

02.11 Water Conservation Districts and Groundwater Use (Edition 1992)

Overview

The drinking water needs of Berlin are met primarily by groundwater. The drinking water supply is managed by the **Berlin Public Water Companies**. Water supplied by the Berlin Public Water Companies is produced from "true" groundwater or as bank filtered water (surface waters filter through the soil and are withdrawn by wells near the banks; contaminants are eliminated by the percolation process). Some surface waters are diverted into groundwater recharge wells to percolate into groundwater, which will then be withdrawn for use. Only small amounts of surface water from Müggelsee (see = lake) were withdrawn for drinking water production up to 1991.

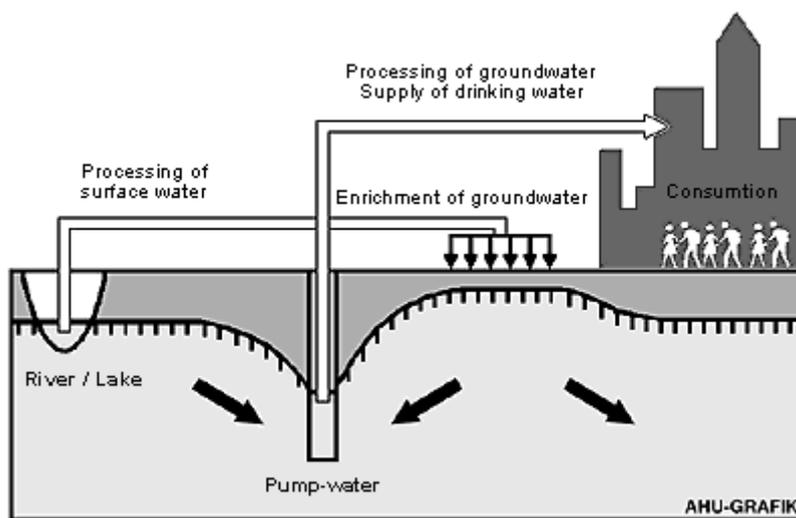


Fig. 1: Principles of Groundwater Production (AHU 1991)

There is also a number of smaller production plants, the **private sector water supply plants**, which withdraw groundwater for private sector, mostly industrial purposes, or withdraw groundwater for public facilities.

In **groundwater retention**, groundwater is withdrawn and held at construction projects. This occurs according to construction activity at various locations and in variable amounts.

Berlin is supplied by the 16 waterworks of the Berlin Public Water Companies. The wells of the waterworks are safeguarded as water conservation zones or water conservation districts. To protect water from pollution, specific actions are forbidden in these areas.

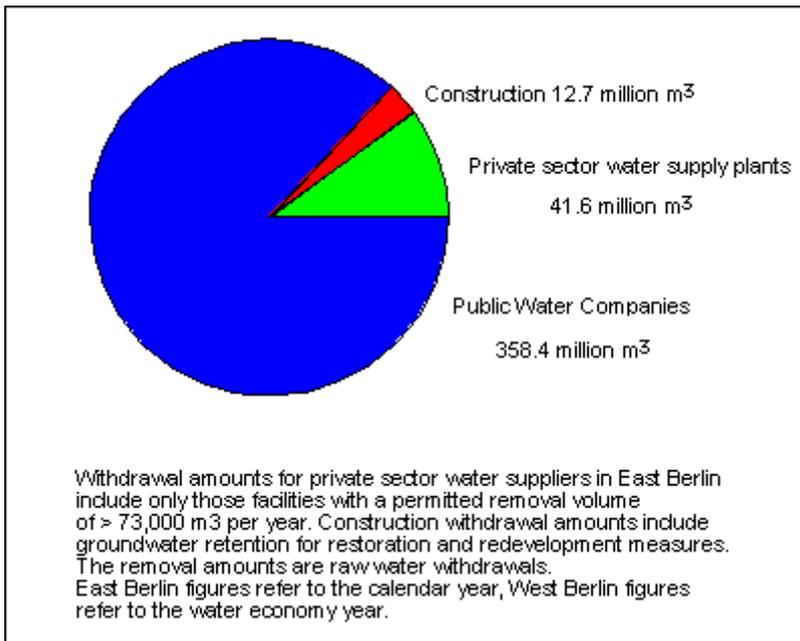


Fig. 2: Groundwater Withdrawal Amounts in Berlin According to Use in 1989 (including Stolpe waterworks)

