

02.09 Management of Rain and Waste Water (Edition 2018)

Overview

In Berlin, precipitation and waste water from private households, public institutions, industry and trade, as well as run-off from public road areas, generate large quantities of rain and waste water. These need to be piped away and treated, if appropriate. In 2017, the sewage plants treated some 717,000 m³ of waste water from private households, trade, industry and public institutions, as well as rainwater from Berlin and its suburban area every day. This quantity is equivalent to a little over 8 m³/sec., or about 15 % of the run-off of Unterhavel river below Berlin, given medium water flow. The amount of waste water generated in Berlin would be sufficient to fill the Great Wannsee lake within three weeks.

Waste waters are carried in a sewerage network with a total length of 9,725 km. The sewerage network is operated by the *Berliner Wasserbetriebe* (BWB, Berlin Waterworks). It was implemented in two different systems, the **combined** and the **separate sewerage systems**, and consists of a total of 4,403 km of waste water drains, 1,928 km of combined water drains and 3,324 km of rainwater drains, as well as numerous special drains and special structures, such as rainwater overflows, rainwater retention basins and culverts. Waste water collected there is pumped to the sewage plants by 163 pumping stations, through a network of 1,183 km of pressurized sewage pipes (Berlin House of Representatives 2015).

Berlin's combined sewage canal system was built in 1873 according to a design by James Hobrecht, to drain the whole municipal area of Berlin as it was then. However, towns and communities surrounding Berlin, which retained their independence until 1920, mainly built systems based on separate drainage. After their incorporation into Berlin, their facilities were amalgamated into the present system. Drainage areas are oriented towards river courses and shipping canals, and also in accordance with the different terrain heights. The boundaries of drainage areas do not follow the borders of Berlin's boroughs. About four fifths of Berlin's drained areas are operated under the separate system, and the remaining fifth under the combined system.

The Separate System

In a system of separated drainage, waste water and rainwater are handled by two different systems. **Waste water drains** carry household, commercial and industrial waste water to the pumping stations. From there, pressurized pipes are used to take it to the Ruhleben, Münchehofe, Schönerlinde, Waßmannsdorf, Wansdorf, and Stahnsdorf **sewage treatment plants**. After treatment, sewage plants discharge purified water into Berlin's bodies of water.

At the pumping stations, there are usually **emergency outlets**, through which the waste water can be discharged into the receiving bodies of water in case of technical defects. Of the 72 emergency outlets, 26 lead to the Spree, 2 to the Dahme, 19 to the Havel, and 18 to the Teltow Canal; 5 lead to standing surface waters, and 2 emergency outlets lead to other pumping stations, via sewage drains. The performance level of the emergency outlets is very different from year to year.

Tab. 1: Treated waste water quantities and receiving water bodies of the major treatment plants in Berlin and the surrounding area, 2017

Sewage treatment plant	Quantity of waste water treated in 2017 (m ³ /day)		Receiving water bodies
	Total	of which suburbs (%)	
Ruhleben	256.703	-	Summer season: Teltowkanal via pipes, at almost 1 m ³ /s via Spree; Winter season: Spree

Schönerlinde	118.560	11	Tegeler See via Blankenfelder Graben/ Nordgraben and Lietzengraben via Schönungsteiche; after 2015 partially via Panke into Spree
Münchehofe	40.385	46	Spree via Erpe
Waßmannsdorf	209.982	8	Teltowkanal and Havel via Nuthegraben/Nuthe
Stahnsdorf	54.683	43	Teltowkanal
Wansdorf	36.543	59	Havelkanal
Total	716.856	13	

Tab. 1: Treated waste water quantities and receiving water bodies of the large sewage plants of Berlin and its suburbs in 2017

