WASTE MANAGEMENT FOR INLAND NAVIGATION ON THE DANUBE

Monitoring Report

Work Package 4: Implementation of Pilot Actions for Ship Waste Management

Activity 4.3: Implementation of Pilot activities for hazardous ship waste

Output No: 4.33 Monitoring Report bilge water service Upper Danube

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Preparation of Document: 2012-03-09

Version: Final Version

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0 SCOPE OF DOCUMENT

Within this report monitoring of the implementation of a mobile bilge water service on the Upper Danube stretch is undertaken. It is the aim to provide basic information and data for future development of ship waste management and harmonized planning of activities. Based on the research results of WP 3 national legislation and the current situation for the collection are described. Data while implementing these pilot activities were collected and will be further described to point out advantages and disadvantages of using a mobile collection service. Finally pilot activities are assessed referring environmental impacts, costs, user friendliness and future practicability.

1 INTRODUCTION - PILOT ACTIVITIES – MOBILE BILGE WATER SERVICE

In 2011 a **mobile bilge water collection vessel** was operating for a duration of 44 days in Austria and Hungary for the first time ever gathering **data for the first time as well as rising awareness** of the inland navigation business. These data serve as a basis for the assessment of **different scenarios for the management of oily and greasy ship waste** and shall prepare the decision about the future development of ship waste management in Austria (mobile services, onshore facilities or a combination).

Bilge water is defined as oil contaminated water from the bilge of naval vessels (WVO idgF §9.01). The bilge is the area at the back of the vessel, below the motor. Bilge oil is water resulting from cleaning procedures or leakages of the body shell and gets contaminated with oil, gas or grease (Bilgenentwässerungsverband 2009). The amount of bilge water is influenced by the age, construction, equipment and maintenance of the vessels.

The legal framework for obtaining permissions of pilot activities comprises regulations according to navigation right, waste management right, water right and environmental right (see also Chapter 3 ‘Legal Framework’).

Through implementing the pilot activities the following goals were aimed:

- Reducing potential risks due to illegal dumping by offering a waste reception service free of charge
- First time data gaining of the acceptance of such a service realized by the inland waterway transport along the Danube and development of a feasible offer for waste reception
- Rising the awareness of such a topic within the international operating navigation

1.1 AS-IS ANALYSIS OF BILGE WATER SERVICE IN AUSTRIA

In Austria, the disposal of bilge water is possible by calling suction vehicles. This service is provided in some ports. In case of public ports, the costs for this services are included in the port fees, but only from vehicles which use the port regularly for turn over (Schifffahrtsgesetz idgF 2009, § 68). For private ports there are actually no defaults for financing, so that plant operators can charge services such as the assumption of wastes separately. Only in cases of emergency and winter conditions regulations for public ports are also valid for them (see navigation law idgF 2009, § 69).

Additionally, to the above described bilge water disposal services, the **DDSG** (Donau-Dampfschiffahrts-GmbH), which is the biggest company for freight transport in Austria and has a fleet of more than 50 motorized vessels registered in Austria, operates its own waste disposal facility, which is a stationary pontoon moored in Linz. Several hundred m³ of bilge water per year are collected and treated by gravity based oil separation. However, an upgrade of both equipment and technology is planned.

The current situation of ship waste management, which has remained unchanged for the last 10 years in Austria, has been assessed in 2000 and again 2004, several scenarios have been investigated and the implementation of a pilot test of a mobile waste collection vessel for bilge water has been recommended. Also, cooperation in the Upper Danube Region has been recommended, in order to achieve a unified, cost-efficient approach.

During the WANDA project, the implementation of a mobile waste collection vessel, which could provide its services beyond national borders, became possible.

In **Hungary**, oily and greasy ship waste can be disposed by ordering a **suction truck** of a licensed waste management firm into a port or by using the services of the Green Terminal of the National Public Port of Baja. The **Green Terminal**, constructed by a state contribution, was opened right for the implementation of WANDA pilot actions (the opening ceremony took place on 18th May 2011). This facility not only collects ship wastes (including oily and greasy materials which are considered as dangerous goods) but also allows of their handling, processing and recycling on the spot or a short way off. In the Green Terminal among others the collecting and professional handling of solid and liquid wastes is possible, as well as the selective collection of other ship wastes, handling of recyclable wastes and water and electric current provisions for ships.

During the second run of the mobile collection vessel, **a combination of the two systems (mobile and stationary facilities)** was carried out when 'Bilgenentöler 8' entered the Green Terminal and delivered oily and greasy waste collected on the Hungarian Danube stretch.

1.1.1 Existing collection Experiences

The Danube Region and the Rhine region are different in terms of socio-economic data. This is not only true for the economic power, but also for fleet characteristics, traffic volumes and available waste disposal services. The data given below are based on results of the existing col-

lection system in Germany[1], and serve as a reference point for the data gathered during the implementation of the pilots in the Upper Danube Region.