There are 7 waterworks in West Berlin. The Riemeisterfenn and Spandau waterworks are protected by the Allied (US/French/British Occupation Authorities) Water Zone Protection Regulations of 1946. The other waterworks are protected by more stringent conservation district regulations according to the Wasserhaushaltsgesetz (WHG-Water Management Law), or the Berliner Wassergesetz (BWG Berlin Water Law). Conservation district regulations, conservation district borders, and limitations of use were only recently determined for the Tegel and Jungfernheide waterworks. A draft for a similar plan exists for Spandau (cf. Tab. 1).

Tab. 1: Water Plants of the Berlin Public Water Companies and Statutory Framework for the Water Conservation District Designation	
Statutory Framework	Water Works
Water Conservation District pursuant to Berlin Water Law (BWG) in concurrence with the Water Management Law (WHG)	Beelitzhof Jungfernheide Kladow Tiefwerder Tegel
Water Conservation District pursuant to Water Law of the GDR	Johannisthal Köpenick Altglienicke Wuhlheide Kaulsdorf Friedrichsfelde Buch Friedrichshagen Stolpe (in Brandenburg)
Water Conservation Zone pursuant to Allied Decree	Spandau (subject to revision) Riemeisterfenn Teufelssee (Works currently out of commission)

Tab. 1: Waterworks of the Berlin Public Water Companies and Statutory Framework for Water Conservation Districts

The remaining nine, 8 in East Berlin and the Stolpe waterworks north of the Berlin city limits, are protected by the GDR Wassergesetz (Water Laws) and its 3rd Durchführungsverordnung (Implementation Regulation) of 2 July 1982. The technical basis is the TGL 24348/01-02 .

The border between West Berlin and the GDR made definition of water conservation areas difficult for both sectors of Berlin. Against the given natural, geological and morphological conditions of the area, protection areas were forced to end at the border. The new definition of drinking water conservation districts can resolve this problem more simply now.

A depiction of East and West Berlin in the same map must take their different criteria in the definition process into account and thus the prohibited and limited permissible actions in individual protection areas.

West Berlin

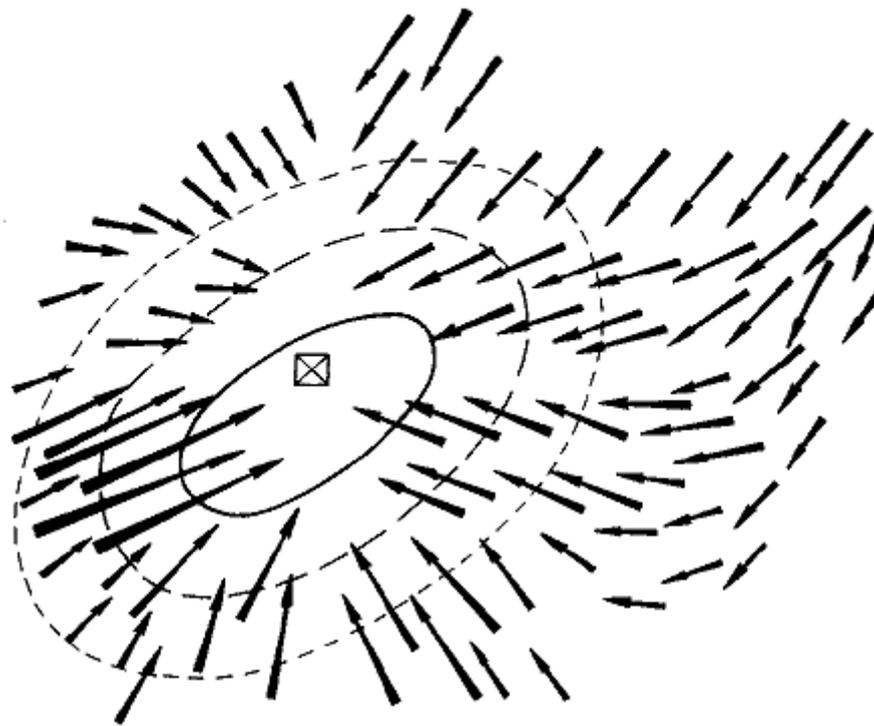
West Berlin water conservation districts are defined according to both the Water Management Law and the Allied Water Zone Protection Regulation.

