of different activities, such as the preparation of scientific expert reports and engineering plans as well as the execution of construction work. The industry, which looks back on a 150-year history, features a high degree of differentiation and companies with a high degree of specialisation.

Regional companies in the water industry maintain extensive relationships with business partners in other parts of Germany and, in some cases, throughout the world. The large number of high-rate technological products and processes reflecting technological leadership attest to their potential for innovation.

Water production

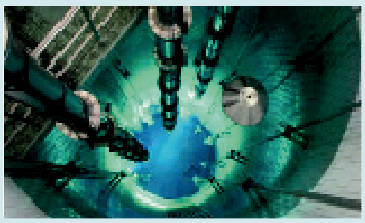
The product manufactured by this branch of the water industry lies mainly beneath the earth's surface in the wells from which ground water is extracted. After exploration and planning work has been conducted by specialised companies, the wells are drilled and fitted with the necessary technical devices (pumps, pipes and control devices).

Wells remain in operation for decades but are subject to aging. The mode of operation, that is the volume of water extracted in a given time, is a major determinant of well aging. WellMa – a joint research project conducted by Berliner Wasserbetriebe, KWB and associated medium-sized enterprises – focuses on this subject. Well maintenance, cleaning and, if needed, regeneration are performed by special well management service providers.

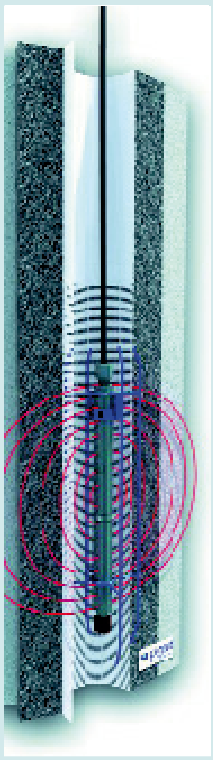
Well at Havel River

Well management services

The spectrum of technological processes available for well regeneration is extensive. Methods range from pulse-wave technology (e.g. Hydropuls® and the detonation shock method Sprengschocken®) and high and low-pressure systems to gravel washing technology. The appropriate method is implemented according to need after a competent situation assessment. Berliner Wasserbetriebe has gathered extensive experience over many years of operation of more than 850 wells; the detonation shock method was developed in Berlin. The company pigadi represents BWB's expertise in well service internationally.



Shaft in a horizontal filter well



Hydropuls® technology

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Water purification and wastewater treatment

It is rare that water taken from a natural environment can be pumped directly into the drinking water system. At minimum, iron and manganese generally have to be removed in order to improve the taste and colour of the water. At large water purification plants, this is done using above-ground sand filter systems. For smaller water volumes also underground water purification systems are applied. When surface water is used, algae and suspended particles must be removed, and disinfection is often required. Specialised engineering consultants provide planning services for the construction of such systems.

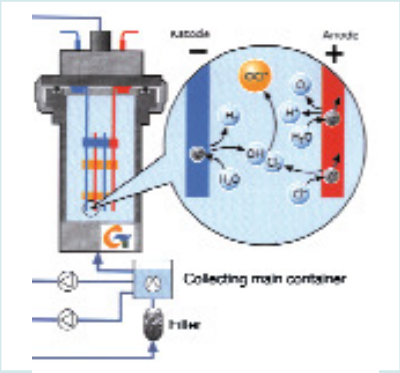
Underground water purification system UWEMAoxygen.

Reproduced with kind permission of Würdig Pumpentechnik, Berlin

Berlin companies also supply electrochemical systems for the production of chlorine for disinfection of drinking water networks and pipes in buildings. These systems not only prevent infections with harmful bacteria such as Legionella, but also eliminate the need for the transportation and storage of chlorine – a poisonous and aggressive gas.

Electrochemical water purification

Legionella contamination in building systems is an increasing problem in hospitals, hotels and other large building complexes. Firms specialised in electrochemical water purification offer electrolysis-based equipment for the production of hypochlorite in building pipe systems. Hypochlorite keeps bacteria from contaminating the water supply.



Electrochemical hypochlorite production system.

Reproduced with kind permission of G.E.R.U.S. mbH, Berlin

Clean surface waters are essential for protection of the environment and for ensuring a clean and safe drinking water supply. Wastewater must therefore be purified at wastewater treatment plants. Berliner Wasserbetriebe has made continual advances in wastewater treatment technology and is applying this knowledge at large-scale treatment plants. The firm p2m Berlin provides international project planning and coordination services as a member of the Berlinwasser Holding group (see "Project Management and Consulting" below).

In sparsely populated parts of Brandenburg, it is not always feasible to connect all areas to a sewer network. Small-scale wastewater treatment systems are a useful alternative for individual houses and communities. Several manufacturers of such systems are located in the Berlin-Brandenburg region. Germany is a world leader in decentralised wastewater purification technology.

Water can be polluted by a variety of different contaminants. The purification of industrial wastewater and of polluted ground water is a complex task. Berlin's history as an industrial city has led to the development of a number of companies that specialise in providing situation-specific water technologies designed to meet the individual customer needs. This technological know-how made in Berlin is marketed around the world.

Process development and plant construction

The purification of water, process water and exhaust air needs situation-specific systems. According to the problem encountered various processes are applied.

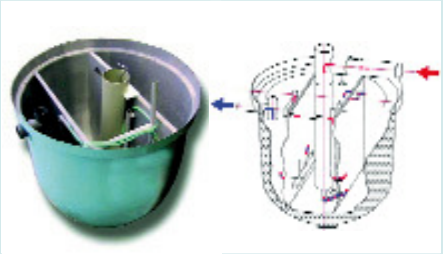
OXI-PURE® – a patented catalytic wet oxidation method.

Neutralisation of textile process wastewater by flue gas in Sri Lanka.

Reproduced with kind permission of Delta Umwelt-Technik GmbH, Teltow

Decentralised wastewater treatment

In sparsely populated areas it is not always feasible to construct a sewer network. Modern small-scale treatment systems purify the waste water of individual houses and can replace cesspits.



Small-scale wastewater treatment system Miniclar for 5 – 15 inhabitants.

Reproduced with kind permission of Protekum Umweltinstitut GmbH, Oranienburg

Water supply and sewerage

Water must first be pumped into the house before it can flow out of the tap, and it must be brought back out of the house after it is used. The necessary water pipeline and sewer systems are built by civil engineering companies specialised in underground pipeline construction. Trenchless technologies have been developed so that the pavement does not have to be broken open every time a pipe has to be installed. Berlin looks back on several successful joint projects in which these technologies were developed by various companies in cooperation with Berliner Wasserbetriebe.

The same applies to the renewal and renovation of old water and sewage pipelines. Karl Weiss Technologies, a company with a long-standing tradition in Berlin (see Section 3.2 – Sewage Networks),

has independently developed various technologies and successfully marketed them in Europe and in the USA.
Sewer systems absorb huge amounts of capital. They are designed for a long life. The companies engaged in sewer construction are certified by the Gütegemeinschaft Kanalbau e.V., whose chairman since 14 years is the Berlin entrepreneur C.-F. Thymian (beton & rohrbau GmbH & Co KG).

Civil engineering – Always more than a scoop and shovel

The installation and replacement of pressurised pipe networks for drinking water, wastewater and gas are two of the main tasks of civil engineering. The press-pull methods available today make it possible to replace old pipes with new pipes in the same trench. In sewer construction, new lines are often installed using underground pipe-driving methods. These companies are generally strongly rooted in the regional market but have grown far beyond the regional borders.

Reproduced with kind permission of Gottfried Puhlmann GmbH & Co KG, Berlin

Temporary sewer bypass DN 2200 at Alexanderplatz, Berlin. Reproduced with kind permission of beton & rohrbau C.-F. Thymian GmbH & Co KG, Berlin

A pipe is a pipe and, as such, it is a system easy to understand. Lots of pipes, on the other hand, form complex systems, the management and characteristics of which are very demanding. For optimised operation of the Berlin sewer system, BWB and KWB conducted various research projects together with business partners in order to test novel procedures and technologies, which are now being implemented throughout the city (see Sec- tion 3.2 – Sewage Networks).

Fittings and pumps

Water flows – and to ensure that it flows where it's supposed to go, pumps must pump and valves must open. The necessary equipment is as diverse as the corresponding applications. Pump technology, in particular, is always finding new solutions for one and the same problem. And rightly so, because drinking water pumps must never discharge compounds into the water, and wastewater pumps are exposed to aggressive mixtures in which solid particles are suspended. May a single pump conduct only a few litres of water, pumping stations convey entire rivers of water through our cities.
Reliability and energy efficiency are the two most important quality features of pumps. Regular maintenance is the primary means of ensuring reliability. Roughly a dozen regional firms supply pump services.
When large wastewater pumps are set at a low rpm for energy efficiency, the frequency of pump clogging increases. In a joint development project, the manufacturer KSB, the Technical University of Berlin and AUCOTEAM, a medium-sized, Berlin-based company, investigated the questions of how to improve the reliability of wastewater pump operations and of how to make them more energy efficient (see Section 3.2 – Sewage Networks).

For continuous flow

Maintenance is the secret of failure-free operation of water supply and sewage pumping stations. Specialised companies are responsible for providing maintenance, emergency, repair and stress testing services.

Pump test stand.
Reproduced with kind permission oft Würdig Pumpentechnik, Berlin

Measurement, control and analytical technology

The processes that must be controlled are as diverse as the ways in which water is used. And it is only possible to control that what has been previously measured. Measurement parameters include "simple" physical variables such as temperature, flow and pressure as well as the chemical parameters that characterise water. These technologies are applied for process control at wastewater treatment and water production plants. They are used to monitor water quality and volume and to control complex drinking water and sewage networks.

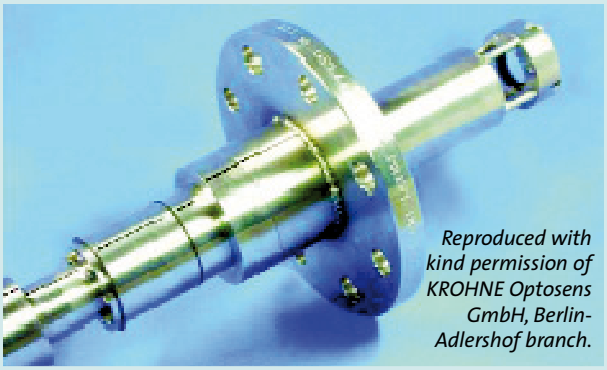
Due to the tremendous number of man-made substances (both toxic and non-toxic) present in the environment today, the analysis of impurities in water is a constant challenge for analytical chemists. Specialised analytical laboratories provide information on all types of bacteria and harmful substances that pollute the water. They therefore provide a basis for the planning of rehabilitation measures. They also serve to monitor drinking water quality and to observe the behaviour of various pollutants in the environment.

Chemical analysis left the confines of the laboratory long ago. Standardised tests that allow on-site determination of the most important parameters have been available for years. Some tests require manual labour, but online analysers feature fully automatic operation. This permits the continuous monitoring and direct input of measurement data into the process control system.

Analytical and measurement technology are research-intensive sectors, and both are a main focus of innovative companies in Berlin (see Section 3.2 – Analytical and Measurement Technology). Many of these companies originated from a university background and are internationally active today.

Light in water

Optical sensors are utilised in fluids and gases. The detection of properties such as light scattering, reflection and absorption at various spectral ranges provides important information about substances contained in the medium.



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Services providers for water and wastewater utilities

Focus on core competencies – this is also the current maxim of the water industry. Specialised service companies are contracted by the usually municipal water and wastewater utility companies and by the municipalities themselves to perform services such as the cleaning of pipe networks, the emptying of cesspit in areas not connected to the public sewer system, and the removal of wastewater treatment sludge. Specialised private firms are also contracted to perform administrative tasks, such as reading water meters and billing customers. This specialisation is cost-saving and helps to improve service.

