Waterless urinal sheds in the inner city Hamburg, Germany

Fig. 1: Project location

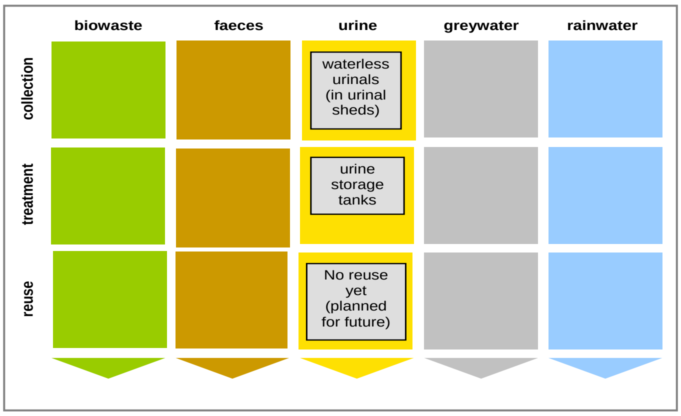

Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Large-scale urban public sanitation system

Project period:
Start of construction: 1996; public urinals since Jan. 2003
End of construction: 2006
Start of operation: February 2003 (ongoing, new constructions are planned)

Project scale:
Number of inhabitants covered: approx. 14,000 – 28,700 male users per week (11 public urinal sheds are the focus of this case study)
Total investment: approx. EUR 500,000 up to now (for 11 public urinal sheds)

Address of project location:
Various locations mainly in the city centre of Hamburg, Germany

Planning institution:
Environmental Protection Office at the Authority for Urban Development and Environment (BSU stands for Behörde für Stadtentwicklung und Umwelt), Hamburg

Executing institution:
District administrations of the Free and Hanseatic City of Hamburg

Supporting agencies:
None

2 Objective and motivation of the project

The main objective of the project was to optimise the quality of the public toilets in Hamburg and their surrounding areas while minimising the financial burden for the City of Hamburg at the same time. The aim was to achieve this goal while also minimising water and energy needs and protecting the environment.

3 Location and conditions

The Free and Hanseatic City of Hamburg has a population of 1.7 million within an area of 755 km². It is the second biggest city in Germany after Berlin (and is also one of Germany's 16 federal states) and was the first city in Germany with a formalised strategic concept for its public toilets.

Hamburg is located in the North of Germany. The river Elbe is flowing through it and leads 110 km downstream into the Northern Sea. Hamburg has the largest port of Germany and is the 2nd largest container trans-shipment centre in Europe. The high groundwater level as well as the tides have to be taken into account for new constructions. Moreover, due to massive destruction in 1945 during the Second World War its underground consists mainly of debris which also influences construction activities.

Fig. 3: A highly frequented public urinal for male pedestrians at the Hansaplatz in Hamburg. Note semi-transparent walls – a user inside is just visible (source: M. Winker, Nov. 2009).

The main driver for introducing improved public toilets in 1996 was the continuously increasing costs for the management and operation of the public toilets in Hamburg. Their appearance and equipment was completely insufficient. The maintenance by private caretakers was only rarely undertaken in an appropriate manner. Of the 207 existing public toilets only 132 were actually open to the public.

4 Project history

In 1994 the BSU performed an overall evaluation of the situation and developed a general concept for the construction and maintenance of the public toilets in order to reduce annual operation and maintenance costs (in 1994, BSU had annual costs of EUR 1.4 million for its public toilets).

Based on this evaluation, the BSU decided to provide public toilets at places which have many passers-by, are attractive for tourists, or at social hot spots[1], as well as at places protected from vandalism.

Four management models were developed: a) toilets in combinations with kiosks, b) automatic high-tech toilets which included recycling of their flush water (up to 50 times), c) toilets integrated in properties of the public transport systems, and d) toilets in public administration buildings close to market places. Retrofitting started in 1996. Due to this new management scheme approx. 55 toilets remained under the direct management of BSU (15 of them run only seasonal at lakes etc.) and approx. 39 remained under the management of the districts as they are placed in areas such as market places in the districts.

In certain areas it was not possible to establish one of the four described management options of the concept as nobody was willing to run the public toilet, because the area was a social hot spot where abuse and vandalism would be a problem, or due to high frequencies in short times (such as close to the main soccer stadium).

For these locations, the BSU developed the concept of public **“urinal sheds”** with a high transparency of the inside activities, and these urinal sheds are the focus of this case study.