Rainwater drains collect precipitation from impervious surfaces, cooling water from factories, and water from drainage ditches. This is carried directly to the larger or smaller surface waters. In some cases, very considerable areas of the city drain into very small receiving water bodies. Altogether, some 48 million m³ of rainwater per year are drained into water bodies by the separate sewerage system (SenStadtUm 2013). **Rainwater** from the separate sewerage systems is heavily **polluted** by dust, air pollutants, rubbed-off road surface and tire particles, leaked oil, leaves, animal faeces, road grit in winter etc. After more intensive rainfall, there have been repeated fish kills in smaller standing water bodies and canals with relatively little water. This is the result of oxygen-depleting processes resulting from the oxygen-consuming decomposition of drained organic substances that sets in immediately after the latter reach the water body. To reduce the pollution of water bodies, rainwater basins and retention soil filters for the treatment of rainwater have been installed at the main discharge points. Twenty-four facilities for rainwater treatment had been commissioned by the Waterworks by 2018; more than ten additional facilities were set up along the motorways.

There are some areas on the boundaries of the inner city which originally operated a combined sewerage system, but later received a rainwater drainage system (a modified combined sewerage system). There, the rainwater is drained into the rain sewage overflow drains of the combined sewerage system.

The Combined System

This system almost single-handedly drains the old inner city of Berlin and Spandau also including the area surrounded by the inner circle line of the S-Bahn (city rail). In this **combined sewerage system**, household, commercial and industrial waste water is collected in a **single drain** together with the rainwater, and then fed to the next pumping station. From there, the combined sewage water usually takes the same route as the sewage from the separate sewerage system. The combined sewerage system includes not only rainwater relief facilities, but also water retention canals and rainwater overflow basins to retain combined sewage during periods of rainfall, and to thus delay its passage to the sewage treatment plant. In 2017, 18 such plants were in operation. In brief heavy rainfall, they are able to completely take up the combined sewage overflow. There are exceptions for situations of extended, intensive rainfall events. Once water then reaches a certain height in the drains, or if the pumping stations can no longer cope with the volume of water received, the combined sewage – which, in case of such downpours, consists mainly of rainwater (at a ratio of about 1:9 of waste water to rainwater) – flows untreated into the water bodies via **rainwater overflow drains**.

Combined sewage overflows depend on the weather. Annual analyses illustrate the great extent to which combined sewage overflows fluctuate. Between 2007 and 2017, the number of days on which combined sewage overflow was recorded fluctuated between 33 and 60 days per year. The overflow volume ranged from 2.1 to 7.5 million m³ per year.

When analyzing the days for which combined sewage overflow was recorded, it should be noted that rainfalls often occur locally and that combined sewage overflows are therefore regionally contained and temporally limited.

In order to achieve the environmental objectives of the Water Framework Directive and to meet the requirements of the water authorities' permission to discharge combined sewage into Berlin's bodies of water, the BWB and the Senate have launched a construction programme to create a total of 300,000 m³ of retention capacity (current storage capacity is about 235,000 m³) in the inner-city

combined sewerage system by 2024. This will considerably reduce overflow frequencies and volumes of combined sewage flowing into the Berlin water network.

Areas without Rainwater Drainage

In the outskirts of the city, there are areas connected to sewerage systems, which do not include, however, rainwater drains. In these areas, rainwater seeps into the ground.

Areas without Waste Water Drainage

Despite considerable efforts by the Berlin Waterworks (BWB), not all inhabited areas have been connected to the sewerage network as yet. In those built-up areas of Berlin with no house connections, sewage is collected in **septic tanks with no discharge**, from where it is taken to sewage treatment plants by authorized transport companies.

A separate map has been developed to document the drainage situation exploring the discharge of rainwater into bodies of water. It shows the **catchment areas of the rainwater drains** (Map 02.09.2). Every built-up area connected to the rainwater drainage system is matched to the water body receiving these discharged quantities of rainwater.

Statistical Base

The sewerage network maps of the BWB provided the primary base to ascertain the type of drainage as well as the catchment areas of rainwater drainage:

- Data on waste water, combined water and rainwater drains (Drainage network map, as of May 2017) including the pressurized sewage pipes (ADL, as of January 2018) of the Berlin Waterworks (BWB 2017),
- Catchment areas of the Berlin Waterworks (as of May 2017) (BWB 2017a),
- Land use data of the Urban and Environmental Information System (as of December 2015) (cf. Environmental Atlas 06.01, 06.02, SenStadtUm 2016) and
- Impervious soil coverage data, as of May 2016 (cf. Environmental Atlas 01.02, SenStadtWohn 2017).