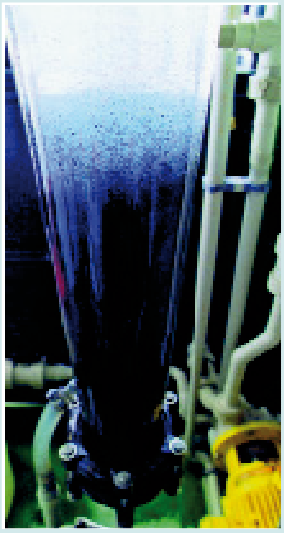
Water pollution control, groundwater protection and contaminated site cleanup

Water is an irreplaceable nutrient and, at the same time, is used as a universal cleaning fluid. Its ubiquitous occurrence in the environment makes water susceptible to all types of pollution. We harm our surface waters and ground water, in many cases, unintentionally. Technical precautions and anticipatory planning are therefore designed to protect our water resources.

In spite of this, soil contamination and the resultant groundwater contamination eventually occur sooner or later due to carelessness, accidents or just plain ignorance. These contamination are hazardous both to humans and to the environment. After preliminary assessment and planning, a wide range of contamination cleanup methods that were developed in the last decades can be implemented.

Biological activated charcoal

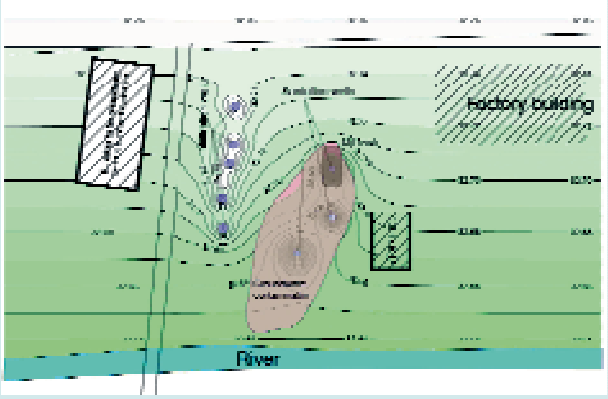
Because of its ability to bind a number of harmful organic compounds, activated charcoal is often used for purification of contaminated water. The decomposition capacity of microorganisms can be exploited so that one does not have to regularly exchange the activated charcoal. This method of combining activated charcoal with microbiological pollutant decomposition was presented as a "Worldwide Project" at EXPO 2000.



"Biological activated charcoal". Reproduced with kind permission of Umwelttechnik Dr. Bartetzko GmbH, Berlin

Focus on groundwater and soil

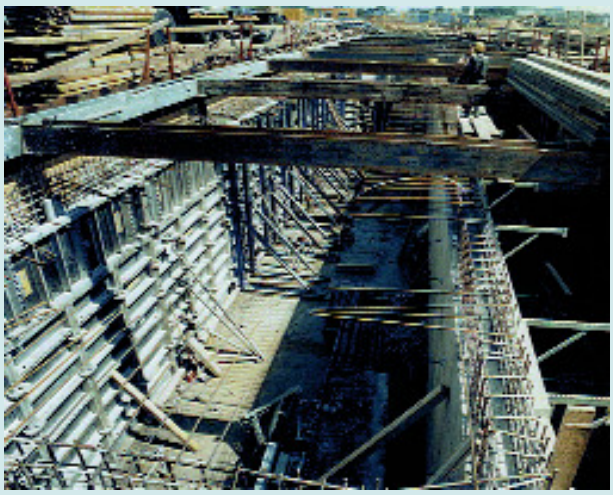
Groundwater flow modelling of soil contamination sites provides a basis for cleanup planning. Modelling makes it possible to evaluate toxic substance flows and to select appropriate cleanup measures.



Reproduced with kind permission of the IGB –Ingenieurbüro für Grundwasser und Boden GmbH, Berlin

Planning for water management

Engineers' contributions to water management are often hidden: Lines, conduits and stormwater treatment tanks are located below the surface, and water supply and wastewater treatment plants are usually located away from residential areas. Urban drainage systems are often run in an inconspicuous manner, and the planning work behind these systems is not apparent to the untrained eye.



Stormwater treatment tank under construction.
Reproduced with kind permission of Müller-Kalchreuth Planungsgesellschaft für Wasserwirtschaft mbH, Berlin

Engineering service providers

Planning – the first step of action – is the field of competence of engineering consultants and design specialists. Several planners must work together before facilities such as a water work can be built. Firstly, groundwater flows and water levels resulting from the pumping of water must be calculated using mathematical models. These data are entered into a computer-assisted geoinformation system and displayed in map form. Landscape designers and specialists then assess the potential effects of the constructed system on nature. The corresponding wells, pipes and pumping stations are then designed during the technical planning stage. Finally, the actual construction of the water supply system can start based on the results of these activities.

Engineering consultants document and characterise systems as a basis for decision-making; this preliminary work makes it possible to make predictions for the future. Planning is always about developing the best solution. The impetus for innovative new methods and planning strategies frequently comes from engineering consultants.

The optimisation of available technologies is an important task, especially in water management, as the basic components are usually available. But better is the enemy of good. Energy efficiency, durability and reliability: improvement of these quality features is a continuous challenge.

Making network preservation predictable

Drinking water and sewage pipes are kept in service for many decades. Large amounts of capital are invested in this long-lived infrastructure. Materials and operations affect the life span of the pipes. Timely rehabilitation of pipe networks contributes to damage prevention and stretches the necessary investment capital over several years.

Appropriate programmes assist in modern anticipatory rehabilitation: Which part of the network must be rehabilitated within a given period? Where can the first damage be expected? For years now, Berliner Wasserbetriebe has worked together with the "Büro für Rohrnetzanalysen" from Neuenhagen near Berlin and the Berlin branch of Pecher & Partner Ingenieurgesellschaft on the development of appropriate rehabilitation programmmess for drinking water and sewer networks, respectively.

Project management and consulting

The realisation of complex projects requires competent project management. The individual steps of planning, approval and execution must be coordinated, financing arrangements must be made, and costs, deadlines and the quality of results must be monitored at each step. These complex processes are overseen by interdisciplinary service providers. Here, technical expertise is just as important as organisational and financial talent.

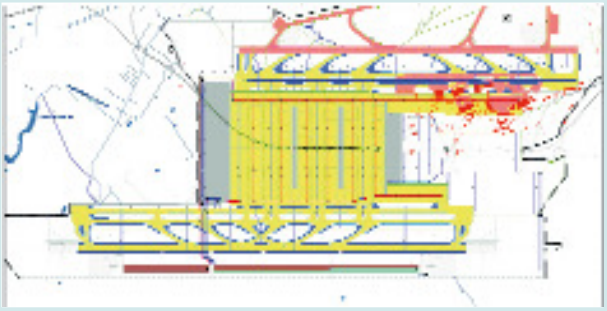
The customers often have experienced consultants at their service who are not directly involved in the process. Even before the decision to launch a project is made, they are employed to summarise and analyse key aspects of the project.

Berlin has several experienced advisors who are active on the international water market. The consulting firms Berlinwasser International (see Section 5) and p2m Berlin GmbH (both part of the Berlinwasser Holding group) as well as HYDER VOIGT Ingenieure Berlin GmbH provide services for water supply and waste water treatment, from preliminary planning to complete plant operation and management.

They serve a market that has shown strong growth in recent years. Rapid expansion in Asia is generating a tremendous demand: There are entire cities in need of new water networks. The Gulf region and the American market also provide great opportunities, which are being embraced by Berlin companies.

Airport Berlin Brandenburg International and water

In the scope of expanding the existing Berlin-Schönefeld Airport to create the new Berlin Brandenburg International Airport (BBI), a variety of systems must be designed and constructed to accomplish the drainage of these large sealed surfaces: soil filter systems, geohydrological site models for water supply and sewerage systems, drainage systems for airside low buildings and secondary road networks.



BBI – Berlin Brandenburg International. Reproduced with kind permission of HYDER VOIGT Ingenieure GmbH Berlin

Scientific services and expert reports

Water flows – but to where? What are the effects of changes in land use, river expansion, or lowering of the groundwater level? These questions lie at the interface between science and practice. The close exchange between expert consultants and Berlin universities and research institutions provides for an interlinkage between practical questions and science.

The increasing performance capacity of computers makes it possible to simulate increasingly complex systems and thus to predict the effects of changes in these systems. Water management and the underlying field of modelling science are two particular strengths of Berlin; both of these fields of competence have an excellent international reputation and contribute to the protection of water resources (see Section 3.2 – Modelling and Water Management).

The analysis of substances suspended in water is a challenging task. In addition to universities, the capital region also features privately owned water analysis firms whose testing and monitoring work forms the basis of decision-making and ensures water quality.

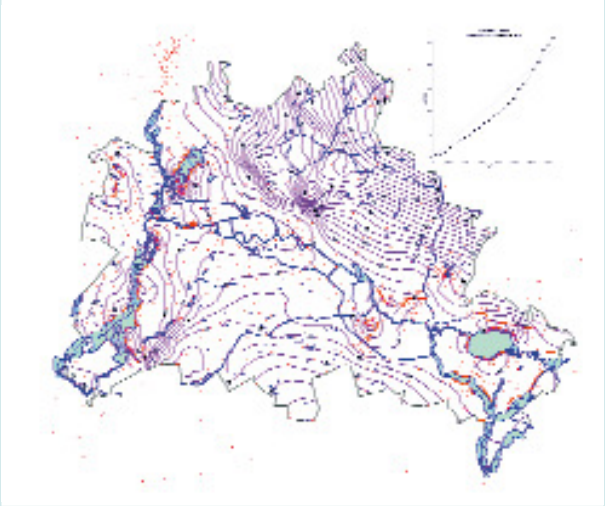
Project planning, controlling and management

Technical know-how in the water management and construction sectors, responsibility-conscious project developers, planners and managers with personal background experience, and technical competence in engineering and project controlling are required for successful management of large projects. All project realisation processes must be mastered – from planning and design to construction and from project controlling and management to commissioning the plant. Innovative solutions and a well-practiced team of highly motivated specialists are the basis of success.

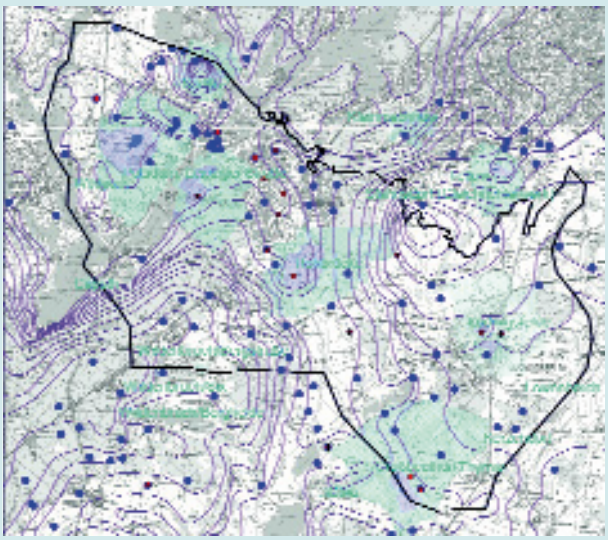
Reproduced with kind permission of p2m Berlin GmbH

Groundwater analysis and characterisation

State agencies are responsible for the monitoring of groundwater quality and groundwater levels. Specialised firms with several years of experience in regional hydrogeology and water management are commissioned to assist the public environmental and water management agencies.



Groundwater contour map of Berlin 2003.



Potsdam vicinity: groundwater monitoring sites.
Reproduced with kind permission of HYDOR Consult GmbH, Berlin

Stormwater management and urban drainage systems

No one likes to step outside the house and land in a puddle of water. Rainwater management is a challenging task. Since 150 years ago, the main strategy was to rapidly divert runoff from sealed surfaces and drain it into the closest river. These concepts have changed in recent years: Rainfall runoff carries dirt from the street into the rivers, resulting in pollution. Moreover, rapid runoff contributes to high water conditions and, in drought years, water is lacking in the places where it is needed.

Delayed runoff and infiltration are solutions to this problem: If stormwater is allowed to infiltrate into the soil at the site where it falls, it will remain there and be available for groundwater production; moreover, it will not pollute the rivers. Ingenieurgesellschaft Professor Sieker mbH from Hoppegarten, a leading engineering firm specialised in the planning of infiltration systems for stormwater management, is involved in several international projects (see Section 3.2 – Stormwater).

Rainwater use in buildings is an alternative solution. Berlin firms started implementing rainwater use systems and design concepts for rainwater harvesting in green areas decades ago.