A first pilot urinal shed was built at Hansaplatz (a social hot spot) in 2003. After one year with excellent experiences (good acceptance and high frequency of users, visible improvement of the surrounding environment), BSU decided to set up further urinal sheds in an improved version in other locations (11 such urinal sheds are currently in use).

The users of the urinal sheds are any male pedestrians, visitors, tourists and so on and also many homeless men and late night (often drunk) partygoers since many of the urinal sheds are in the amusement areas (red light district) of Hamburg.

5 Technologies applied

All urinals installed in Hamburg’s public toilets are waterless urinals (instead of conventional water flushed urinals which use 4-6 L per flush). There are 1,200 public toilets in Hamburg (an unusually high number for a city, probably owing to the public toilet strategy of Hamburg). It is not known exactly how many urinals are installed in these public toilets but a typical number of urinals in one public toilet is one (for trough urinals) to five (for wall-hung urinals). All of these waterless urinals in Hamburg have the Keramag flat rubber tube system for odour control.

In 11 locations, public **“urinal sheds”** were installed with a similar appearance to bus stops (these sheds are locally called “pissoirs”).

Fig. 4: Public urinal shed with waterless urinal trough at Hansaplatz, Hamburg, showing semitransparent walls (source: P. Grönwall, 2003).

In the sheds there are urinal troughs with a stainless steel drain and an integrated **Keramag flat rubber tube for odour control** (see Section 6 for details). The material for the urinal troughs is marble powder. The trough is designed in a very massive and solid way to prevent vandalism.

Fig. 5: Glassfibre reinforced plastic (GFP) tanks for urine storage before installation (volume 2.5 m3). These tanks are buried next to the urinal shed (source: P. Grönwall, 2003).

At these 11 urinal sheds, there are also **urine storage tanks**:
- At Hansaplatz there is one underground GRP (glass fibre reinforced plastic) storage tank (volume 2.5 m³) covered by a concrete slab.
- At other 10 locations: optimised underground GRP tanks (2.5 m³ each) containing two GRP layers and a layer of polymer concrete in between to improve the hardness of the tanks and to avoid the need for a concrete slab above the tank (vehicles can now drive over or park on the tank).
- The tanks are equipped with a floating device measuring the urine level in the tank.

[1] A social hot spot in the context of Hamburg means areas with high unemployment

The urine storage tanks are strictly speaking not necessary, as all the urinal sheds are connected to a sewer and centralised wastewater treatment plant. It was decided to install them anyway for three reasons:

1. There was a fear that the pure urine from the urinal shed may cause damage (corrosion) to the local sewer pipe.
2. It is possible that in the future agricultural reuse of urine may become economically feasible.
3. Also in the future, the urine may be treated separately for nitrogen removal or struvite production.

6 Design information

The public urinal sheds have a waterless urinal trough produced by a local craftsman. The troughs are placed at a height of 40 cm and are 2 m wide so that three men could urinate comfortably next to each other. The depth of the trough is 25 cm. The corners of the trough are rounded to ease cleaning.

Fig. 6: A urinal trough (2 m width) before installation, made of marble powder (source: P. Grönwall, 2006). The outlet in the middle has a Keramag flat rubber tube for odour control, see photo below.

The urinal trough is placed inside a semi-transparent bullet-proofed glass and steel construction (2.5 m x 2 m, height: approx. 2.3 m) which has an appearance similar to a bus stop. The walls are positioned in a way that nobody can see inside while men are urinating, but they are also purposefully semi-transparent for prevention of misuse and vandalism. The design as well as installation (except earthwork) was carried out by Decaux.

The locations of the public urinal sheds were selected by BSU in cooperation with the respective district and the police.
The shed is placed on a concrete floor which contains a floor drain. This avoids infiltration of spilled urine into the ground and the resulting smell.

The drain of the trough is located in the trough's centre and is designed so that it is impossible to take it out with common tools (to avoid vandalism) but it can be easily taken out with a specialised tool by the maintenance staff.

To prevent odour from the sewer (or urine storage tank), a **flat rubber tube** is fitted to the outlet pipe. This rubber tube, supplied by the German company Keramag, is flat at the bottom when not in use (and hence blocks odour from the sewer or urine storage tank) but opens up when urine is flowing through it. The same odour seal is also used in Keramag's waterless urinals of the model "Centaurus" (see Section 14 for supplier's details).