Water conservation districts are determined by Section 19 of the **Wasserhaushaltsgesetz (Water Management Law)** or Section 22 of the **Berliner Wassergesetz (Berlin Water Law)**. They are divided into 3 protection areas with differing protection status; certain actions are forbidden or permissible with limitations. The borders of protection areas and descriptions of limitations of use are defined in the respective regulations for the respective areas.

The size of the protection areas is measured according to the **DVGW Regelwerk (DVGW Regulatory Rules)** "Richtlinien für Trinkwasserschutzgebiete" (Guidelines for Drinking Water conservation districts). The areal extent of Zone I is generally at least 10m surrounding the extraction well. Zone II reaches from the border of Zone I to a line at which groundwater requires 50 days to seep into the extraction well feed area. Zone III comprises the area between the outer border of Zone II and the border of the subterranean watershed. If the watershed is larger than 2 km, a subdivision into conservation district III A and III B is possible.

This guideline, however, is only a recommendation and has not been implemented in this form in West Berlin. Zone II here has an areal extent of 100m around the extraction well. Zone III reaches only from the border of Zone II to a 500m radius around the extraction site. The enforcement of the guidelines mentioned above in the definition of water conservation districts would have led to considerable conflicts regarding land-use.

The rigid radius drawn around the extraction well does not take into account the differing hydrological and geological conditions in the watersheds of the individual water withdrawal sites. Regulations are currently being revised for this reason. The water conservation districts of Tegel and Jungfernheide have recently been redefined. Their borders were determined by different criteria, according to the **isochronic concept** (cf. Fig. 3). The isochronic concept determines the size of water conservation districts and their geometric forms in pure hydraulic terms: from the flow time of water to the removal site. Lines of identical flow time are called isochrons. The determination of the isochrons, and thus the conservation district boundaries, proceed from hydrogeologic examinations of a given area. A regional groundwater flow model is developed for this area. The goal of the concept is to have sufficient time for damage control should soil be contaminated.



-  Extraction wells and water protection area I
-  50-day isochron (protection area II)
-  500-day isochron (protection area III A)
-  2,500-day isochron (protection area III B)
-  Flow velocity of groundwater
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The flow velocity of groundwater is indicated by the length of the arrows.
The longer the arrow, the higher the flow velocity.

Fig. 3: Example for Definition of a Water Protection Area According to the Isochron Concept

Conservation zone I remains at a size of 10m surrounding the withdrawal site. The size of conservation zone II is determined by the 50-day isochron (at the inner city waterworks Jungfernheide). Conservation zone III A has a 500-day isochron and conservation zone III B has a 2,500-day isochron.

Supplements and extensions of use-limitations within protection areas resulting from the application of the isochron concept are being undertaken in a new draft of the Water Conservation District Regulations.

The Berlin Landscape Program of 1988 defines water production areas in West Berlin to be **Priority Areas for Groundwater Protection**. These planning definitions are binding for public authorities but are not legally binding. They are to serve the priorities of restoring existing polluted areas and/or to prevent facilities which present a potential threat to groundwater from being established within 2 km of withdrawal wells.

Water conservation zones in areas regulated by Section 4 of the **Magisterial Ordinances** of 8 October 1946 were not accorded comprehensive use limitations. This ordinance proceeded from an order of the Allied Commandant of Berlin, valid for all Berlin. The conservation zones are divided into a narrow conservation zone with a radius of 100m around extraction wells, and into a wider conservation zone with a radius of 500m. All areas currently protected under the Magisterial Ordinance will eventually fall under regulations now being drafted according to the Berlin Water Law. These regulations shall supersede the Magisterial Ordinance.

East Berlin

The **water conservation districts** in **East Berlin** were defined under GDR law. The legal basis is the **Water Law of the GDR** in its 3rd Durchführungsverordnung (Implementation Regulation) of 7 February 1982 in regard to protection and reserve areas. The East Berlin protection areas enacted at the 14th Berlin city council meeting on 19 October 1984.