Making water visible

Including water as a design element of green areas while simultaneously ensuring the drainage of rainwater runoff from roofs and pathways requires close cooperation between technical and creative designers.

Kirchplatz square in Dortmund-Scharnhorst.

Reproduced with kind permission of Landschaft planen+bauen GmbH, Berlin

2.3 Water and Wastewater Utilities

In Germany, the municipalities are responsible for water supply and sewerage. Water and wastewater utilities are obligated to supply all households and enterprises with clean drinking water and to ensure safe wastewater disposal. Hence, they are the main customers on the water market.

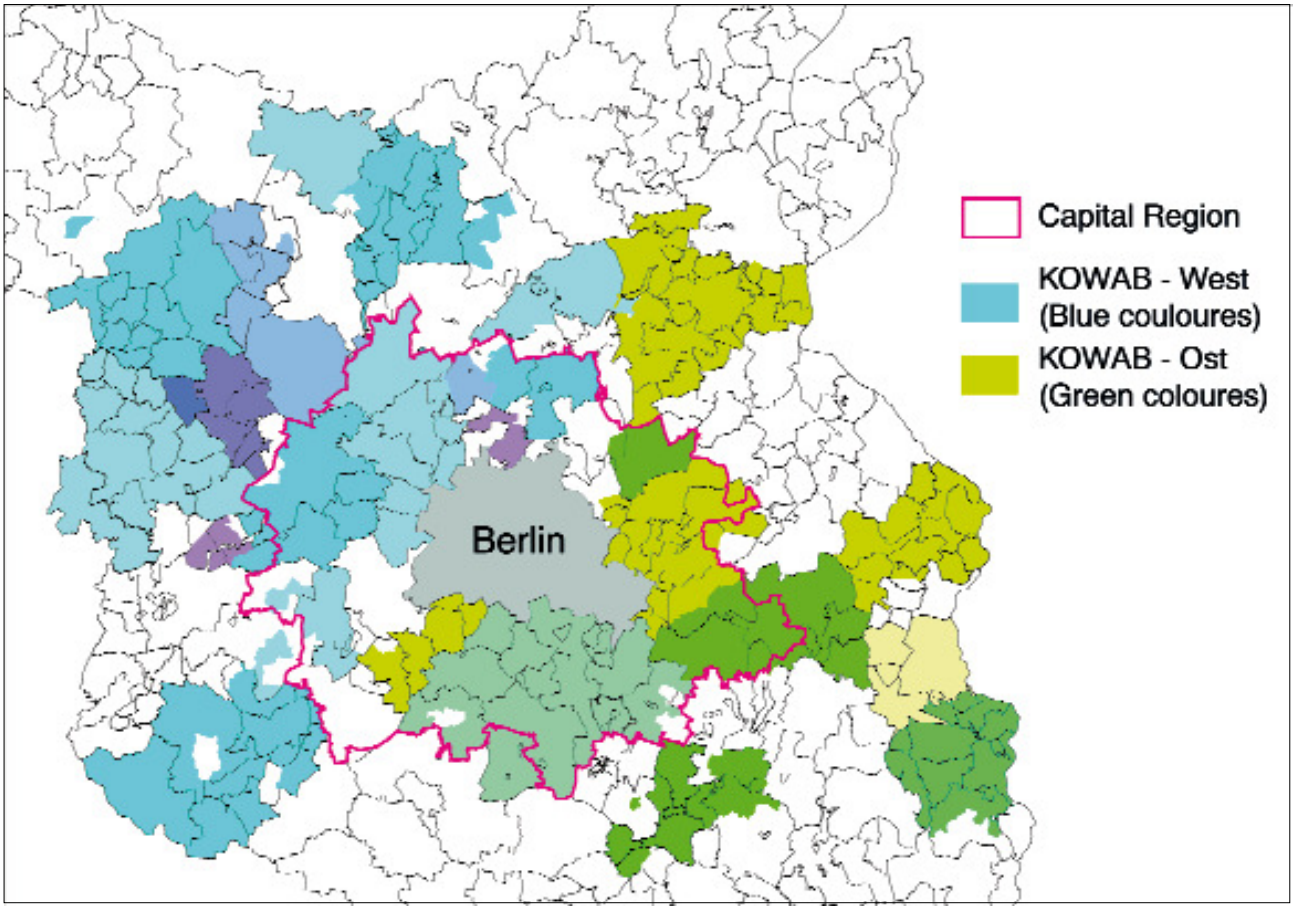
Berliner Wasserbetriebe (BWB) is the utility company responsible for providing water and wastewater services to Berlin (see Chapter 5). The BWB provide their services not only in Berlin, but also to some of the surrounding municipalities.

Most municipalities in Brandenburg have joined their forces to form larger organisations that generally manage for both the water supply and the sewage services within the joint territories.

These so called Zweckverbände in Brandenburg merged to form two large cooperation groups. Kooperation Wasser und Abwasser (KOWAB) East and West each represent 15 Zweckverbände active as public water and wastewater utilities. The goal of KOWAB is to promote the exchange of information between members, to provide employee training at joint training events, to obtain cost advantages by pooling demands for suppliers, and to represent the interests of the organisation in politics. The activities of KOWAB East and West extend far beyond the capital region in to Brandenburg.

The infrastructure and technical facilities in Berlin and Brandenburg have been modernised during the last 10 years. Most of this work has been completed, so investment activities can now be focused on ongoing replacement and maintenance of the existing networks. The Zweckverbände contract regional and national firms from all over Germany for these tasks if they are not performing them themselves.

Map of KOWAB territories



2.4 Supporting Actors, Associations and Networks

A number of actors in the water market play a supportive role in the development of the water sector. Irrespective of their legal form, a common feature is that they do not pursue primary self-interests.

Institutions for promotion of trade and industry
Public institutions promote economic development in the region via the provision of advisory services, the organisation of interests and, to a limited degree, the provision of financial resources. BerlinPartner GmbH and Zukunftsagentur Brandenburg (ZAB) are the state-funded advisory and service agencies. Both have special offerings for enterprises, including those of interest for the water industry. BerlinPartner and ZAB provide access to market information and organise trade show exhibits and travel abroad. The water industry has also received increased perception in recent years, in particular, from the Berlin Senate Department for Economics.

Wasserplenum Working Group of the Senate Department for Economics, Technology and Women's Issues
The Wasserplenum, which was founded in 2006, supports the efforts of enterprises to become more active in international markets. It operates complementary to existing networks of research and enterprises (see Section 3.3).

Development Cooperation
InWEnt (Capacity Building International, Germany) and GTZ (Gesellschaft für Technische Zusammenarbeit GmbH) – the state organisations for development cooperation – have offices in Berlin. They are important sources of information on the situation in other countries as well as demanders of services. Their worldwide network of foreign experts provides first-hand information and mediates contacts in potential target markets. They are actively involved in the Wasserplenum Working Group of the Senate Department for Economics (see Section 3.3).

Chamber of Industry and Commerce – IHK
The Chambers of Industry and Commerce in Berlin and Brandenburg support their members by supplying them information and by representing their interests. They operate UMFIS-Online, the national database of companies in the environmental sector. More than 10,000 firms operating in the environmental sector are registered in the database.
Outside of Germany, the IHK maintains a worldwide presence through the network of Foreign Chambers of Commerce (AHK).

Trade associations
The German water industry is represented by several economic associations. These associations represent the interests of water and wastewater utilities, issue technical regulations, and are involved in the legislative process. DVGW is the umbrella organisation for drinking water utilities, and DWA for wastewater utilities. Apart from these professionally oriented associations, the BDEW represents the common interests of electricity, district heating, gas, water and wastewater utility companies in Germany. All of these associations have offices in Berlin. Figawa, which has its headquarters in Cologne, is the umbrella organisation for companies in the gas and water sector. Figawa is mainly active in the preparation of standards and regulations, in research and development, and in training and continuing education.

Umbrella organisations in the water industry

Deutsche Vereinigung des Gas- und Wasserfaches e.V.
Josef-Wirmer Straße 1-3,
D-53123 Bonn,
Tel.: +49(0)228 91 88-5
info@dvgw.de, www.dvgw.de

DWA Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V.
Theodor-Heuss-Allee 17,
53773 Hennef,
Tel. +49(0)2242 872 333,
info@dwa.de, www.dwa.de

BDEW Bundesverband der Energie- und Wasserwirtschaft e.V
Robert-Koch-Platz 4,
10115 Berlin,
Tel. +49(0)30 72 61 47-0,
info@bdew.de, www.bdew.de

Bundesvereinigung der Firmen im Gas- und Wasserfach e. V.
Marienburger Straße 15,
50968 Köln
Tel. +49(0)221 37 668 20,
info@figawa.de, www.figawa.de

Technology Foundation Berlin Group (TSB)
TSB promotes technological development and applied research in collaboration with the State of Berlin (see Section 3.3). It supports among others the:

Berlin Centre of Competence for Water – KWB
The Berlin Centre of Competence for Water (KWB) has been operating as a publicly and privately funded research network partnership since 2001. WaterPN Berlin-Brandenburg, a Network that allows water industry companies to jointly develop their innovation potentials and market opportunities, was established at KWB in the summer of 2006, supported by the Berlin state government using joint task force funds (see Section 3.3).

2.5 Public Administration

Public administrations perform mainly planning and coordination tasks. Within the legislative framework, they approve the use of surface waters, carry out water management planning and coordinate the related requirements. In addition, they monitor the volume and quality of surface waters and facilities that impact upon them (e.g. wastewater treatment plants). Water resources management by the State also includes the construction, maintenance and operation of waterways as well as road drainage.

Public administrations act to a variable degree as direct demanders of services, such as expert reports, design and planning, monitoring services (data collection), and concrete building services, especially in the stormwater drainage system. They induce the services of others in order to fulfil their regulatory obligations. As an example the drainage of excavations for constructions require a permit from the authorities and are usually subject to special conditions. In the contamination cleanup sector, concrete measures are sometimes financed directly by public agencies; the same holds for environmental protection measures such as the renaturation of shores and shoreline stabilisation along susceptible surface waters.

In some cases, very specific requirements apply (e.g. the production of groundwater maps). Public agencies can therefore obtain a commanding position in certain market segments.

The actual economic significance of public administration is much greater. Coordination services and the creation of legal certainty in water use or the maintenance of surface waters as transportation routes benefit the general economy. Inversely, the private sector has to bear the costs necessary to comply with administrative regulations and procedures.

The Senate Department for Urban Development has supported model eco-friendly construction projects in Berlin for years. Novel strategies for stormwater management, water reuse and use of rainwater for air conditioning are being tested and implemented in these projects. Berlin companies are frequently involved in the implementation process.

The river Spree with Oberbaum Bridge and TV tower at Alexanderplatz

3. Innovation in the Region

German Museum of Technology Berlin (GMTB) at Landwehrkanal

Berlin – a metropolis in the middle of a region with many lakes but little water. In this sentence lies the principle driving force behind the water sector innovations made in Berlin. Why?

Berlin's drinking water is supplied from wells within its borders, and its wastewater is discharged in the Spree and Havel rivers in spite of the fact that many drinking water wells are located close to the shores of these rivers. In dry summers, the wastewater fraction in the Havel River downstream Berlin can be as high as 60 percent.

These few facts show how careful Berlin must be with its water resources. Berlin's wastewater treatment system originally consisted of sewage farming – a technique that was new back in 1870. The first wastewater treatment plants were built at the beginning of the 20th century. Then and today, they were among the leading facilities of their kind. They have to be, too, because the low water volumes in Berlin's rivers make it especially challenging to meet the high demands on treated water quality.

Wastewater technology is only one of many innovations made in Berlin. In our days sewer networks and pipeline systems are often installed underground with only limited excavations. Berlin-based companies are leaders in this field of trenchless technology. Additional fields include analytical and measurement technology, stormwater management, modelling and geoinformation systems, integrated strategies and membrane technology.

Developments are driven by Berliner Wasserbetriebe, universities and technical schools as well as by private companies that market their products around the world.

The long tradition of careful water resources management has allowed a technically mature sector to develop. Pioneering developments are therefore less likely than innovations that evolve gradually from small steps of improvement and adjustments to new conditions.