Below the trough is a lever to direct the urine into either the sewer or to the underground urine storage tank. Therefore, the cleaning staff can direct cleaning water into the sewer to keep the urine in the tank clean and undiluted. The pipes are plastic wastewater pipes and are laid with a slope of 2%.

The urine tanks are made of glassfibre reinforced plastic (GRP). They have an overflow to the sewer if they are not emptied by pumping the urine to a tank truck (see Section 10 regarding frequency of tank emptying). The inlet pipe goes down to the bottom of the tank to avoid ammonia and odour emissions from the liquid's surface. The tank does not have any ventilation.

It was not economical to use bigger tanks or more than one tank per urinal shed due to the high groundwater level and the presence of debris in much of the city area: The costs of earthwork would increase dramatically. A depth of 3 m is required for the tanks which was difficult to achieve in many locations, as the space is already occupied by other underground service pipes and cables.

In total about **20-30 m³ of urine is collected per month** (from all the 11 urinal sheds). This number was estimated by monitoring 9 of the 11 urinal sheds in winter between December 2008 and March 2009 (Goldhammer, 2009, see Section 13 for details). The average monthly amount of urine collected might be even higher when the summer months are taken into considerations where more users can be expected.

If we assume 200 mL of urine is excreted per use and each male client uses the urinal shed only once on a given day, we can estimate that **4200 users** frequent the 11 urinal sheds per day. On the other hand estimates performed by Goldammer (2009) result in **approx. 2000 users** per day for all sheds.

Fig. 7: Odour seal for waterless urinals: flat rubber tube from Keramag, model Centaurus. Left: clean tube (source: E. v. Münch, 2007)[2]; right: used, unclean tube (source: P. Grönwall, 2006).

[2] For more information about this type of odour control for waterless urinals see publication: Technology review on urine diversion components by v. Münch and Winker (GTZ) on http://www.gtz.de/en/themen/umwelt-infrastruktur/wasser/9397.htm

The collected urine varies widely by location. For example 5 m³ per month of urine is collected at the urinal shed at Hansaplatz, whereas only 1 m³ per month is collected at the urinal shed in Neddelfeld.

There are no handwashing facilities at these urinal sheds, which is a drawback from a hygiene point of view, but is due to fear of vandalism and abuse (such as letting the water flow uncontrolled) – as the urinal sheds are not manned.

7 Type and level of reuse

Currently no reuse of urine in agriculture is taking place in Hamburg. However, in many of Hamburg's public toilets, separate pipes from the waterless urinals are already installed which would enable future separate collection of urine if there was a driver for reuse of urine (such as for example increased fertiliser prices).

As part of a research project in 2009, urine samples were analysed for nutrients and pathogens from seven urine storage tanks of the public urinals (results shown in Table 1 and Table 2). The aim of this research was to check the suitability of urine for use as a fertiliser.

Table 1: Average values of the measured parameters in the urine samples (source: Goldammer, 2009). (approx. 60 samples)

Parameter	NH_4^+-N	P	K	SO_4^{2-}
Concentration (mg/L)	3680	263	859	410

Table 2: Range of values for two pathogenic indicators in urine samples. (source: Goldammer, 2009).

Pathogen	**Range of CFU/100 ml**[a]
Streptococcus	400 – 4,000
Staphylococcus	10,600 – 1,288,200

[a] CFU stands for colony forming unit and represents (via the number of colonies) the amount of pathogens present.

The nitrogen concentrations in the collected urine are only one third of the expected (literature) values. The reason for this is unknown, but is probably due to ammonia losses via gaps between the tanks and tank lids (rainwater or groundwater entering the tanks is deemed to be unlikely).

The pathogenic contamination of the urine is surprisingly high, indicating that some users abused the troughs for defecation or for vomiting.

8 Further project components

There are no further project components.

9 Costs and economics

One urinal shed has investment costs as shown in Table 4. The most expensive part in the construction is the earthwork caused by the difficult situation of Hamburg's underground: the amount of debris from the Second World War and all the telephone and TV cables, gas, water, and wastewater pipes, supply for subway and many others (as these are inner city locations).

The above ground installations are also rather costly as they are constructed with very robust materials according to German security standards for public areas and to reduce vandalism.

Table 3: Investment costs for one urinal shed.