With the aid of the current digital statistical base dated between 2015 and 2018, the frequently updated data on "Management of Rainwater and Waste Water" of block and block segment areas, first developed as part of the Environmental Atlas in 1992, last revised in 2011; has now, once again, been updated.

Methodology

The **type of sewerage system** of the block and block segment areas has been updated using the information presented in the chapter "Statistical Base". By reference to the types, courses, and slopes of sewage drains, it was possible to mark off **catchment areas of combined sewerage** and of separate sewerage systems, respectively. It is not possible, however, to exactly match individual roof and courtyard areas to the catchment areas of rainwater sewers by reference to maps of the sewerage network. Entire **blocks** and **block segment areas** as represented on the map were always allocated in their entirety to one of the categories or one of the first receiving water bodies, even if individual properties or block segments are drained differently from the remaining block area under specific circumstances. Depending on how far they are located from the canal (max. 25 metres), the block and block segment areas were semi-automatically categorized as combined systems, waste water or rainwater sewers. For this, several GIS tools were used. A new **processing method** was thus applied, as compared to that of the year 2012. The process of categorizing blocks and block segment areas into different sewerage systems was fine-tuned using available data on land use and the degree of impervious soil coverage for blocks and block segment areas. This was followed by a manual check and, if required, a correction step. At times, there are considerable differences regarding the extent to which properties are actually connected, if they are connected at all, and whether rainwater from impervious surfaces is actually discharged into rainwater sewers. The text accompanying [Map 02.13.1 "Surface Runoff from Precipitation"](#) documents the corresponding data, based on information from the BWB and contains generalized connection rates for different building structure types (SenStadtUm 2013). The proportion of impervious areas actually connected to the canal depends on the location within the city, the building structure (e.g. airports) and the degree of impervious soil coverage. As part of **de-coupling measures** or alternative rainwater management measures, which have often already

been used in the planning of new construction areas in recent years, the rainwater from impervious areas is not always discharged into bodies of water but managed locally. The exact locations of these areas have yet to be determined.

To some extent, data on the type of sewers cannot be derived from the documentation available. This is especially true of large-scale **industrial and commercial areas**, where maps of the sewerage networks of the BWB do not provide any information as to the type of disposal of rainwater. The rainwater of some of these surfaces is drained directly into water bodies via private drains.

Parts of the city with **green and open spaces** which may be considered unconnected to sewers were not included in this analysis and are therefore not included in the catchment area presented. In areas with **separate sewerage systems**, rainwater is drained into water bodies. For every block or block segment area with rainwater drains, the so-called **first receiving water body** into which the rainwater drain discharges was defined. During the 2017 update, the information on first receiving water bodies was supplemented and checked by sample. For the presentation of this Environmental Atlas map, these first receiving water bodies were combined into water body sections into which they discharge to render the map more comprehensible. So what is shown are the catchment areas of the respective water bodies.

Areas in which rainwater is fed into **decentralized percolation facilities** (such as basin or trenching systems etc.) were assigned to the sections of the sewerage system or bodies of water, into which they drain via overflows in case of heavy rainfall (such as Karow-Nord).

Map Description

02.09.1 Type of Drainage

In Berlin, four fifths of the sewerage-equipped urban area is drained by separate sewerage; about one fifth has combined sewerage. Thus, a total of 52.8 % of Berlin's overall area is connected to a sewerage system. Urban areas connected to a separate sewerage system fall into the following 4 categories: separate **sewerage systems with waste water and rainwater sewers** account for the largest share (66.1 % of the type of drainage), followed by **separate sewerage systems with waste water sewers without rainwater sewers**, e.g. in areas where all rainwater seeps into the ground. A minute share of **separate sewerage systems** is made up of areas with **rainwater sewers without waste water sewers**, which are mainly traffic areas. Areas where rainwater sewers **discharge into the overflows of combined sewerage systems** constitute a unique case (2.2 % of the type of drainage).

The number of block and block segment areas that are drained via **combined sewerage systems** has increased by just under 5 %. Much like in 2012, they account for almost 18 % of the total municipal area.