3.1 Mechanisms

Innovations evolve from different pathways and for different reasons, as is highlighted below.

Innovations in response to concrete needs

The development of trenchless pipe installation and rehabilitation technologies was driven by the desire to save costs and to reduce the obstructions caused by construction sites. Berliner Wasserbetriebe and Berlin companies have provided joint impetus for these technologies.

The field of stormwater management was mainly driven by environmental protection laws implemented in the 1990's, which gave on-site stormwater infiltration priority over stormwater drainage. The EU Water Framework Directive (WFD) extended this concept to existing stormwater discharge practices by stipulating extensive provisions for consideration of water quality. BWB, KWB and TU Berlin have therefore launched joint development projects to address the issue of sewage system management. One of the main objectives is to reduce the discharge of combined sewage (stormwater runoff and sewage in the same sewer system) into surface waters during heavy rainfall events.

As was already mentioned, the regeneration of drinking water wells is another important element of water supply practice in Berlin. Corresponding technologies have been developed and are currently being marketed international by the Berlin-based company pigadi.

Innovations based on technology transfer from other fields

Geophysical well logging is an example of the transfer of existing technologies to new fields of application. The geophysical techniques originally developed for oil prospecting and mining have been adapted and refined for this application. Bohrlochmessung-Storkow GmbH, a company based in the identically named city south of Berlin, is a leading supplier of this technology.

Innovations deriving from the development of new technologies

New technological potentials have led to innovations in the modelling of surface waters, ground water and of entire catchment areas. In particular, improvements in geoinformation systems and mathematical models used with them have led to new applications that were inconceivable only 10 years ago. Collaboration between business and research institutions has promoted these developments in Berlin.

The interaction of IT and process automation has created new potentials in the fields of automated analysis and measurement and optical sensor technology. This has led to the development of companies that operate on an international scale.

However, the necessary financial framework conditions must be in place to ensure the success of an innovation. Development work costs money. Whereas planning and advisory services can be built up step-by-step, this applies only true to a limited degree for technological equipment. When a completely new technology is developed (e.g. trenchless pipe rehabilitation with tube inliners), the entire process line must be available to place on the market simultaneously.

The necessary funds can be procured only if a market for the product exists. In the ideal situation, a potential customer is involved in the development process. This has often been the case with Berliner Wasserbetriebe in Berlin.

Research contributions from universities are essential. They lay the scientific foundations, validate methods developed in practice by scientific characterisation of processes and assist enterprises by sharing their extensive expert knowledge. Promising developments from universities repeatedly result in the formation of companies that develop the product to market maturity.

3.2 Main Areas

Analytical and measurement technology

"Only that which is measured is known." This statement, though exaggerated, expresses a basic tenet of natural sciences and technology. However, it is a long way from the simple gauge to systems for fully automated analysis of chemical and physical parameters. Quite different solutions must be found and developed along the way. The range extends from chemical analytical methods via direct physical measurements to indirect methods, many of which are based on optical properties.

Whereas analytical testing used to be real hands-on work in the laboratory, routine analyses are now more and more frequently being performed by machines. The trend is increasingly moving towards fully automated systems with remote data transmission capabilities. This technology allows us to continuously collect sampling data for input in process control systems and to continuously monitor processes, even in remote places.

Wastewater quality and, in particular, the processes at wastewater treatment plants, must be monitored continuously. This is often done by the use of chemical reactions, that produce colour changes. These can be measured using opto-electrical (photometric) devices. The use of standardised reagents and measurement devices are well-suited for daily routine testing. Such test systems have been developed in Berlin and sold worldwide for decades. The company HACH LANGE GmbH, formerly Dr. Lange, has been a name in the water analysis sector for decades. The firm also manufactures fully automated sampling systems for continuous online monitoring.

Sum parameters such as chemical oxygen demand or total organic carbon content are important variables for assessing the performance of wastewater treatment plants or the degree of purity of water. In a mixture like wastewater, complete testing of substances without limitations relating to the reagents used can be achieved most reliably by complete combustion. Continuous sampling and analysis devices that are based besides others on this principle are manufactured and marketed internationally by LAR Process Analysers AG.

Water analysers from Berlin

Laboratory fotometer with ready-to-use reagents for analytics in water and wastewater.

Online Controller with Probes (oxigen, conductivity, ammonia).

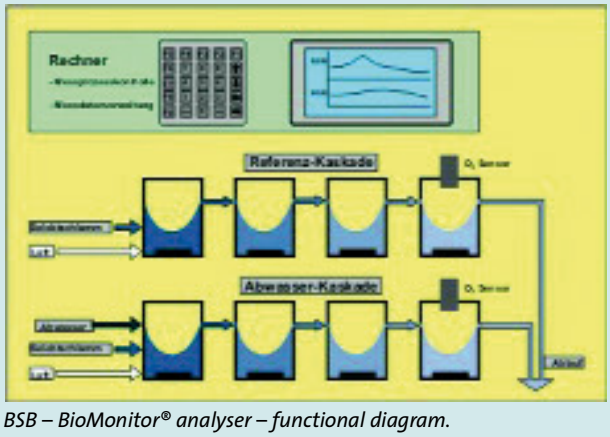
Reproduced with kind permission of HACH LANGE GmbH, Berlin

Online up to date

Fully automated analytical systems deliver continuous sampling data for process control in wastewater treatment and water production plants.

Quick TOC®

BSB – BioMonitor® analyser (detail).



BSB – BioMonitor® analyser – functional diagram. Reproduced with kind permission of LAR AG, Berlin

How much water goes where? This is a basic question in water resources management. Modern measurement systems utilise ultrasonic technology to provide the answers. Water currents alter the transit time and frequency of ultrasound signals transmitted in water. These changes can be measured, and water flow velocities can be calculated accordingly. The special challenge lies in processing the signals and in aligning the transmitters and receivers for precise measurement across great distances. Quantum Hydrometrie GmbH, a measurement and systems technology company that arose from the Institute of Water Engineering and Water Management of the Technical University of Berlin, has mastered the technology for underwater ultrasonic flow measurements at distances of up to 2 km.

With modern camera systems, it is no problem to inspect the inside of a well. However, it is much more difficult to obtain a view inside the soil or rock surrounding the well. This view inside the hidden depths is essential for determining whether the well was installed as it was supposed to be, whether it was optimally positioned, or whether it is already damaged. Geophysical techniques make this possible. Bohrlochmessung-Storkow (BLM) currently uses geophysical methods originally developed for exploration of deep boreholes for well logging. This is made feasible by continuous R&D work by the company. BLM is one of the few firms in Europe that provides this type of geophysical technology for water management applications, and their services are sought far beyond Germany.

Ultrasonic flow measurement technology

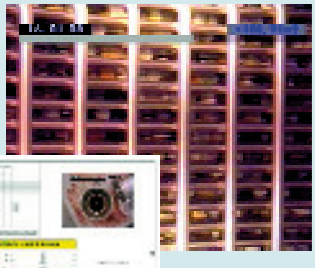
Reproduced with kind permission of Quantum Hydrometrie GmbH, Berlin

Q-PIPE Flowmeter

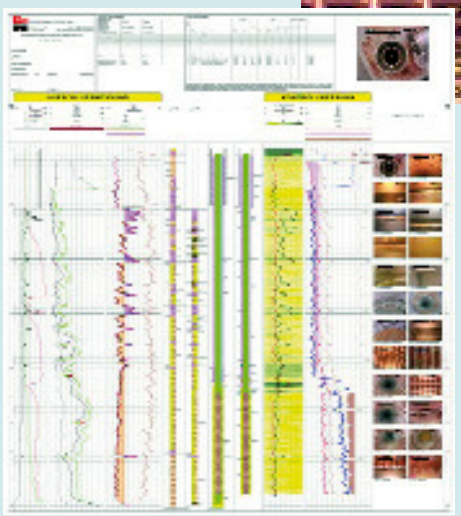
Q-Aqua Flowmeter

Making the invisible visible

Measuring probes in operation.



Filter pipe inside a well.



Analysis of measurements.

Reproduced with kind permission of Bohrloch-messung-Storkow GmbH

Modelling and water management

Where sampling provides information on the current situation, modelling provides information on relationships between processes. Modelling makes it possible to generate predictions that supply information important for planning. Originally developed for surface water management applications (flow measurement), modelling techniques now are also used for three-dimensional modelling of groundwater flows. Water quality computation was recently added to the repertoire. In the field of modelling science, there is close collaboration between the industry and the universities that perform valuable preliminary groundwork in the development of mathematical models.

Thanks to the development of computer based geoinformation systems that link geometric shapes (i.e. topographical data) with field data, it is now possible to document and model conditions in entire river regions. Planning services thus have a powerful tool for predicting the effects of wastewater discharges, construction measures and land use changes.

In planning practice, advanced modelling systems are being further refined hand-in-hand with their application, and the results are constantly tested for correlation with reality. Thus, it is not by chance that DHI-WASY GmbH from Berlin and Ingenieurgesellschaft Prof. Sieker mbH from Hoppegarten, two leading planning and consulting firms, are at the same time leading suppliers of software solutions for groundwater and catchment area modelling and for stormwater management planning (see below).

Designers and engineering consultants strive to achieve integrated water resources management with the aid of modelling technology. Integrated management goes far beyond this: It intends the development of new concepts by the integration of divers demands and potential solutions. This is where the advantages of having an extensive research landscape in connection with regional and international planning consultants become evident. TU Berlin's Centre for Water in Urban Areas has a number of projects involved in the development of integrated solutions for the management of water resources which are implemented, for example, at the Olympic facilities in Beijing or in stormwater management applications in Seoul.

Resource protection

Resource protection goes hand-in-hand with integrated water management. Research institutions and Berlin companies work together with Berliner Wasserbetriebe to analyse existing problems and to develop new strategies for their solution. Pollutants in the water cycle, their distribution and associated risks are main areas of research at KWB and TU Berlin.

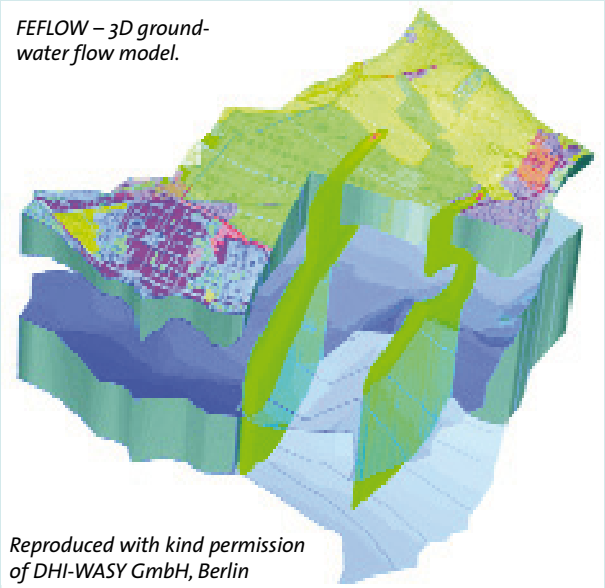
The risk of groundwater contamination arises from various sources: Pollutants in wastewater infiltrate the ground water via surfaces waters. Land cultivation and construction can also lead to groundwater contamination. The maintenance of rivers, lakes and ground water of good quality is the goal of responsible water resources management.

Main areas of research include the fate of various substances and organisms in water in the scope of drinking water production in wells located near surface waters (bank filtration), blue-green algae (cyanobacteria) development and related risks (swimming, use of surface waters for drinking water), and the occurrence of drug residues in wastewater and surface waters.

The search for pollution avoidance strategies encompasses the refinement of water treatment technologies, the selective treatment of problematic wastewater flows (e.g. from hospitals), and the testing of new approaches such as those for separate capture and treatment of urine and faeces.

Modelling and software for planning

Groundwater modelling, description and prediction of river catchment areas – geoinformation systems perform these tasks in conjunction with modelling software. The aim is to provide the appropriate advisory services, solutions and software designed to meet any given demand. This requires cooperation between engineers, natural scientists and computer specialists.



FEFLOW – 3D groundwater flow model.