Item	**Costs (EUR)**
Subsurface installations	25,000 – 45,000
Installations above ground	10,000
Sum (average)	**40,000**

[a] Subsurface installation includes pipes, pump sump, installation of the tank (cost per tank: EUR 4,000-5,000) and digging.
[b] The item with the highest cost is the waterless urinal trough: EUR 3,000.

The annual maintenance costs are **EUR 9,500** per public urinal shed. The city has a contract with the company Decaux who is paid for this service. Information regarding the replacement of spare parts are not available as they are paid directly by Decaux. This service includes daily cleaning and maintenance (at some urinal sheds even twice a day) which takes normally 30 min per urinal shed (this equates to 183 hours per year at EUR 52 per hour, all inclusive).

With the implementation of its new management concept for public toilets (which includes the public urinal sheds), the BSU could reduce its annual costs by half (compared to their costs before which were EUR 1.4 Mio in 1994). This is due to the fact that they only have to pay for those public toilets which are still under their direct supervision (approx. 55) for cleaning agents, toilet paper, water, heating, telephone, energy and staff which amounts up to EUR 631,000 per year.

Tenants of public toilets usually have to pay a small rent depending on their annual turnover to the local district. In 8 public toilets (in highly frequented and touristic areas) turnstiles are installed. Single use costs EUR 0.50 which result in an annual income of EUR 350,000.

10 Operation and maintenance

The above ground construction as well as the daily maintenance, cleaning, checking and replacement of broken equipment was/is carried out by the company Decaux.

The staff of Decaux take out the drains once per day and rinse the Keramag flat rubber tubes with water. When this is done on a daily basis, urine stone precipitation along the inlet and one the rubber tube is prevented. The rubber tube is replaced once a year. The maintenance personnel comes with its own truck containing a water tank as now water connection is provided in the sheds.

The district is responsible for the emptying of the urine tanks (which hold 2.5 m^3). To do so, private companies are engaged. The urine tank emptying takes place typically once per month, and twice per month at Hansaplatz. Not all districts constantly follow this practice. Odour problems during the emptying do not occur. The urine is brought to the wastewater treatment plant of Hamburg.

Additionally, it is the districts' responsibility to check the urinal sheds on a regular basis and to react in the case of problems with the service of Deceaux.

The overall supervision and control lies in the hand of BSU who also carries out checks on a regular basis (each public toilet and urinal shed is checked 3-5 times per year). BSU is also in charge of any further optimisation of the urinals.

11 Practical experience and lessons learnt

Overall, a high acceptance of these public urinal sheds has been observed as well as the appearance of the surrounding area improved dramatically. Before the establishment of the urine sheds there was a urine smell in the air. Only in some occasions females complained about the missing "decency" but could be convinced of the benefits of such urinal sheds.

A key factor to prevent public toilets and urinal sheds from being destroyed by vandalism lies in the social control. Hence, the higher the transparency (of what is going on in the urinal shed) and the more (indirect) surveillance, the less likely is vandalism and destruction to occur.

The amount of vandalism and destruction of the urinal sheds is low, although graffiti spraying occurs every now and then. Also the urinal sheds are sometimes abused for vomiting or even defecation, or deposition of empty bottles and other rubbish. This is difficult to avoid. Only one urinal trough has been destroyed so far since the establishment of the first urinal shed in 2003.

Fig. 8: Vandalism and abuse in one of the urinal troughs which led to blockage of the drain pipe (source: P. Grönwall, 2008).

Urine stone incrustations and precipitation have not been observed so far. The urinal sheds cannot be checked directly. But a regular visual check is done in one of the public urinals (called Rotunde located next to the main train station). No precipitation in the pipes was observed there since the system started six years ago. Hence, the collection of urine without wasting water for flushing has been shown to work successfully.

The cleaning staff sometimes does not switch the lever back after they have cleaned the urinals: In this case urine flows directly into the sewer instead of being collected in the storage tank. Additionally, the levers are placed in the middle directly below the trough which is uncomfortable for the cleaning stuff to operate (see Fig. 9). For future urinal troughs it is planned to place the lever at a location that is easier to reach. As authorities do not have a real incentive to have the tanks emptied by tanker, it is tempting for them to let if go via the overflow to the sewer.

Fig. 9: This hatch provides access to a lever to direct urine from the urinal trough either to the sewer or to the urine storage tank (source: P. Grönwall, 2006).

12 Sustainability assessment and long-term impacts

A basic assessment (Table 4) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects were not emphasised (weaknesses).