Inhabited areas without any type of drainage are blocks and block segment areas that are not connected to a sewerage system, which, however, presumably produce waste water based on their type of use. Here, sewage is mainly collected in **septic tanks**. The sewage is then taken to sewage treatment plants by transport companies. Since the early nineties, when 12 % of the inhabited area (7 % of West Berlin and 19 % of East Berlin) was still not connected to the public sewerage system, this figure has dropped steadily and amounts to about 1.3 % according to the current analysis. The population-referenced **overall connection rate** to waste water sewers is thus almost 100 %.

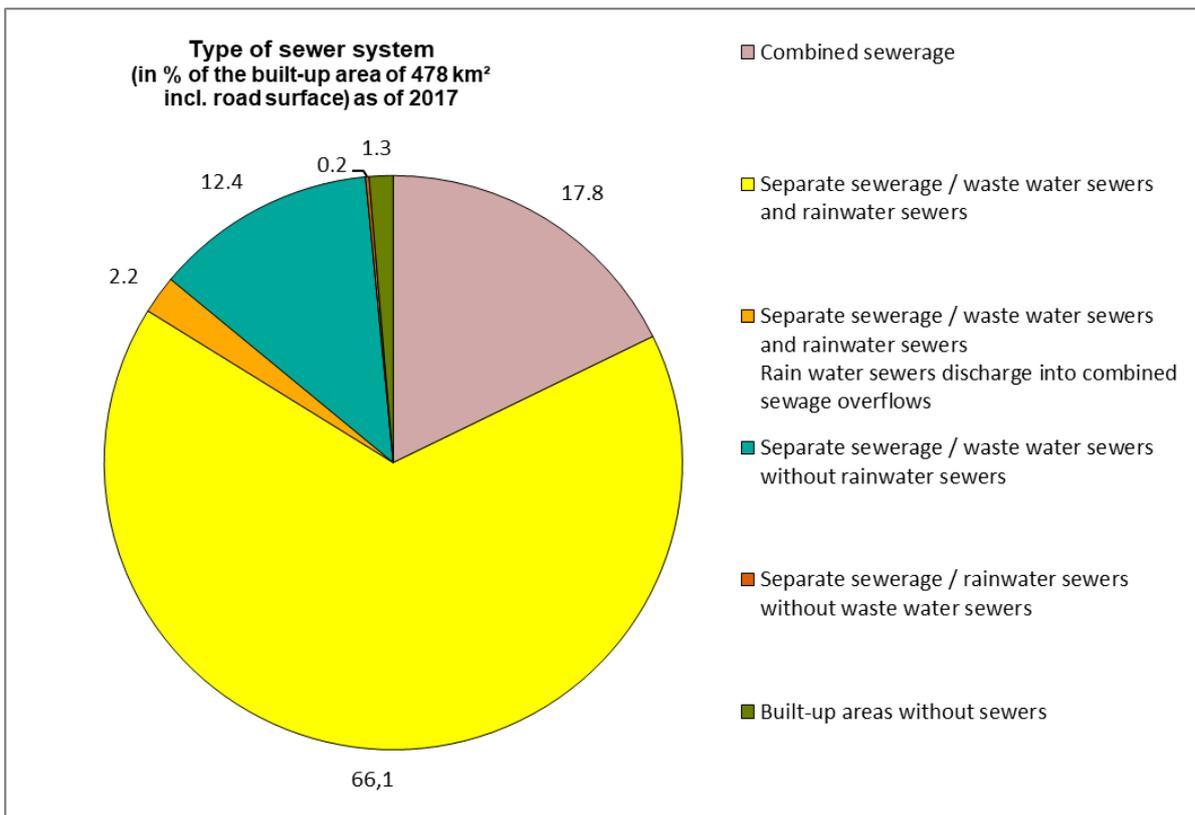


Fig. 1: Type of sewerage network, as a percentage of built-up areas, including road surfaces (478 km²), as of 2017

In recent years, **increased construction activity** and the associated increase in both impervious areas and the efforts of the Berlin Waterworks to **expand the sewerage network** into previously unconnected residential areas have resulted in new areas being connected to a sewerage system. This has been confirmed, too, by the most recent analysis, even though the methods used differ between the years 2012 and 2017. Overall, the share of areas connected to a sewerage system has risen by 2 % in the total built-up area.