- 2,4 – 3 disposal services per ship and year
- The amount of collected bilge water per service has a very high range of fluctuation, which varies from 50 litres up to 30,000 litres. The average amount for the year 2002 is about 3,200 litres for one bilge water service.
- The average amount of waste oils, collected together with bilge water ranges between 100 and 125 liters per service[2]. If the whole oil is changed, the amount can be up to 500 liters (twin-engine vessel).
- The amounts of other oily and greasy ship waste collected are between 10 and 20 kg/service.
- Other hazardous wastes are produced sporadically, the amounts are rather low. However, the range for other hazardous wastes can be estimated between 5 and 10 kg/service.

An overview about different types of vessels and the average amount of bilge water is given in Table 1 based on gained experiences of the Rhine region.

Type of vessel	**Average amount of Bilgewater [m³/service]**
Motorized cargo vessel	3,7
Tanker ship	4,0
Push boat	3,5
Passenger liner	1,8

Table 1: Average amount of bilge water for different types of Vessels (BEG, 2003)

The oil content of the bilge water averages at 14.3 % (push boats: 16.7 %), the fluctuation range varies from 5 % und 15 %. Potential bilge water amounts have been estimated and projected.

According to the experiences of the Bilgenentölungsgesellschaft, the average discharged oily bilge water quantity is approx. 3 - 4 m³/ship/service. The quantity of the oily bilge water on board of ships depends on different factors. The most important of them are the followings:

- The age of the ship
- The maintenance level of the ship
- The technical condition and quality of tank shaft sealing (PHARE, 2000)

[1] In Germany the existing system is a combination of mobile bilge water collection vessels and stationary components. More information can be gathered at http://www.bilgenentoelung.de/index.htm and http://www.bilgenentwaesserung.de/.

[2] The frequency in Germany is between 2,4 – 3 disposal services for bilge water per ship and year. More information can be found in Output 4.1 Concept Paper Bilge Water Austria.

2 IMPLEMENTATION OF PILOT ACTIVITIES

In summer 2011 the implementation of a mobile bilge water collection service on the Upper Danube Stretch within the WANDA project was undertaken. A detailed map of the project area can be found in the appendix.

Therefore several scenarios for mobile, stationary and combined collection services for oily and greasy ship waste have previously been investigated, intensively discussed and assessed already from the projects start[3].

Out of the following three alternatives, the usage of a mobile bilge water collection vessel (Alternative A1) was chosen for subsequent implementation:

- **Alternative 1** (A1): The collected bilge water will be separated on board of the collecting vessel. The cleaned water will be charged into the Danube River. The separated waste oil will be disposed on land in cooperation with waste management companies.
- **Alternative 2** (A2): The collection of the bilge water shall be done by a collecting vessel. The incurred bilge water as well as the disposal of waste oil will be carried out on land through specialised waste management companies.
- **Alternative 3** (A3): Transport vessels will get the possibility to dispose their bilge water in appropriate ports free of charge along the Danube.

After a tendering procedure, which was won by a German company, and gathering of all necessary permissions a mobile waste collection vessel – the " Bilgenentöler 8" operated on the Austrian and Hungarian stretch in two periods in 2011. In Slovakia, the operation of this vessel was not possible[4].
The first trip of the mobile waste collection vessel in the Upper Danube region took place between Linz and Budapest during June 2011 (27.05.-16.06.2011). During the second implementation in September 2011 (06.09.-30.09.2011), the area of operation was extended downstream to the Hungarian – Croatian border (Mohács). Hence, for the first time ever, a stretch of app. 700 river kilometres was served with waste collection services.

[3] See Output 4.7 – Implementation Concept bilge water service Upper Danube Region

[4] As an alternative, an international conference was organised and a brochure edited by Water Research Insitute Bratislava in August 2011, focussing on the situation of SK ship waste management.

In order to get data about the most frequent places for waste delivery, the following **Danube sections** were defined:

Table 2: Sections for Monitoring on the Austrian and Hungarian Danube

Austrian Danube		
Section	from river km	to river km
Jochenstein - lock Ottensheim (above)	2203,33	2146,82
Linz (below lock Ottensheim – above lock Ab-winden)	2146,82	2.119, 54
Enns (below lock Abwinden – above lock Wallsee)	2.119,54	2.095,06
Below lock Wallsee - lock Persenbeug	2.095,06	2060,42
Ybbs (below lock Persenbeug- above lock Melk)	2060,42	2038,06
Melk (below lock Melk - Krems)	2038,06	2005
Krems	2005	1990
below Krems – above lock Greifenstein	1990	1.949,20
Wien (below lock Greifenstein)	1.949,20	1910
below Wien – country border	1910	1880,2
Hungarian Danube		
Section	from river km	to river km
Esztergom	1880,2	1718,52
Route Esztergom-Budapest International Port	1718,52	1645,7
Budapest-Csepel	1645,7	1640,5
Budapest - Mohacs	1640,5	1450
Route Budapest-Esztergom	1640,5	1718,2
Komaron	1718,2	1768,15