The technical basis for the definition of water conservation districts in the GDR was TGL 24348/01-02 (effective 1 Sept. 1980). This differentiated 3 or 4 conservation zones, but 3 zones are usually used. Conservation zone I includes the direct area around the well or well gallery. The areal extent is at least 5m around the well. Conservation zone II should be large enough that possible microbial and biological degradation pollutants which might contaminate water are eliminated by the time the water enters the well. This is usually accomplished after unpurified water has been in the ground for 30-50 days before it is used again. The borders of Zone II are defined by calculations of the groundwater flow velocity. The borders thus vary according to subterranean conditions and run about 300-600m from the well. The areal extent of Zone III reaches maximally to the subterranean or surface watershed. Zones II and III are substantially larger than in West Berlin.

The definition of water conservation districts in the GDR according to an extended isochronic concept after the new TGL of April 1989 (TGL 43850) was planned. This TGL intended considerably extended use-limitations and bans, but it was never applied to East Berlin water conservation districts.

The GDR also determined **reserved areas** for future water supply production, where no groundwater is currently withdrawn. Special use limitations are in force in these areas, provided in the Water Law of the GDR or in TGL 43271 of Sept. 1984.

East Berlin water conservation districts have been carried over in a supplement to the Berlin Water Laws. Comparable use limitations have been issued. These will remain in force until the German federal government has issued a new designation of water conservation districts. This is to be expected within the next 8-10 years.

Water conservation districts in the **surrounding areas** of Berlin are also defined according to GDR law. New delineations and changes in conservation areas, and changes in protective status or area associated with a new definition, can only take place after the enactment of a Brandenburg state water law.

Use Limitations in Water Conservation Districts

Substantial discrepancies between requirements and **use limitations** exist beyond the differing procedures used in East and West Berlin to determine protection area borders, and their different resulting sizes.

All actions - except measures necessary for maintenance of the water supply - are forbidden in Zone I in federal German law. The GDR permitted agricultural use as a meadow to be mown and short-term pasturing of sheep, depending on local conditions; the use of solid organic manure; and the use of forests, in accordance with specific, basic management principles.

GDR law permitted mining and drilling in conservation zone II under certain conditions, but not for the purposes of water supply. Development was possible under certain restrictions. Storage and transport of liquid organic manure were not strictly forbidden; nor was construction of traffic ways (and its consequences, such as winter anti-icing salts and grit).

Protective ordinances for Zone III allowed the mining of clay, sand, gravel, and stone quarries. Depot operation for residual products was permitted, as was handling oil, oil products, and other water endangering liquids.

These actions, permissible in certain conservation areas under certain conditions, are examples from the TGL of December 1979. The new TGL of April 1989 ((TGL 43850) was more precisely formulated in many points. It also set considerably wider use limitations and bans. Some of these went further than West German law. Yet they have not been the basis for defining any water conservation districts in East Berlin. The protective status for individual conservation zones in East and West Berlin is not comparable, because the older TGL in East Berlin defined considerably fewer use limitations.

There is a number of smaller groundwater supply facilities in the private sector, usually for industrial purposes, or commissioned by public facilities. Water is withdrawn and treated in these **private sector water supply plants** by users themselves. This water is not drawn as a finished product from the Berlin Public Water Companies. These plants are usually established and run by industrial and commercial

operations, but also by public institutions such as hospitals and swimming facilities. The groundwater they withdraw is used as drinking, operating, and cooling water, and to water plants, lawns and meadows. Both the Berlin Public Water Companies and private sector water supply plants require official permits or special approval with specified use conditions and restrictions. These are mandated by the Berlin Water Economy Law or the Berlin Water Law for Water Supplies.

Statistical Base

Water conservation districts and zones and the location of **wells and well galleries** are demarcated following the large-scale maps Berlin Public Water Companies and the Berlin Department of Urban Development and Environmental Protection. Amounts withdrawn by waterworks wells or well galleries are set by the public water companies. The location and removal amounts of **private sector water supply plants** for West Berlin are taken from the corresponding data base of the Arbeitsgruppe Wasserwirtschaftliche Grundlagen (Work Group Water Management Standards) of the Berlin Department of Urban Development and Environmental Protection. East Berlin data was taken from a provisional regional committee list made by a GDR Institute for Water Management.