Reproduced with kind permission of DHI-WASY GmbH, Berlin

AQUISAFE – Protection of drinking water

The use of surface waters for drinking water production often requires the use of technologically demanding water treatment methods. By protecting these water bodies from contamination, we can reduce the costs of water treatment and lower the risk of hazards to human health. The list of potential sources of drinking water reservoir contamination in rural areas, especially those located on the outskirts of large cities, is extensive: fertilizers, pesticides, rainwater runoff from streets and gardens, gas and oil tank leakage, and discharges from wastewater treatment systems, to name a few.

After determining the sources of contamination, the expert's job is to investigate the distribution of contaminants in order to plan or optimise the construction of "detention areas", such as riparian corridors and biological treatment ponds.

The Federal Environment Agency (UBA) and Purdue University of Indianapolis (IUPUI) will conduct joint research for the development of data analysis and contaminant retention concepts and systems in Europe and the USA, which will subsequently be tested in the USA in collaboration with IUPUI.

AQUISAFE – A project of KWB and its partners

Well at Havel River

NASRI – Bank filtration: A natural method of drinking water production

Bank filtration and artificial groundwater discharge have been practiced as natural treatment processes for many years – not only in Berlin. Nonetheless, the biodegradation mechanisms and chemical reactions that occur during the water´s passage through the ground have not been investigated thoroughly. NASRI, an interdisciplinary research project on the subject of bank filtration and artificial groundwater recharge, was therefore initiated. The NASRI project was conducted to study the transport and fate of pollutants in surface waters that can potentially contaminate to the groundwater during these processes. The results were very encouraging: Bank filtration proved to be a safe method of producing drinking water for Berlin.

NASRI – A project of KWB and its partners

TRACE – Tracking trace organic compounds

Persistent trace organic compounds can infiltrate surface waters via wastewater treatment plants or by diffuse pollution. If these water bodies are used directly or indirectly as sources of drinking water, then this type of contamination makes the drinking water produced from them potentially hazardous. Factors that determine risk levels include: the production output and application quantities, solubility, degradability, sorption behaviour and toxicity of the substance and its metabolites. The objective of the TRACE project is to estimate the potential risks associated with the occurrence of complexing agents, selected pesticides and perfluorinated compounds in surface waters used for drinking water production by means of bank filtration and artificial groundwater recharge.

TRACE – A project of KWB and its partners

Cleanup of contaminated soil is a technical challenge. A number of Berlin companies use special equipment and specialised technologies to clean up contaminated sites in order to eliminate the related hazards to the environment and to human health. Harbauer Umwelttechnik GmbH, Delta Umwelttechnik from Teltow, and Umwelttechnik Dr. Bartetzko GmbH are some examples.

Sewage Networks

Sewage networks in big cities are highly complex systems with a branching system of pipes, trenches, overflow pipes, pumping stations, valves and emergency spillovers. Heavy rainfall events are particularly challenging – the risk of sewage runoff into surface waters must be prevented and the load on wastewater treatment plants evenly distributed.

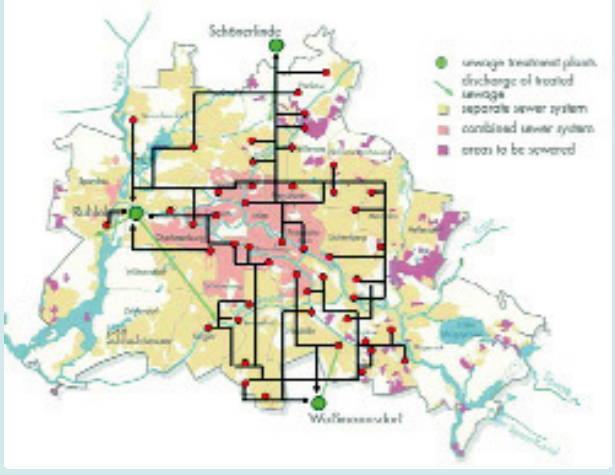
BWB, KWB and Veolia have worked together for several years to achieve integrated management of the Berlin sewer system. Their goal is to achieve optimal utilisation of the sewage network capacities in order to reduce stress on natural waters through the use of appropriate measures and control elements.

ISM/EVA – Intelligent sewage system management

ISM – Integrated Management of the Berlin Sewage System pursues the development of integrated management strategies and decision support instruments for planning and operation of the Berlin sewer system. The goal is to install local control elements and to implement an integrated central control system that is as comprehensive as possible.

By integrating catchment area modelling as an element of operational decision support, it should be possible to achieve optimised use of storage and treatment capacities throughout the entire wastewater treatment system and thus to reduce water pollution.

This is being done in practice: A decision support system for the global control of sewage pumping stations (EVA project) has been implemented, and studies designed to determine the potentials of radar data-based online precipitation measurements and predictions as operational support tools for wastewater pumping stations are being performed.



Berlin sewer system: map of main lines.
ISM and EVA – Projects of BWB and KWB and their partners

The SPREE 2011 project of Luri.Watersystems.GmbH, a Berlin-based company, pursues another approach: The installation of catchment tanks in the Spree River at the site of sewage overflows is designed to permit temporary storage of combined sewage and its subsequent return to the sewer system. At the same time, useable surfaces are created along the banks. The first prototype, which is scheduled for installation in 2008, is being developed in a joint research project of the TU Berlin, Luri.Watersystems.GmbH and other partners.

Pumps convey the sewage to various sites. Energy-efficient sewage pump operation results in specific problems due to the presence of numerous solids in the wastewater. When the pumps are operated at a low rpm, the solids can clog up the pumps. OKADAR, a joint research project of TU Berlin and cooperating businesses, was designed to address this problem.

OKADAR – Failure-free sewage pump operation

OKADAR – Diagnostic system for optimisation of complex wastewater treatment systems. The project aims to investigate fundamental flow phenomena in sewer systems and their effects on sewage pump clogging mechanisms. Investigations of these interactions are therefore conducted under laboratory conditions at a test block at TU Berlin's Department of Fluid System Dynamics. Variable-speed rpm control is an emphasis of study.

Glass-enclosed test block for simulation of clogging mechanisms.

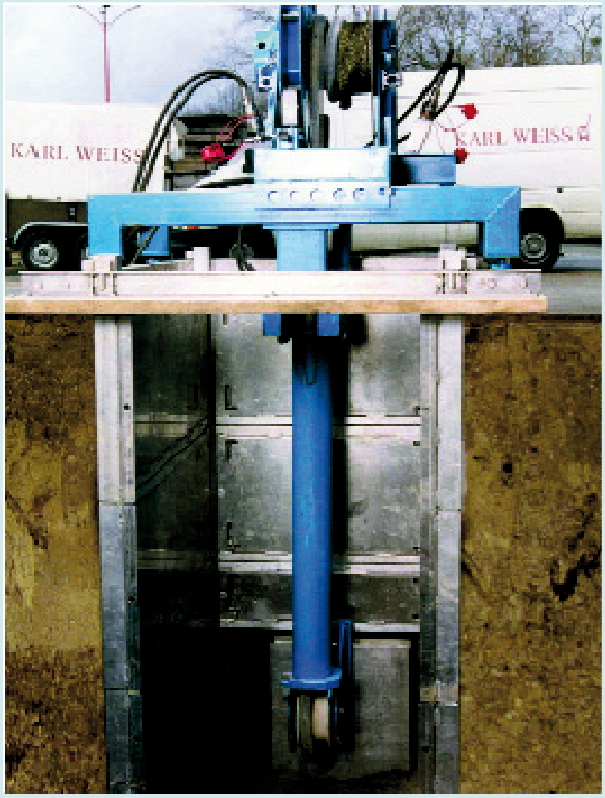
Project partners: TU Berlin, AUCOTEAM GmbH Berlin (control systems), KSB AG (pump manufacturer), and Network Consult Berlin GmbH (advisory services), with funding from Investitionsbank Berlin (IBB).

The installation of sewage pipes and networks is costly. If the digging of trenches along the entire length of a pipeline can be avoided, then significant costs can be saved and the obstruction of traffic due to construction work can be reduced. Berliner Wasserbetriebe and Berlin companies have played a leading role in the development of trenchless technologies.

In particular, Karl Weiss Technologies stands for the development of modern pipe rehabilitation technologies. Instead of excavating and replacing a damaged pipe, a resin-impregnated fabric hose is inserted into the existing pipe and cured in place (fabric hose relining). KARL WEISS has also developed independent solutions for underground pipe replacement. The company has internationally successful joint ventures in the Czech Republic and the USA and has licensees around the world.

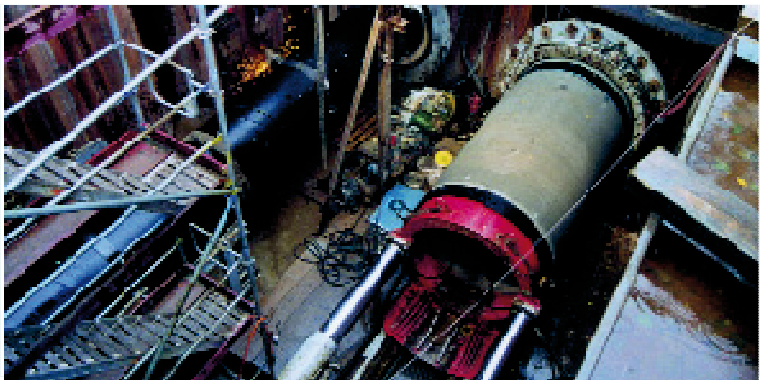
Underground pipe installation and rehabilitation
Trenchless technologies for the installation and rehabilitation of water, sewage and gas pipes minimise construction-related impairments and reduce costs.

Fabric hose relining (Starline® HPL).



Reproduced with kind permission of KARL WEISS Technologies, Berlin

Large-scale special civil engineering projects
Modern push/pull technologies permit underground installation of pipes between two small excavations. This can be done for pipes up to diameters of 3 meters.



Push/pull technology – Starting pit.

Reproduced with kind permission of GILDEMEISTER GmbH & Co. KG, Berlin

Stormwater

Rain, the driver of the natural water cycle, is a problem in settlements because stormwater can cause flooding and damage buildings if it is not drained from paved roads and yards. Stormwater runoff has therefore been collected in sewer systems and discharged into rivers and lakes for decades. Although stormwater itself is clean, it washes dirt from the streets and thereby contaminates the surface waters. Stormwater drainage also diminishes groundwater production, and the pooling of stormwater from different areas promotes high water and flood development.

On-site infiltration is an alternative method of stormwater management. Companies from the German capital region have been leaders in the development of this methodology. The stormwater calculation models, management strategies and infiltration systems available today make it possible to allow stormwater runoff to flow into the natural cycle without reducing site usability, even when this method is used at large commercially used land sites.

Stormwater infiltration systems are decentralised units. They can be continuously expanded and they permit the organic growth of settlements: A large drainage system does not have to be in place already during the expansion period.

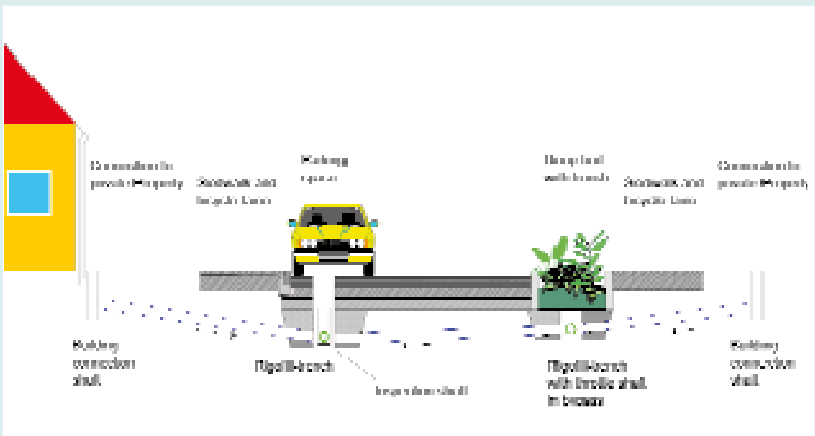
Moreover, an existing stormwater system can be fitted with filters that clean the runoff from roads before it reaches the surface waters. Berlin planning consultants contracted by Berliner Wasserbetriebe and the State of Berlin have developed large soil filter systems in the city for this purpose.