Local rainwater management is becoming increasingly more important, which entails rainwater remaining directly on site and not being discharged. Only in case of difficult conditions (e.g. poor percolation properties), does this type of rainwater management require an additional, controlled discharge via drains. The distribution of this new type of rainwater management is not yet recorded in the current map "Type of Drainage". It will be considered, however, going forward.

When analyzing how the different systems are distributed across the municipal area, the following key areas emerge.

In the **inner-city areas** of Wedding, Tiergarten, Mitte, Prenzlauer Berg, Friedrichshain, Kreuzberg, Schöneberg, parts of Neukölln and Wilmersdorf, Westend and in the **old town of Spandau**, waste water and rainwater is drained together via the **combined sewerage system**.

Outer areas, including Reinickendorf, Pankow, Weißensee, Hohenschönhausen, Marzahn, Hellersdorf, Lichtenberg, Köpenick, Neukölln, Tempelhof, Steglitz, Zehlendorf, Spandau, and parts of Wilmersdorf and Charlottenburg are connected to the **separate sewerage system**.

In Berlin, the prevalent type of **separate sewerage system** is that of **rainwater drainage plus a sewerage system**. Areas with this type of system are mainly found in outer areas, in the new boroughs of Spandau, Reinickendorf, Pankow, Lichtenberg, Marzahn-Hellersdorf, Treptow-Köpenick, Neukölln, Tempelhof-Schöneberg and Steglitz-Zehlendorf, as well as some south-western parts of Wilmersdorf-Charlottenburg, a small area in the north-eastern part of Mitte, and the Stralau peninsula in the south-eastern part of Friedrichshain.

To reduce the load on the combined sewerage system in some parts of Wilmersdorf, Weißensee and Spandau, as well as some areas of Charlottenburg, along Schloßstraße, **rainwater sewers** were built

which **discharge into the rain overflow drains of the combined sewerage system**. There, sewage continues to pass through these combined sewers.

In areas with **sewerage systems without rainwater sewers**, rainwater percolation may be controlled or uncontrolled. These areas can be found at the outskirts predominantly in parts of Gatow, Kladow, Spandau, Staaken, Konradshöhe, Heiligensee, Frohnau, Karow, Adlershof, Biesdorf, Kaulsdorf and Köpenick.

The development of Category I old settlement areas (main areas to be connected to a sewerage system) has been completed (House of Representatives of Berlin 2009). The development of the Wartenberg settlement area was also completed in 2018 but is not part of the map. There are still further old settlement areas without sewerage systems. It was decided that the sewerage development of five of these areas (Biesenhorst, Buchholz Nord I, Schönholz, Karow Süd, Karow Ost) would be completed by 2030. The strategy for the remaining eight old settlement areas (Schmöckwitz-Werder, Schmöckwitz Schwarzer Weg, Neu-Venedig, Rahnsdorf-Süd, Siedlung Schönhorst, Siedlung Spreewiesen, Gatow Siedlung Habichtswald, Blankenfelde Altsiedlung) will be decided at a later stage.

What is more, there is still a variety of individual roads, that has not yet been connected to the central waste water treatment system either (gap closure areas). These will be developed successively. According to available documentation, there are also isolated plots of varied use (e.g. restaurants or sports facilities) outside settlement areas not yet connected to sewerage systems.

02.09.2 Catchment Areas of Rainwater Drainage

Depending on the main receiving water body, the catchment areas of rainwater sewers are found in the catchment areas of the **Spree and Dahme** rivers in the eastern and southeastern areas of Berlin, of the **Havel** river in the northern, northwestern and southwestern parts of Berlin, and of the catchment area of the **Teltowkanal** in the south of the city.

Lakes, park lakes, ponds and other blind drainage water bodies are spread over the entire area of the city.