The delineation of protection areas and the removal amounts of the **Brandenburg Waterworks** was made available by the water supply operators themselves.

The data for withdrawal volumes of private sector water supply plants and the waterworks or well galleries in West Berlin are based on the **water economy year** (November - October). All other figures are based on the **calendar year**. Figures for Berlin Public Water Companies plants are from 1990; those of the private sector water supply plants and of the Brandenburg Waterworks are from 1989.

Methodology

The wells of the Berlin Public Water Companies cannot be portrayed individually but only as groups, **well galleries**, because of the selected scale. For the same reason there is no depiction of conservation zones I and II, or the narrow conservation zone in West Berlin, or the East Berlin Zone I.

Private sector water supply plants are depicted in the map with their **permitted** as well as their actual water **withdrawal** amounts. Not all facilities use withdrawn water for drinking water purposes. Those facilities which do use withdrawn water for **drinking water purposes** are specially characterized.

Corresponding to the statistical base, East Berlin private sector water supply plants with a permitted withdrawal of more than 73,000 m³ are depicted. In West Berlin all those registered with the public administration are depicted. Single wells on private property which decentrally serve domestic water consumption are generally not depicted. None could be depicted for the state of Brandenburg because data was not available.

Raw water withdrawals from groundwater are depicted. Smaller portions of the 5.7 million m³ groundwater withdrawn by the Jungfernheide waterworks serve internal operating purposes, or are used to protect other wells (groundwater restoration) against threats to their quality. These portions are not calculated in the drinking water supply. Approximately 1.2 million m³ are not included in depicted withdrawal amounts for the Friedrichshagen, Johannistal and Wuhlheide waterworks. This water was used to recharge the Krumme Lanke, in purge wells, or discharged into the Teltow canal and the Spree river.

Map Description

The Berlin Public Water Companies waterworks are located mainly in the Berlin Pleistocene watercourse. Private sector water supply plants are located throughout the city.

The **Teufelsee** (see = lake) waterworks was closed in 1970. The gallery section at **Nikolassee** is not in operation either. Current water quality is too poor at parts of the **Wuhlheide** waterworks west gallery, at the Alte Königsheide gallery, at the Teltow canal in **Johannistal** and at 6 wells of the **Jungfernheide** waterworks. Therefore no water is being withdrawn.

The **Stolpe** waterworks is located to the North, just outside the city limits. It is operated by the Berlin Public Water Companies and serves the drinking water supply of Berlin and a few nearby communities in the state of Brandenburg. The protection areas of the **Staaken, Eichwalde and Erkner** waterworks, which serve communities in the vicinity of Berlin, are located both inside and outside Berlin.

Tab. 2: Groundwater Withdrawals 1913 and 1990 resp. 1989

	Groundwater Withdrawals (million m3)			
	Pre-War Berlin	Berlin	West Berlin	East Berlin
	1913	1989/90 1) 2)	1989/90 2)	1989/90 1) 2)
Berlin Public Water Companies	73,9	324,0	191,6	132,4
Private sector water supply plants	20,0	41,6	24,3	17,3
Groundwater retention at construction sites	20,0	12,7	5,7	7,0
Total	113,9	378,3	221,6	156,7
Groundwater withdrawals per inhabitant (liters/day)	143	302	281	336

1) including Stolpe waterworks

2) for Berlin Public Water Companies and population 1990, all other figures from 1989

Figures for withdrawal amounts of commercial and domestic water supply facilities in East Berlin contain only facilities with a permitted withdrawal amount of > 73,000 m3 per year. Groundwater retention figures for West Berlin in 1990 include groundwater retention at restorative and redevelopment construction. The figures are of raw water withdrawals. East Berlin figures refer to the calendar year; West Berlin figures to the water economy year.

Tab. 2: Groundwater Withdrawals 1913 and 1990 or 1989

Three **reserve areas** for future drinking water supplies were defined in East Berlin: Planterwald, Gosener Wiesen and Kaulsdorf-South. They are located in direct vicinity to Protective Zone II in existing water conservation districts.