Modern systems that collect rainwater for use as cooling water, irrigation water and service water (for toilet flushing and cleaning purposes) have been installed in buildings in Berlin and practice-tested in model projects. At the Department of Physics of Humboldt University Berlin, for example, the building cooling system operates using the evaporation of rainwater.

New methods of rainwater management

Infiltration through the soil is the natural method of rainwater drainage. Urban settlements allow little space available for infiltration; stormwater runoff is pooled and must infiltrate into the ground within a short period.

Trough-trench systems make this possible: The stormwater is collected in troughs; from there, it slowly infiltrates through a layer of soil (cleaning) to gravel-filled infiltration trenches. The trenches store the water until it has completely infiltrated into the subsoil. Trough-trench systems allows for stormwater infiltration even at sites where water is absorbed slowly by the natural subsoil.



On-site trough-trench stormwater infiltration system. Reproduced with kind permission of Ingenieurgesellschaft Prof. Sieker mbH, Hoppegarten

Membrane technology

Membranes – In water technology, this is used to denote extremely fine filters made of various materials. The pore sizes of the membranes vary in accordance with the applications for which they are used. Some are designed to retain unicellular organisms such as bacteria, and others must remove viruses that are 10-times smaller. Ultra-fine membranes allow only water molecules to pass but retain the salts suspended in the water. These membranes are used to desalinate seawater for drinking water production.

Membranes have also been utilised for the development of new water purification and wastewater treatment methods. A common denominator is that energy is needed to press the water through the membranes. The smaller the pore size, the greater the energy requirement for the system. Membranes have been used in water technology for about two decades, but a number of technical problems remain unsolved.

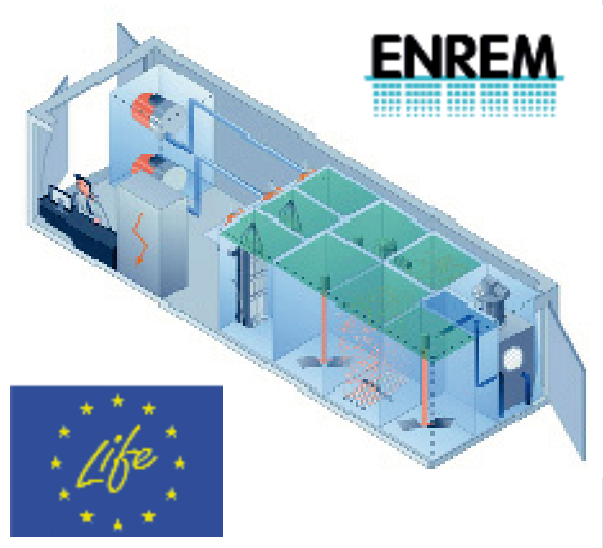
Whereas the use of membranes for water purification is now state-of-the-art, their potentials in wastewater treatment have not yet been exhausted. Membranes make it possible to design wastewater treatment plants that are much more compact, yet more efficient than conventional WWTPs. A particular advantage of membrane technologies is their capacity for retention of pathogens. Discharge from wastewater treatment plants equipped with the appropriate membrane technology can be recycled and used as service water in households, for example. It can also be treated to yield drinking water quality.

The development of membrane technology is a special focus of interest at TU Berlin. KWB is involved in two European joint projects in this research area, in one of them TU Berlin is participating. In a settlement with 200 inhabitants (Margarethenhöhe) located on the outskirts of Berlin, Berliner Wasserbetriebe is currently operating a demonstration plant for membrane-based wastewater treatment technology; intensively accompanied by KWB. TU Berlin and Veolia are also involved in this project (ENREM).

At the demonstration plant, processes related to membrane aging are being studied during continuous plant operation; in addition, operation modes are being optimised, and the limits of such a membrane bioreactor's potentials for removal of nutrients (phosphorous and nitrogen) are being assessed.

ENREM – Wastewater treatment with new membrane technology

The ENREM demonstration plant is the first operational-scale membrane bioreactor (MBR) in Europe that functions based on biological phosphorous removal. When put into operation, the ENREM unit has been the MBR plant with the highest degree of phosphorous and nitrogen removal worldwide. Successful completion of the demonstration project would therefore enable the widespread use of MBR technology for decentralised servicing of settlements in Germany, Europe and around the world.



ENREM – A project of BWB and KWB and its partners, supported by the EU-Life programme

AMEDEUS – Membrane technology network

AMEDEUS – An EU project for development of membrane bioreactor technology in Europe, which is coordinated by KWB and conducted by 12 partners in Europe and Australia, including water and wastewater services and membrane manufacturers in Germany, France and Italy (www.mbr-network.eu).

The river Spree with Museumsinsel (Museum Island) and Bahnhof Friedrichstraße

3.3 Networks

Water is an important part of our lives in many different aspects, and the range of questions relating to this element is likewise diverse. Because of the fascinating diversity of water, an interdisciplinary approach to water research is essential. In Berlin, a number of network nodes are in place to ensure communication and cooperation between research institutions and industry. The Berlin Centre of Competence for Water (KWB), which stresses an application-oriented approach to problem-solving, and TU Berlin's Centre for Water in Urban Areas, which supports university research, are networks established for the advancement of water research. WaterPN Berlin-Brandenburg represents Berlin's extensive corporate landscape.

Technology Foundation Berlin (TSB) supports the advancement of technological development. TSB has therefore been dedicated to making the Berlin Centre of Competence for Water an internationally renowned centre for water research since its inception. The foundation supports the KWB's network activities through financial support and personal engagement. Technology Foundation Berlin is also represented on KWB's Supervisory Board and Project Commission.

These networks are flanked by the Senate Department for Economics' "Wasserplenum" Working Group, which forms the interface between politics and industry. Wasserplenum was launched as an initiative of the Berlin Senate Department for Economics, Technology and Women's Issues in 2006. It pursues the goal of making Berlin's water industry more internationally oriented. The Wasserplenum brings together the Senate Departments of Economics and Urban Development, the Berlin Centre of Competence for Water, WaterPN, TSB, GTZ and InWEnt (the two development cooperation organisations), the Technical University of Berlin, the Berlin Chamber of Industry and Commerce and a number of regional enterprises to promote coordination of their activities. The Wasserplenum organised the "II. International Water Conference" in Berlin in 2007.

TSB TECHNOLOGIESTIFTUNG BERLIN

TSB – Technology Foundation Berlin Group

Water research – A field of innovation at TSB

Technology Foundation Berlin (TSB) promotes practice-oriented research. The water sector is a field of technology with tremendous innovation dynamics and relevance to practice. Berlin has substantial potentials in all areas related to water supply and sewerage systems.

Support of the Berlin Centre of Competence for Water augments the various activities of TSB in the other fields of competence in Berlin namely biotechnology, medical engineering, transport & mobility, information and communication technology, and optical technologies. The initiatives TSB FAV, TSB Medici and BioTOP are working to achieve further progress in these fields though their networking and joint projects. TSB has promoted the concentration on the fields of competence in Berlin and with support from all relevant actors has promoted a coherent innovation strategy. It has established itself as the first stop for all questions relating to innovation policies in Berlin.

3.3.1. Berlin Centre of Competence for Water (KWB)

The Berlin Centre of Competence for Water (KWB) is an international network organisation for the promotion of water research and knowledge transfer. KWB links research institutions in the Berlin region with Veolia Wasser and the Berlinwasser Holding group. Projects of public interest are conducted, communicated and publicised in the framework of the KWB network. The network partners are represented in Europe and around the world.

KWB conducts research projects that contribute to implementation of the principles of prevention and sustainability in water resources management. Main areas of research include the development of innovations in the water supply and urban drainage systems sector as well as projects for the development of knowledge and procedures of surface water and groundwater protection.

KWB connects Berlin's water know-how from universities and technical institutes, small and medium-sized enterprises, Berliner Wasserbetriebe and Veolia Wasser. Its activities include:

- Planning and execution of research projects
- Acquisition and allocation of research funding
- Dissemination of network communications
- Organisation of international congresses, workshops and symposia
- Technology transfer
- Press and public relations work

The Berlin Centre of Competence for Water was founded as a non-profit organisation in December 2001 in the scope of the partial privatisation of Berlin's water utility company Berliner Wasserbetriebe. Its shareholders are: Veolia Wasser (50.1 %), Berliner Wasserbetriebe (24.95 %), and TSB Technologiestiftung Berlin (24.95 %). Berlin's universities, technical institutes, research institutions, small and medium-sized enterprises, and city administrations are further partners.

KOMPETENZZENTRUM WasserBerlin

KWB – For the flow of knowledge

Kompetenzzentrum Wasser Berlin gGmbH (KWB) promotes and conducts research projects that contribute to implementation of the principles of prevention and sustainability in water resources management. Urban water supply and sewerage systems and their effects on the aquatic environment are a main focus of research.

Innovative water and wastewater management techniques for:

- Improved efficiency of wastewater treatment plants (through process control systems, measurement technology, membrane technology, etc.)
- Solutions for decentralised wastewater and stormwater management
- Production-integrated wastewater treatment
- Assurance of adequate drinking water quantity and quality

Sustainable water resources management:

- Development of knowledge and procedures of surface water and groundwater protection

3.3.2 WaterPN Berlin-Brandenburg – Network for Water Industry Enterprises in the Capital Region

WaterPN Berlin-Brandenburg was established as a platform network for enterprises in the water industry in the capital region in 2006. It was founded as a project of the Berlin Center of Competence for Water (KWB) and is integrated into KWB's existing infrastructure and research activities. The network's mission is to further develop the competencies of its members, to let new developments arise from the combination, and to support its members. WaterPN Berlin-Brandenburg now has more than 20 members who represent the diversity of enterprises in the water industry.

WaterPN membership is open to other planning, advisory, development and technologically-oriented companies in the water industry. The network enables research institutions, policymakers and potential customers to have direct access to the water industry.

The facilitation of contacts within the network is the core task of any network organisation. WaterPN does this by disseminating information, scheduling regular network meetings and, above all, by facilitating selective contacts. This cooperation between the enterprises helps to strengthen their positions on the national market as well as on international markets, where many of the members are already operating.

The network management engages in organisational and public relations work and collects suggestions and topics proposed by the members. WaterPN played a leading role in the organisation of the International Water Conference, which was held in Berlin in the framework of the Asia Pacific Weeks 2007 event.

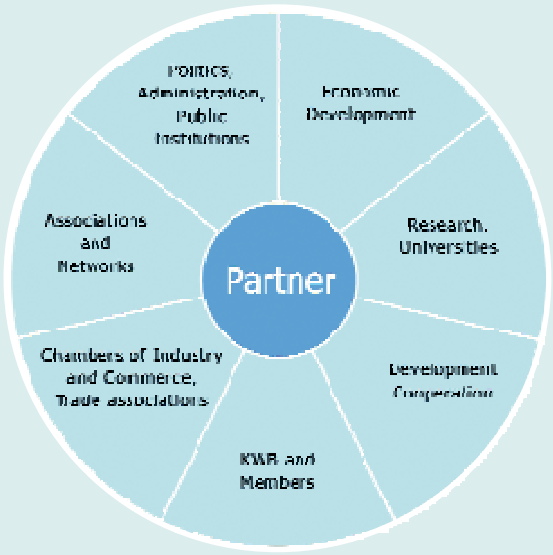
WaterPN received start-up financing from the joint task force fund (until 2009), which is supplemented by contributions from member companies and from the Berlin Centre of Competence for Water (KWB).

WaterPN – Water Platform Network for Berlin-Brandenburg

WaterPN Berlin-Brandenburg serves as an information and communications platform for its small and medium-sized business partners and mediates contacts with other parties inside and outside of the network.

WaterPN Berlin-Brandenburg actively engages in dialogue with administrative, political and research institutions.

The network receives financial support from the "Improvement of Regional Economic Structure" joint task fund of the Berlin Senate Department for Economics, Technology and Women's Issues.



3.3.3 TU Berlin's Centre for Water in Urban Areas

The Centre for Water in Urban Areas (FSP-WIB) is an interdisciplinary initiative of the Technical University of Berlin. TU Berlin has numerous research units that make substantial contributions to the field of water research. More than 20 research units in 5 faculties join forces in the university's water research activities. Scientists from the fields of natural sciences, social sciences, business and economics, and engineering collaborate under the motto "Methods and Instruments of Future-oriented Management".