Since within the **inner S-Bahn Circle Line**, the combined system prevails, and rainwater only rarely enters the water system, it has not been assigned to any rainwater drainage catchment area. The only exceptions are Tempelhofer Feld and parts of Wilmersdorf to the north of the urban motorway, which drain into the canals south of the Spree (the Neuköllner Schiffahrtskanal and the Landwehrkanal).

Tab. 2: Rainwater drainage into the sewer system - catchment areas and adjacent impervious area, as of 2017

Water body section number	Catchment areas by water body section	Total area [km ²]			of which impervious area [km ²]				of which adjacent to impervious area [km ²]			
		Block and block segment areas	Road	Sum	Buildings (built-up, impervious)	other impervious area (paths, parking areas)	Road	Sum	Buildings (built-up, impervious)	other impervious area (paths, parking areas)	Road	Sum
110	Oberhavel (city border to above mouth of Tegeler See)	3,0	0,4	3,4	0,6	0,4	0,4	1,4	0,3	0,2	0,3	0,8
120	Oberhavel (mouth of Tegeler See to Schleuse Spandau)	3,8	0,7	4,5	1,1	1,0	0,6	2,6	0,8	0,6	0,5	1,9
130	Tegeler See	2,2	0,4	2,6	0,7	0,5	0,4	1,5	0,5	0,3	0,3	1,2
131	Tegeler Fließ	5,5	1,1	6,6	1,3	0,7	0,9	2,8	0,6	0,3	0,7	1,6
132	Nordgraben	10,9	1,7	12,5	2,6	2,4	1,4	6,4	1,8	1,3	1,1	4,3
133	Panke north of Verteilerbauwerk	7,2	1,0	8,2	1,3	1,3	0,8	3,4	0,8	0,7	0,6	2,1
210	Unterhavel from mouth of Spree to Jungferensee (excl. Wannsee)	15,0	2,4	17,4	3,4	3,4	2,0	8,8	2,5	2,0	1,7	6,2
220	Großer Wannsee	2,6	0,4	3,0	0,4	0,3	0,3	1,0	0,2	0,1	0,3	0,6
230	Kleine Wannseekette	1,6	0,2	1,8	0,3	0,2	0,2	0,7	0,2	0,1	0,2	0,4
310	Müggelsee (including Großer Müggelsee, Dämeritzsee and Erpe)	7,4	1,2	8,6	1,6	1,4	1,1	4,1	1,1	0,8	0,9	2,8
320	Langer See, Dahme and Große Krampe	5,4	0,9	6,3	1,1	1,0	0,8	2,9	0,6	0,5	0,6	1,8
330	Stadtspree to Britzer Verbindungskanal branch-off	6,0	1,1	7,1	1,6	1,8	1,0	4,3	1,3	1,1	0,8	3,2
331	Wuhle	19,1	4,2	23,3	3,9	4,2	3,2	11,3	2,7	2,4	2,7	7,7
340	Stadtspree to Landwehrkanal branch-off	5,8	1,0	6,8	1,3	1,4	1,0	3,7	1,0	0,8	0,8	2,7
350	Rummelsburger See	8,8	1,7	10,5	2,4	3,0	1,6	7,0	2,0	1,9	1,4	5,4
351	Marzahn-Hohenschönhausener Grenzgraben	13,6	2,3	15,8	2,8	4,3	1,9	9,0	2,2	2,8	1,7	6,8
380	Stadtspree to Berlin-Spandauer-Schiffahrtskanal branch-off	5,5	1,2	6,7	1,6	1,5	0,9	4,0	1,3	0,9	0,8	3,0
390	Stadtspree to mouth	6,3	0,9	7,1	1,7	2,0	0,8	4,5	1,4	1,4	0,7	3,4
400	Canals north of Spree	6,3	0,7	7,0	1,3	2,4	0,6	4,4	1,1	1,9	0,5	3,5
401	Panke (from Verteilerbauwerk to Nordhafen)	14,9	3,4	18,3	3,8	3,6	2,7	10,2	2,9	2,1	2,4	7,4
500	Canals south of (Neuköllner Schiffahrtskanal and Landwehrkanal)	5,1	1,5	6,5	1,7	1,7	1,4	4,8	1,5	1,1	1,3	3,8
600	Teltowkanal	55,8	10,8	66,6	14,9	11,3	10,3	36,5	10,4	6,4	8,4	25,3
610	Rudower Arm	22,0	3,9	25,9	5,0	4,6	3,7	13,3	3,2	2,4	3,0	8,7
620	Britzer Verbindungskanal	2,5	0,5	3,0	0,7	0,6	0,5	1,8	0,6	0,4	0,4	1,4
810	Grunewaldseekette	9,3	2,2	11,5	2,4	1,6	2,1	6,0	1,7	0,9	1,7	4,2
820	Flughafensee	5,2	0,9	6,1	1,6	1,4	0,8	3,8	1,3	0,9	0,7	2,9
830	Biesdorfer Baggersee	4,0	0,7	4,7	0,8	0,8	0,5	2,1	0,4	0,5	0,4	1,3
840	Fauler See/Obersee	1,2	0,3	1,4	0,3	0,2	0,2	0,8	0,2	0,1	0,2	0,5
850	Schäfersee	2,0	0,4	2,4	0,7	0,6	0,4	1,7	0,6	0,4	0,3	1,3
860	Groß-Glienicker See	0,8	0,1	0,9	0,1	0,2	0,1	0,5	0,1	0,1	0,1	0,3
900	Small bodies of water (ponds, water holes, ditches)	16,9	3,0	19,9	3,4	2,5	2,7	8,6	1,9	1,2	2,1	5,3
	Separate sewerage, Total	275,5	51,2	326,6	66,4	62,2	45,0	173,7	47,3	36,7	37,7	121,7
	Combined sewerage	64,6	20,2	84,7	26,6	17,7	19,2	63,5	23,8	11,8	17,5	53,1
	Sum of all areas with rainwater sewers (combined and separate)	340,0	71,3	411,4	93,1	79,9	64,2	237,2	71,1	48,5	55,2	174,8