Withdrawal Amounts

Amounts withdrawn by the Berlin Public Water Companies have risen ever since the beginning of public water supplies. A clear reduction of removal amounts occurred after World War II. West Berlin removal amounts steadied in the mid-70's. In East Berlin there was a continual increase until 1989 (cf. Fig. 4).

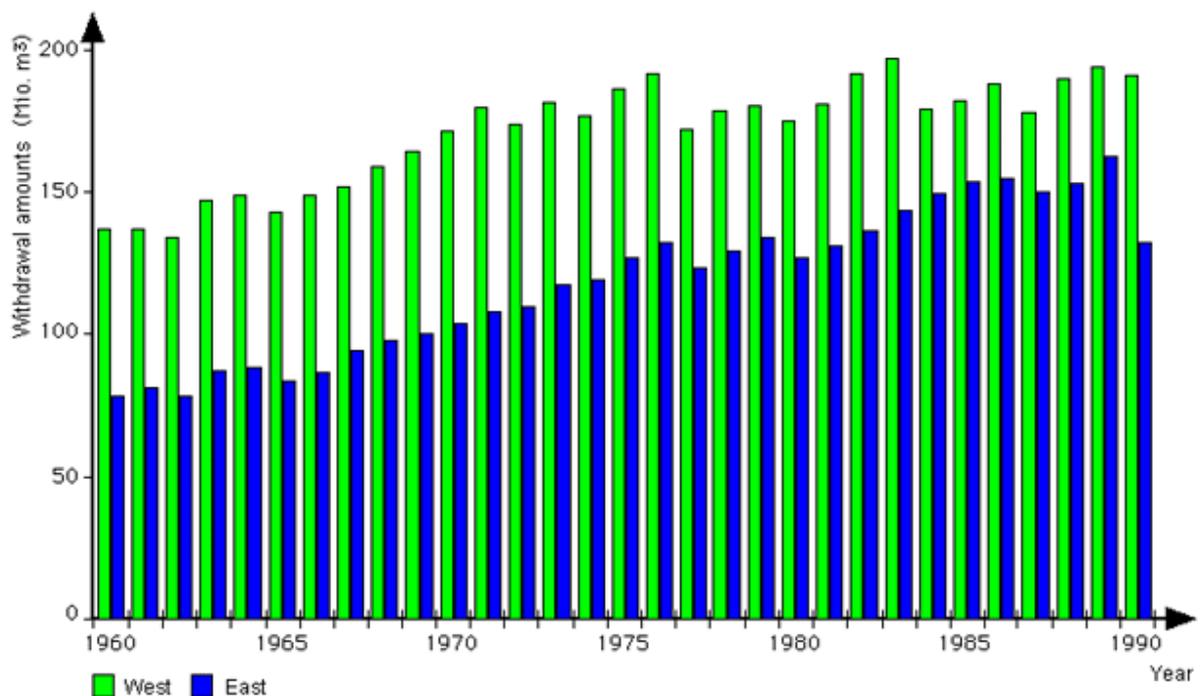


Fig. 4: Groundwater Withdrawal Amounts of the Berlin Public Water Companies 1960-1990, Figures are for withdrawals of raw water. East Berlin waterworks (including Stolpe waterworks) refer to the calendar year. West Berlin waterworks refer to the water economy year. The sum for 1973 includes 8.2 million m³ for filling Teufelsee lake in Grunewald. The figure for 1990 includes 5.7 million m³ used in the Jungfernheide waterworks mainly for restoration of groundwater, and not for the drinking water supply.

The Berlin Public Water Companies removed 358.4 million m³ of raw water from groundwater in 1989, including Stolpe waterworks. Adding the 41.6 million m³ removed by private sector water supply plants (17.3 million m³ in East Berlin) and the 12.7 million m³ for groundwater retention at construction sites, yields a sum total of 412.7 million m³ withdrawn from groundwater for Berlin. In 1990, the groundwater amounts removed by the Berlin Public Water Companies sank almost 10%, down to 324 million m³ (cf. Fig. 4). This reduction is due to the drastically reduced withdrawals of East Berlin waterworks, including Stolpe waterworks.