Goals and main areas of interest

The common goal of the network is to develop solutions for sustainable and future-oriented water management in large urban centres. The Centre for Water in Urban Areas (FSP-WIB) works together with small and medium-sized enterprises from the Berlin-Brandenburg region as well as with the Berlin Centre of Competence for Water and Berliner Wasserbetriebe. Externally funded projects with an annual budget of approximately 3.5 million euros are processed each year. The percentage of international projects, especially those receiving EU subsidies, is especially high (approx. 25%).

The centre's ongoing research co-operations are divided into four core research areas:

1. Water, nutrient and pollutant cycles in natural and technical systems

Technical processes in the fields of membrane technology, oxidation technology and pump technology are the main areas of investigation in this core research area. Recycling techniques for control of industrial water cycles or for reclamation of municipal water for irrigation purposes, service water production or artificial groundwater recharge are the subjects of research. The network is also involved in natural water treatment systems, such as bank filtration, and in the characterisation of the infiltration behaviour of wastewater.

SWITCH – Sustainable Water Management Improves Tomorrow's Cities' Health

This EU project for promotion of a secure water supply in future megacities has 33 partners from around the world, including SMEs in Brandenburg and the TU Berlin, which is investigating the potential for removal of phosphates and trace organic contaminants from municipal wastewater using adapted technologies (www.switchurbanwater.eu).

2. Analysis and behaviour of contaminants in water and soil
This core research area is characterised by the development of analytical methods for detection of hazardous substances in water and soil. Organic residues, heavy metals, bacteria and viruses are studied. The investigations also include the study of transformation processes. The objective is to achieve an integrated characterisation of biotic and abiotic transformation processes in water and soil.

Contaminants in Water – What, when and where?

- RECLAIM WATER: EU project with 19 partners. TU Berlin's task is to determine residual concentrations of pharmacological contaminants in wastewater and to develop rapid tests for the detection of resistance to antibiotics. Six demonstration plants for wastewater reclamation are being tested at different locations around the world (www.reclaim-water.org).

- Use of plants for remediation, mapping and monitoring of sites contaminated with highly volatile halogenated hydrocarbons: SINBRA (eight research partners) is a project funded by the German Federal Ministry of Education and Research (BMBF) for the development of analytical techniques for determination of trace organic compounds in plants for characterisation of site conditions.

- The German Research Foundation's FOR 566 research group studies veterinary pharmaceuticals in the soil of commercial animal production sites. Eight project subgroups will investigate the analysis, behaviour and transformation of veterinary pharmaceuticals at different sites. One main research area is Mexico City.

3. Organisation, planning and analysis of water resources management measures
Successful water resources management requires the use of transparent analytical and planning instruments that adequately characterise the complexities associated with the multifunctional nature of water. This also implies that management plans can only be implemented in the framework of a suitable organisational form. This core research area studies the potentials of using technical and organisational process analysis techniques as decision support tools. Pricing models, multicritical analysis models, and models for cross-border conflict resolution are developed by these partners.

4. Knowledge transfer and international co-operations
This core research area is a cross-sectional field that overlaps with the above area.
The objective is the international transfer of knowledge about technology and integrated methods. The research partners develop and offer international courses of study in the field of water resources management (curriculum development) and need-oriented short courses for SMEs for this purpose. In this context, TU Berlin's Centre for Water in Urban Areas is working together with WaterPN Berlin-Brandenburg to establish a technology transfer platform for SMEs.

TU Berlin's Centre for Water in Urban Areas (FSP-WIB)
The following departments of TU Berlin are engaged in water research:
- Applied geophysics
- Dynamics and operation of technical facilities
- Ground engineering and soil mechanics
- Fluid system dynamics
- Hydrogeology
- Water resources management and hydroinformatics
- Laser spectroscopy
- Food chemistry
- Ecology of microorganisms
- Ecotoxicology
- Site science and soil conservation
- Soil science
- Urban water management
- Environmental chemistry
- Environmental economics
- Process engineering I/II
- Building materials science
- Comparative agricultural economics
- Water conservation
- Economic and infrastructure policy

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4. Economic Significance

The value added by the water industry makes a significant contribution to the economy of the German capital region. Export, in particular, must be named in this context because of the economic power it brings to the region. The following sections back these statements up with statistical data gathered in the framework of a survey of companies active in the water industry.

4.1 Water Industry Survey – Database

At the turn of the year 2007/2008, the KWB wrote to companies active in the regional water industry requesting their assistance. The address list was compiled by merging the address databases of TSB and KWB, the national registry of firms in the environmental sector (UMFIS), and a selection out of the member databases of the Chambers of Industry and Commerce (IHKs) of Berlin, Potsdam, Cottbus and Frankfurt/Oder relating to relevant activities. We would like to expressly thank the TSB and the IHKs for their assistance. The data were compared, and addresses of companies identified as not belonging to the water industry were deleted. Relevant companies with headquarters or branch offices in the capital region were considered.

The remaining total of 397 companies was sent the information. Of these companies, 69 responded that they were not active in the water industry or were not active any more. 103 completed and returned the questionnaire.

In order to document the water and wastewater utility companies in the target region, the Zweckverbände were identified and sent questionnaires. Of the 25 Zweckverbände operating in the capital region, 10 returned the questionnaire.

4.2 Structure of the Companies

For characterization purposes, the business segments outlined in Section 2.2 were combined to groups. Otherwise, the number of enterprises in the respective segments might have enabled to deduce the identity of individual firms.

Engineers and consultants are clearly a dominant group in the industry: Nearly half of all survey responses came from them.

Companies involved in water production, treatment and purification were the second largest group, followed by the construction companies involved in water distribution and sewerage. The measurement, control and analytical technology group and the firms contracted by water and wastewater utilities were roughly equally represented among the responders.

Companies according to field of activity	
Consultants and engineers	48
Water production, treatment and purification	23
Water distribution and sewerage	16
Measurement, control and analytical technology	7
Service providers for water and wastewater utilities	9
Water industry Berlin-Brandenburg in numbers (excluding utility companies)	
Employees in the capital region	3,300
Employees in regional water industry	1,650
Combined turnover	797,000,000 Euro
Turnover from water sector	323,000,000 Euro

The 103 companies surveyed have a total of 8,120 employees, roughly 3,300 of whom work in the capital region. According to the company responses, 1,650 employees work in the "water" sector. The size of the companies was extremely variable, ranging from 1 to 2,000 employees. However, half of the companies have 1 to 10 employees and can be classified as small enterprises.

The turnover figures reflect the range of company size: annual turnover ranged from 50,000 euros to more than 200,000,000 euros, and the median annual turnover was around 500,000 euros. The overall turnover of the companies amounted to 797 million euros, and 323 million euros (40 %) of this have been earned in the water sector.

Group classification for the analysis	**Group classification in Section 2.2**
Consultants and engineers	Engineering service providers including stormwater management and urban drainage systems, water pollution control and groundwater protection, project management and consulting Scientific services and expert reports
Water production, treatment and purification	Water production Water treatment and purification, including contaminated water
Water distribution and sewerage	Water distribution and sewerage Fittings and pumps
Measurement, control and analytical technology	Measurement, control and analytical technology, including analytical laboratories
Service providers for water and wastewater utilities	Service providers for water and wastewater utilities

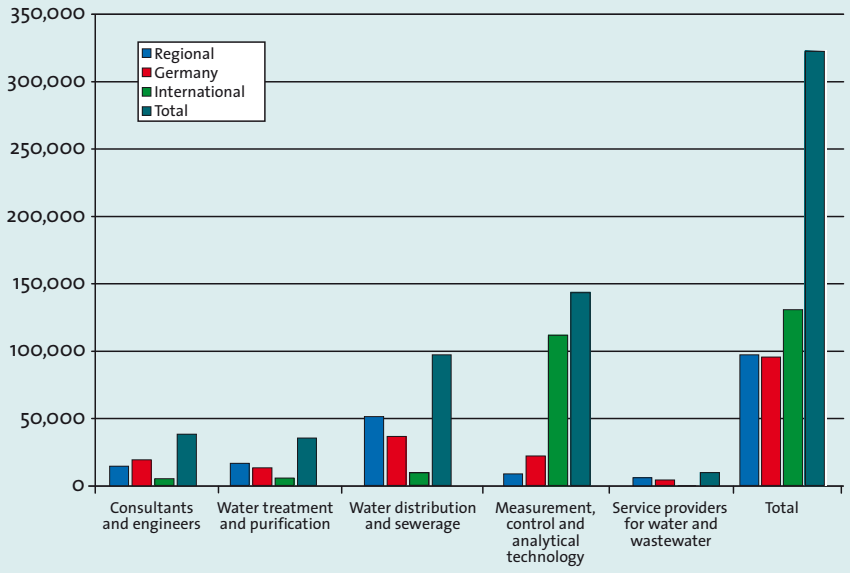
4.3 Markets

Most of the companies are not limited to the region, but operate throughout all of Germany and, to a lesser degree, abroad. The sector generated more than half of its turnover outside the Berlin-Brandenburg region, thus contributing to the strengthening of economic power of the region.

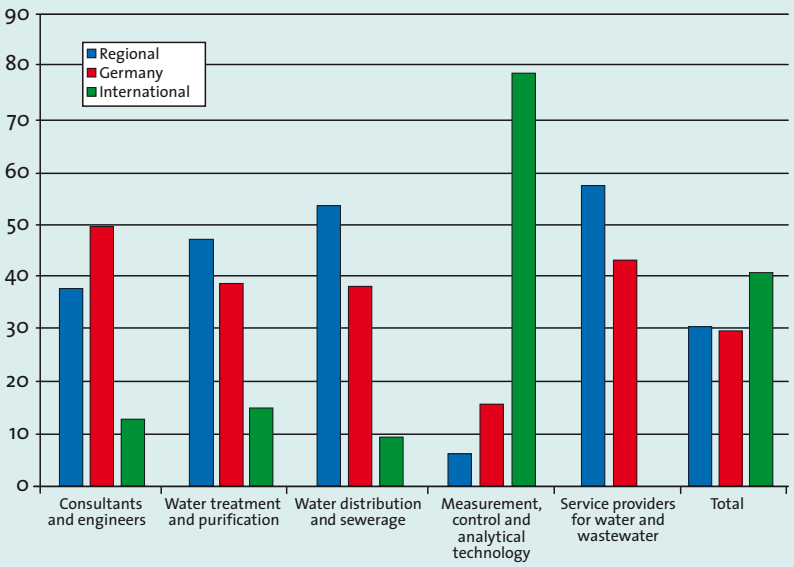
Half of the companies conduct international business. The contribution of international business to the annual turnover varied within the individual groups. The measurement, control and analytical technology companies were the most successful group by far on the international market: They generated nearly 80 % of their annual turnovers abroad. In the other groups, international turnover ranged from 12 to 15 % p.a.. As can be expected, the service providers for water and wastewater utilities were an exception: Their focus of operations is clearly regional, and they had no business operations abroad.

Regarding the international market, the regional water industry is active on all continents. The main area is clearly Europe (named 43 times), followed by Asia (25) and North America (12). Export connections to South America (8), Africa (10), and Australia (3) were also reported.

Regional distribution of turnover



Turnover T Euro



Turnover % Total

4.4 Research and Development

The industry is very active in research and development. Half of the companies develop products of their own and exhibit in addition above-average representation on the international market. Hence, it is not surprising that the number of employees engaged in research and development was reported to be 249. The strength of this area is backed up by the high rate of cooperation between business and research institutions and universities. Nearly all companies involved in R&D reported such co-operations.

On average, the companies invest 5.5 % of their annual turnovers for research and development; 19 companies report a share of more than 8.5 % for R&D.

4.5 Market Expectations

The surveyed companies were asked to give their opinion of the water market. This revealed a positive development: Compared to the previous years, business in the water sector increased for 40 companies, and only 17 companies reported a decline.

In the opinion of the companies, the outlook for the market in the future is also positive: 64 companies expect a rise in business volume in the water sector, and only 8 assume a decrease for their companies.