Tab. 2: Rainwater drainage into the sewer system - catchment areas and adjacent impervious area, as of 2017

Table 2 shows the total catchment areas for individual water body sections. Based on the 2016, most recent, mapping of the impervious soil coverage degree of block and block segment areas (cf. Environmental Atlas 01.02, SenStadtWohn 2017), impervious areas that lie within catchment areas may be identified for each individual catchment area. As already described, however, not all impervious areas within blocks and block segments that are considered to be equipped with drains are completely connected to the rainwater sewer system. [Table 1 of the text accompanying Map 02.13.1 "Surface Runoff from Precipitation"](#) (cf. Environmental Atlas 02.13.1, SenStadtUm 2013) was used to establish the **actual proportion of the impervious area connected**. This table contains generalized actual connection rates for the Urban Structure Types (Area Types), divided into buildings, roads and other impervious areas. In the Area Types in the outskirts, the connection rate amounts to only 30 % of the impervious area in part. The actual connection rates may vary considerably on site, but the figures provide some insight into the characteristic properties of the catchment areas.

[Table 5 of the text accompanying Map 02.13.1 "Surface Runoff from Precipitation"](#) shows the amounts of introduction into the Berlin waters, summarized by segments. Except for those quantities which at heavy rainfall flow through the emergency outlets of the pumping stations and through the rain overflows of the wastewater network, and then also flow directly into the bodies of water, the surface runoff in the area of the mixed system is passed to the sewage treatment plants, from where they are fed into the bodies of waters after appropriate sewage-treatment, together with the treated sewage.

The **Teltowkanal** has the largest catchment area of the rainwater drainage, with more than 95 km² (including the Rudower Arm). Its long-term average intake is 14 million m³ of rainwater from the separate sewerage system. It is followed by the **Wuhle**, with a catchment area of 23 km² and 3 million m³ of intake, and the **Panke** (downstream from the Verteilerbauwerk) with approx. 18 km² and also about 3 million m³ of intake. The area of combined sewerage accounts for some 84 km² and about 21 million m³ of rainwater are mostly discharged to the sewage treatment plants (cf. Environmental Atlas 02.13.1, SenStadtUm 2019).

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