The approximately 320 larger **private sector water supply plants** removed 42 million m³ of groundwater in 1989. This water was used as drinking, operating, and cooling water, and for plants and green areas. The approximately 60 plants which also remove for drinking water are specially monitored to maintain a water quality fit for human consumption. The largest plants in East Berlin each removed about 1.2 million m³ in 1989. In West Berlin the largest remover withdrew about 2.8 million m³.

The map depicts some private sector water supply plants whose permitted withdrawal amounts are zero, but which do remove groundwater. A few of these plants have received a permit in the meantime (the information in the map is from 1989). Other operators fall under the no-permit-required use, since their removals are minimal (§ 33 WHG resp. § 38 BWG). No permit was required under Allied law.

Amounts removed by West Berlin private sector water supply plants are dropping (cf. Fig. 5). There is a tendency to close such plants, primarily for economic reasons, and to take water from the public network. There are no comparable figures available for East Berlin.

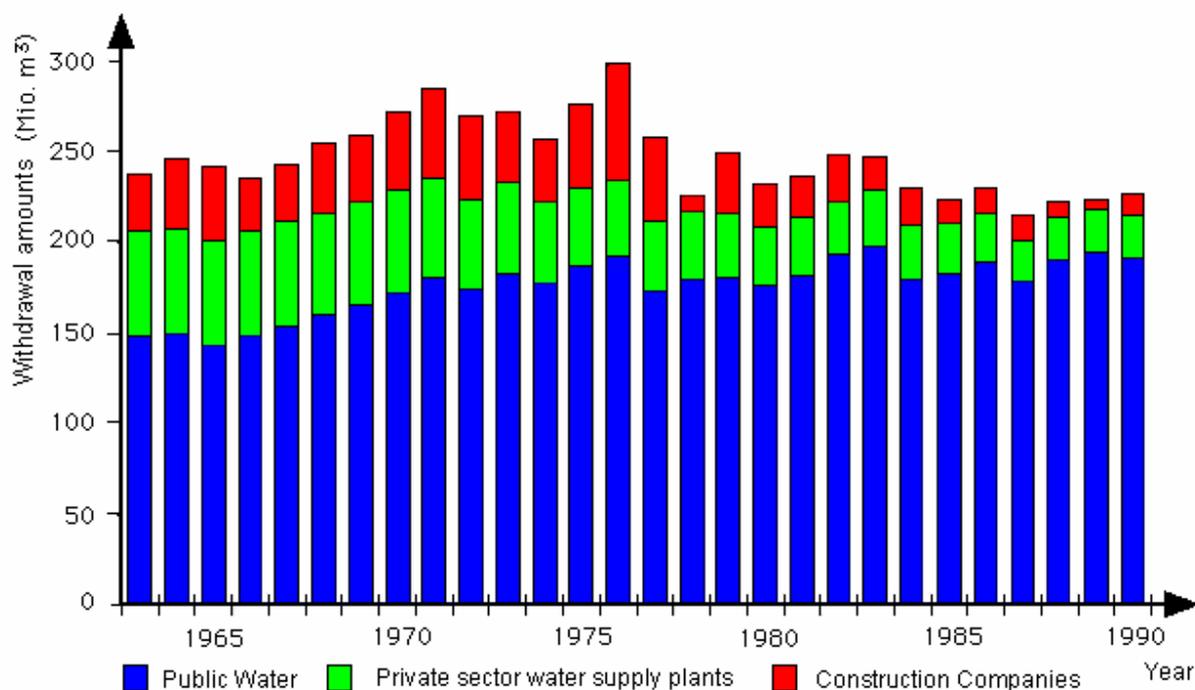


Fig. 5: Groundwater Withdrawal Amounts According to Use in West Berlin from 1963-1990, Since 1987, construction groundwater retention for restoration and redevelopment measures have been included. The figures are for raw water withdrawals and refer to the water economy year.