4.6 Water and Wastewater Utilities

As can be expected, the regional water sector is dominated by the water and wastewater utility companies with a statutory mandate to provide water supply and sewerage services. In this group, there is a direct correlation between turnover and employee figures and the number of inhabitants in the service region: Berliner Wasserbetriebe generated a turnover of 1.15 billion euros with roughly 4,900 employees. The 10 regional Zweckverbände that responded to the survey generated a turnover of € 122 million with roughly 450 employees.

Water and wastewater utilities were included in the survey because they are the main demanders of services on the water market. The value of contracts ordered by water and wastewater utilities is a particularly good indicator of the demand for services and goods triggered by the utility companies. In the target region of the survey, the total order volume of the utilities was approximately € 500 million p.a., roughly € 370 million of which was commissioned by Berliner Wasserbetriebe.

Berliner Wasserbetriebe was the only utility company active in research and development in the target region. BWB invests € 1.3 million p.a. for technical development. The Zweckverbände are not active in R&D.

Utility company statistics

Berliner Wasserbetriebe (BWB)

Employees	4,900
Turnover	€ 1,150 million
Investments	€ 305 million
Other orders	€ 65 million
Technical development	€ 1.3 million

Zweckverbände in the capital region (10 out of 25)

Employees	440
Turnover	€ 122 million
Investments and orders	€ 75 million

(The large volume of orders is due to the fact that some of the Zweckverbände pay fees to use BWB's wastewater treatment plants)

4.7 Conclusions

Since the response to the survey comprised about one-quarter of the companies, conclusions about the overall turnover of the regional water industry based on the survey must be interpreted cautiously. The annual turnover for private regional companies in the Berlin-Brandenburg water industry can be estimated to range from € 500 million to € 1 billion.

Based on the responses from utility companies concerning their investments and services ordered from third parties, the scope of the regional market is estimated to be roughly € 400 million p.a.

The high percentage of turnover generated outside of the region is of great economic significance. Work orders placed by utility companies are paid using fees collected from local citizens and thus do not bring new impetus to the region. Extra-regional earnings, on the other hand, bring economic power to Berlin and Brandenburg. The surveyed companies in the industry contributed 216 million euros to this factor. The survey showed that the industry has an astonishingly strong export focus. The export experiences of the companies seem to have been mainly positive since 60 out of 82 companies with foreign transaction indicated further interest in exporting.

The high percentage of measurement, control and analytical technology companies in export markets can be attributed to the special characteristics of their products: they market special state-of-the-art devices that can be shipped as independent units. Hence, these companies can serve customers abroad easier than others offering products that require the physical presence of the providers.

The degree of networking with scientific institutions is very high: half of the companies co-operate with research institutions. It is therefore evident that the industry is well integrated in the research and science community of Berlin.

5. Water Supply in Berlin, Germany and Worldwide

5.1 Berliner Wasserbetriebe (BWB)

Berliner Wasserbetriebe (BWB) is the water utility company responsible for providing drinking water and sewerage services to the German capital. BWB is also responsible for the drainage and treatment of rainwater from roads and squares as commissioned by the State of Berlin. Wastewater from numerous municipalities in the surrounding State of Brandenburg with a total of 500,000 inhabitants is also processed at wastewater treatment plants run by Berliner Wasserbetriebe, and approximately 100,000 Brandenburg inhabitants drink water supplied by the company.

With an annual turnover of more than 1.1 billion euros and delivery of approximately 200 million cubic meters of drinking water per year, Berliner Wasserbetriebe is the largest utility company on the German water market. Sustainable management and strict quality management guarantee high-quality drinking water, which is clearly above the legal standards for various parameters.

Berliner Wasserbetriebe's six wastewater treatment plants are equipped with the latest state-of-the-art biological treatment technology. Consequently, all of their WWTPs comply with the Berlin-Brandenburg specifications for purified wastewater, which are stricter than the federal standards. In addition to the water and wastewater treatment plants for water supply and sewerage, BWB maintains a highly complex infrastructure with a total of around 18,400 kilometres of pipes and trenches, 155 water and wastewater pumping stations, and numerous special facilities such as stormwater basins and retention soil filters.

In the last years, BWB developed and implemented two innovative automation solutions for water and wastewater management, the LSW system for water supply control and the LISA system for information and control of wastewater. The LISA system permits integrated control of all 147 Berlin sewage pumping stations from one central control point. Capacity-oriented guidance of sewage flows within the city through central control of the pumping stations make it possible to reduce combined sewage overflows by one-tenth. The LSW system permits central monitoring and control of BWB's 6 water and 9 drinking water pumping stations.

Without Berliner Wasserbetriebe, many standard-setting innovations available today would be inconceivable. The widespread and proven wastewater treatment method of nitrification after denitrification, for example, has its roots in Berlin as do numerous trenchless pipe installation and tunnelling techniques developed through cooperation of Berliner Wasserbetriebe with companies in the construction industry. One out of every two kilometres of Berlin's sewage network installed since the mid-1980's (more than 600 km to date) has been constructed using microtunnelling technology.

One of the most recent research projects investigates the individual biological, chemical and mechanical processes involved in bank filtration. The Berlin water supply has relied on bank filtration for more than a century. After the practice of directly using water of Spree River in Friedrichshagen ended in 1990, Berlin's drinking water has been supplied exclusively from groundwater, roughly two-thirds of which is produced by bank filtration. The soil, particularly the biological active soil layer of the first 50 cm under the surface, purifies the water that infiltrates into it so efficiently that no further treatment besides near-natural iron removal has to be performed at the waterworks; moreover, it is not necessary to chlorinate the water.

The company's classical water supply and sewerage tasks are flanked by numerous other projects related to the water industry. This also encompasses the field of groundwater management, including local strategies for the recharge or the lowering of groundwater. In addition, the regional water balance is stabilised by the use of purified wastewater for irrigation at three of BWB's wastewater treatment plants. Two surface water treatment plants remove phosphates from the Havel River, thus ensuring high-quality bank filtration as well as preservation of the important nature and recreational landscapes in Berlin's Tegeler Lake and Grunewald forest regions.

The treatment of contaminated stormwater also plays an important role in improving the quality of Berlin's surface waters. Trough-trench systems are constructed in the city where possible. Retention soil filter systems are increasingly used for treatment of more highly contaminated stormwater, e.g. runoff from industrial sites or heavily trafficked roads. These systems accomplish stormwater purification by biological and mechanical means.

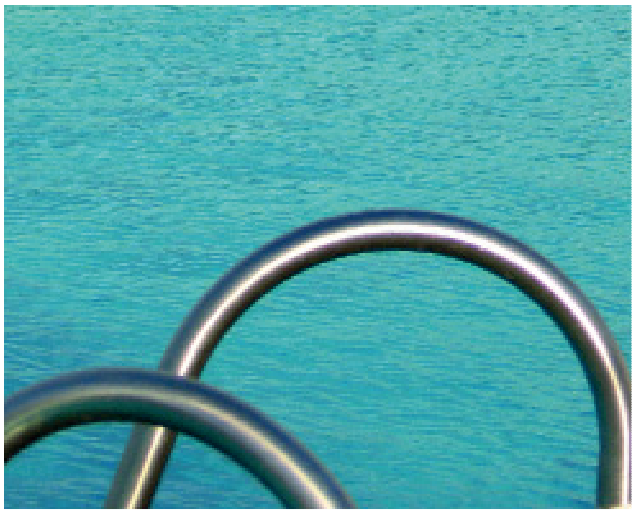
Partial privatisation of Berliner Wasserbetriebe in the 1990's resulted in the establishment of a corporation that is active in numerous water-related business areas in Germany and abroad. As a public law corporation, Berliner Wasserbetriebe forms the core of Berlinwasser Holding AG, which was partially privatised in 1999. The State of Berlin holds 50.1 percent of the shares of Berlinwasser Holding AG, and the RWE and Veolia corporations each own 24.95 percent.

5.2 Berlinwasser International AG (BWI)

Berlinwasser International AG (BWI) is a leading German management and services provider in the drinking water supply and sewerage sector. The company has been active in Central Europe, Southeast Europe, Asia, Latin America and Africa for more than ten years.

BWI develops and sells complex drinking water supply and sewerage systems on international markets. As part of the Berlinwasser Holding group, the firm plans and develops projects for sustainable and resource-saving water management. Berlinwasser International has extensive experience in the infrastructure and consulting business. With its headquarters in Berlin and over 2,000 employees in 12 countries, BWI is involved in the process of supplying drinking water and sewerage services for roughly 20 million people, and it directly serves some 5 million of these customers. BWI works with international finance companies, development cooperation organisations and export financing companies to secure investments.

Operation, leasing and management contracts as well as advisory services and employee training are its core business areas. Its project development services encompass feasibility studies, financing strategy development, cost management and fee development as well as comprehensive management of water resources, optimisation strategies, disposal concepts and planning services at all levels as well as the construction, operation and maintenance of water supply and wastewater treatment plants. Berlinwasser International is thus a full-service provider for all water supply and sewerage system management needs



5.3 Veolia Wasser GmbH

Veolia Wasser GmbH, which is based in Berlin, is one of the leading service providers in the field of water management for municipalities, industrial clients and private customers in the German-speaking region. Veolia Wasser GmbH is a business partner for more than 450 municipalities, organisations and industrial corporations in Germany and Austria.

The core competencies of the company are:

- Supplying water and sewerage services and management to municipalities, utility companies and industrial customers
- Supplying drinking water to private households as commissioned by the municipalities
- Collecting wastewater from private and industrial customers
- Providing comprehensive project management services such as consulting, financial planning, and supervising construction during the execution of investment projects
- Operating waterworks, water purification plants and water distribution networks
- Operating sewage networks and wastewater treatment plants
- Managing the complete water cycle for industrial customers, from the supply of drinking water, service water and process water to the environmentally friendly treatment of industrial wastewater.

Veolia Wasser GmbH is the reliable business partner for municipalities, organisations and companies in nine German states. Veolia Wasser GmbH has a share in Berliner Wasserbetriebe since 1999 (see Section 5.1) and is a shareholder in KWB (see Section 3.3.1).

Together with OEWA Wasser und Abwasser GmbH, its 100% subsidiary based in Leipzig, Veolia Wasser operates in numerous municipalities in the states of Saxony, Saxony-Anhalt, Brandenburg, Lower Saxony, Mecklenburg-Vorpommern and Thuringia. OEWA also holds shares in the MIDEWA (Central German water utility) in Merseburg and indirectly in Ostthüringer Wasser- und Abwasser GmbH (OTWA) in Gera.

Veolia is also active in other municipalities. For example, Veolia is the controlling shareholder of the municipal utility company of the city of Görlitz (Stadtwerke Görlitz AG). As such, it manages the entire operative end of the company's electricity, gas, district heating and water supply business as well as its sewerage and local transportation services. In Weißwasser, Veolia was able to increase the operating results of the town's municipal utility company after taking over the controlling share. In Braunschweig, Veolia holds

the controlling share of Braunschweiger Versorgungs-AG (BVAG), a utility company that supplies roughly 200,000 inhabitants with drinking water, electricity, gas and district heating. Veolia Wasser also took over Braunschweig's municipal wastewater service in 2006.

For companies with an increasing focus on their core business area, Veolia Wasser designs individual solutions for water management problems ranging from individual tasks to the complete takeover of complex water systems. Examples include MD Papier GmbH & Co KG in the Bavarian town of Plattling (Veolia now manages its complete water cycle, from the provision of process water to the treatment of highly contaminated wastewater) and the Julius Schulte paper factory in the Saxon town of Trebsen, the wastewater treatment plant of which is operated by Veolia. In the framework of an industrial water supply holding, Veolia Wasser also operates the cooling system and wastewater treatment system of GlobalisService GmbH in Düren. GlobalisService GmbH was founded in November 2003 for fulfillment of contract to Visteon Automotive GmbH, the third largest automotive supplier in the world.

Veolia Wasser GmbH is part of the international environmental services company "Veolia Environnement". Veolia Environnement is a world leader in environmental services. In Germany, the company has a total of around 15,000 employees who meet the needs of municipal and industrial customers in four business segments: water (Veolia Wasser), energy (Dalkia), waste disposal (Veolia Umweltservice), and transportation (Veolia Verkehr).

Great "Müggel" Lake