Table 4: Qualitative indication of sustainability of system. A cross in the respective column shows assessment of the relative sustainability of project (+ means: strong point of project; o means: average strength for this aspect and – means: no emphasis on this aspect for this project).

	collection and transport			treatment [a]			transport and reuse[a]		
Sustainability criteria	+	o	-	+	o	-	+	o	-
• health and hygiene	X								
• environmental and natural resources	X								
• technology and operation	X								
• finance and economics		X							
• socio-cultural and institutional	X								

[a] Not included in this project.

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Sustainability criteria for sanitation:
Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.
Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.
Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.
Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, such as from fertiliser and the external impact on the economy.
Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

Long-term impacts of the project are:
1. An improved hygienic situation in areas surrounding the public urinal sheds, especially odour from urine could be reduced.
2. Water savings are achieved (and related energy savings although this has not been quantified yet): 100% for public urinal sheds compared with conventional water flushed urinals.
3. Demonstration of a public toilet solution which is water saving.
4. A sustainable management scheme of the urinal sheds' operation and maintenance has been developed.
5. Inclusion of an additional option in the public toilet concept of the City of Hamburg which is well accepted and used by the different groups of people present in the centre of the city.

13 Available documents and references

- More **photos** are available here: http://www.flickr.com/photos/gtzecosan/sets/72157622651533713/
- Environmental Protection Office (2006-2008). Three press releases are available in German: http://www2.gtz.de/dokumente/oe44/ecosan/de-pressemitteilungen-zu-den-wasserlosen-urinalen-in-hh-2008.pdf
- Genath, B. (2010). Trinkwasser kein Vehikel für Abfalltransporte (Drinking water is no appropriate media for waste transport.) Georg Siemens Verlag. Installation DKZ, 11-12, pp. 2-8. http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=1182
- Goldammer, N. (2009). Potential for flow separation in Hamburg, determination of actual concentrations and loss of nutrients (in German: „Potenzial der Teilstromerfassung in Hamburg, Ermittlung realer Konzentrationen und Untersuchung von Nährstoffverlusten". Diploma thesis at Hamburg University of Technology, Germany. Available from: Felix Tettenborn.
- Keramag AG (2006). Hamburger Michel: Wahrzeichen mit wassersparender Sanitärtechnologie. *IKZ-Haustechnik* Heft 24, S. 62-64. http://www2.gtz.de/Dokumente/oe44/ecosan/de-Hamburg-Keramag-2006.pdf

14 Institutions, organisations and contact persons

Authority for Urban Development and Environment (BSU), Environmental Protection Office - role: Project owner (and also involved in planning and installation)
Billstraße 84
20539 Hamburg, Germany
Main contact person: Peter-Nils Grönwall
E: Peter-Nils.Groenwall@bsu.hamburg.de
I: http://www.hamburg.de/bsu

Several district authorities of the Free and Hanseatic City of Hamburg – role: planning and installation

JCDecaux Deutschland GmbH - role: service for maintenance of public urinals
Grusonstr. 46
22113 Hamburg, Germany
E: hamburg@jcdecaux.de
I: http://www.jcdecaux.de/hamburg.html

Institute for Wastewater Management & Water Protection, Hamburg University of Technology – role: scientific support
21071 Hamburg, Germany
Contact: Felix Tettenborn und Joachim Behrendt
E: tettenborn@tuhh.de und j.behrendt@tuhh.de
I: www.tuhh.de/aww

Company Haase GFK-Technik GmbH (supplier for urine storage tanks made of glassfibre reinforced plastic)
Adolphstraße 62
01900 Großröhrsdorf, Germany
I: http://www.ichbin2.de/

Keramag AG (supplier of flat rubber tube odour control)
Kreuzerkamp 11
40878 Ratingen, Germany
Contact: Roland Herkt
E: info@keramag.de, Ronald.Herkt@Keramag.de
I: www.keramag.de and http://pro.keramag.com/Home.english.0.html (search database for keyword Centaurus)

Waterless urinal sheds in the inner city Hamburg, Germany

Case study of SuSanA projects

Waterless urinal sheds in the inner city, Hamburg, Germany

SuSanA 2010

Authors: Martina Winker (GTZ), Peter-Nils Grönwall (BSU)

Editing and reviewing: Elisabeth von Muench (GTZ, ecosan@gtz.de), Felix Tettenborn (TUHH)

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