Groundwater Recharge

The goal of water management is to maintain a balanced **groundwater economy**. That means only so much groundwater should be removed as can be recharged. If removals exceed recharge, the groundwater reservoir will gradually empty; the groundwater level sinks. The West Berlin water level sank strongly in 1950-1975, due to large removal amounts of the Berlin Public Water Companies, private sector

water supply plants, and groundwater retention at construction sites. The groundwater level has been rising since the mid-70's (cf. Map 02.07). This is caused by smaller removals of groundwater by private sector water supply plants, and by smaller groundwater removals as well as groundwater returns at construction sites. The Public Water Companies had also established **groundwater recharge plants** in order to increase groundwater. Groundwater recharge plants in Spandau and Jungfernheide injected 53 million m³ of prepared surface water for percolation in 1990.

Besides "true" and **manmade recharged** groundwater, a considerable portion of water withdrawn by the Public Water Companies comes from **bank filtered** water. Wells in the vicinity of surface waters produce cones of depression, and water from the bank areas of the Havel, Dahme and Spree flow into them. The proportion of bank filtered water in the total withdrawal amount of each well gallery depends on the distance of the well from the surface waters. An average of 50% of the removals of the Berlin Public Water Companies has been assumed. Figure 6 depicts the origin of waters used by the public water supply, as well as a division of its uses. Water consumption from public water supplies (purified water including lake water) per inhabitant in West Berlin was 233 liters/day in 1990 (1991: 229 l/d). In East Berlin it was 318 l/d (1991: 254 l/d). The average for all Berlin was 268 l/d. Water consumption of Berlin households totaled 213 million m³, and per inhabitant was 172 l/d.

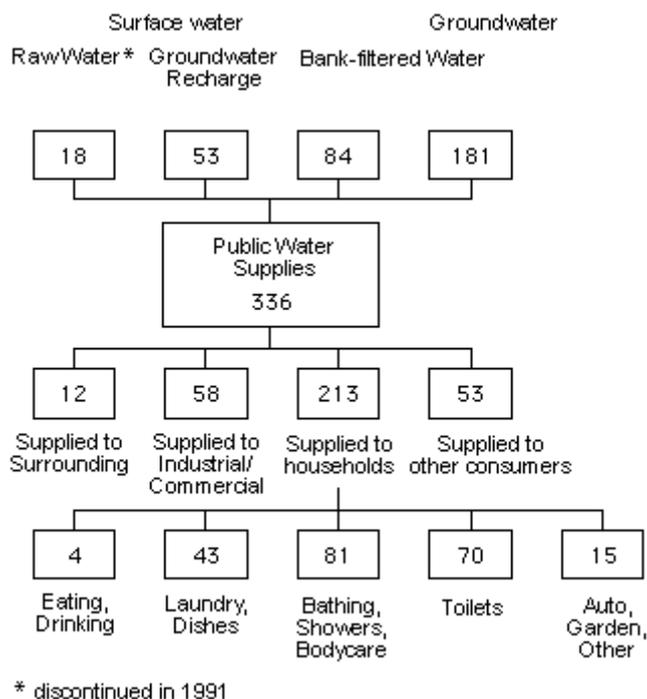


Fig. 6: Origin and Use of Water from Public Drinking Water Supplies in Berlin 1989/90 in million m³ per year (according to AHU 1991)

Increased sealing of soil surfaces and Berlin's rising population necessitate more water conservation and new methods of recharging groundwater both to maintain groundwater balance, and avoid use of drinking water supplies from distant areas. One procedure striven for as a solution to this problem is the use of former **sewage farms** for the return of purified surface water, or the best purified water from sewage treatment plants. The groundwater recharge rate could also be raised by returning rainwater to percolation. Rainwater that would otherwise flow into the canalization could be separately collected and either directly discharged onto non-built-up surfaces, or discharged into artificial ponds to infiltrate the ground and percolate into groundwater. In this sense, measures to 'de-seal' surfaces would also contribute to an increased groundwater recharge.

In 1990, an ordinance providing for a **groundwater withdrawal fee** was adopted in the Berlin Water Law (§ 13a, Para. 1). This was intended as an economic incentive to promote thrifty groundwater use. This was intended as an economic incentive to promote thrifty groundwater use. It allows Berlin to charge users a fee for the removal of groundwater, for the purpose of a more sparing use of groundwater. The resulting income should be applied to the protection of the quantity and quality of existing groundwater, particularly to ward off threats to groundwater, and to ameliorate damages.

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