The pilot action was realized by a German company, the 'Bilgenentölungsgesellschaft mbH' (**BEG**) that operates collection vessels for oily and greasy ship waste in Germany. Operators of boats on the Upper Danube were informed about the pilot action by RIS (notices to skippers), leaflets, emails and personal contacts, e.g. at lock Persenbeug in Austria. For using the service a **booking** had to be made via phone, where time and place for the waste disposal service was set in advance.

The mobile collection vessel offered its service at the following timeframes at different locations:

Table 3: Location and date of the mobile bilge vessel operation

Location	Date	
	1st run	2nd run
Linz	28.5.-29.5.2011	6.9-7.9.2011
Grein	30.5.2011	8.9.2011
Melk	31.5.2011	9.9.2011
Vienna	01.6.-03.6.2011	10.9-11.9.2011
Esztergom	05.6.2011	-
Komárom	09.6.2011	13.9.2011
Budapest (city center)	05.6.-08.6.2011	14.9-15.9.2011
Budapest – Csepel Freeport	-	16.9-17.9-2011
Dunaújváros	-	18.9.2011
Mohács	-	19.9.2011
Baja	-	20.9.2011
Budapest	-	21.9.2011
Győr-Gönyű	-	22.9-23.9.2011
Bratislava	10.6.2011	-
Vienna	11.6. -12.06.2011	24.9-26.9.2011
Korneuburg	13.6.2011	-
Krems	14.6.2011	27.9.2011
Wallsee	15.6.2011	-
Melk	-	28.9.2011
Linz	16.6.-17.6.2011	29.9-30.9.2011
Passau	18.6-19.6.2011	-

The service included the disposal of **bilge water**, used **oils** and other **solid oily and greasy ship waste** such as rags, filters, bins etc. free of charge. After the disposal of waste, a confirmation into the oil control book was given. If there was no oil control book on board, the skippers received a certificate for approvement of waste disposal according to the rules.

In the following chapter a detailed description of the used bilge water collection vessel and its treatment plant for the bilge water is given.

2.1 TECHNICAL DESCRIPTION – 'BILGENENTOELER 8'

Length: 38,95 m
Gauge: 6,44 m
Loading capacity: 207 t

Technical Equipment: Main Engine: 368 KW (500 HP)
Generator: 70 KVA
Crane: 750 kg carrying capacity

Waste treatment plant: oil separator and an ultrafiltration system (description see below)
Nautical equipment: radar, radio, AIS etc.

Figure 1: Mobile Bilge Water Vessel - Bilgenentoeler 8 (via donau, 2011)

2.2 TREATMENT OF OILY AND GREASY SHIP WASTE

For the treatment of the collected bilge water a double stage cleaning procedure was undertaken. In the first step an oil separation under the force of gravity is made, followed by ultrafiltration. Due to this method a residual content of oil with less than 1ppm is reached in 90 percent of cases. The content of water of the remaining oil accounts about 20 to 30 percent.

1st step: Gravity based oil separation: The sucked off bilge water is separated into an oil and a water part within the oil separator, which had a total volume of 16m³. The majority of contain-

ing oil is already eliminated within the first separation chamber (out of 7). The separated oil floats and is afterwards channelled into the oil tanks. The remaining oil-water-mixture – after several stages of separation – is transferred to the ultra filtration system.

2nd step: Ultrafiltration: The remaining oil-water-mixture is transferred trough a membrane under high pressure and flow velocity. The remaining water is discharged into the river system with less than 1ppm remaining oil content in 90 percent of cases. Also a control system for misting and exceeding 7-8 ppm limits is installed, which immediately stops the discharge.

3 LEGAL FRAMEWORK

In **Austria** the legal framework for obtaining permissions of pilot activities comprises regulations according to navigation right, waste management right, water right and environmental right. Details about the necessary permissions and authorities are provided in Output 4.22.

According to **Inland Waterway Regulation (WVO)** a mobile bilge water collection vessel is allowed to discharge cleaned water, if the oil content doesn't exceed 10ppm. This permission is limited however according to which in ports and locks reaching in is forbidden. (Source: WVO idgF 2009; §9, 11, 12)

According to the **waste management right (AWG)** a bilge boat is a waste collector and therefore permission for the collection and transport of hazardous wastes issued by the provincial governor was necessary. After examination by the Austrian Ministry for Environment, the German permission for waste collection was accepted to be valid in Austria.

The bilge boat also provided a plant for waste treatment, namely the 2 step separation process; for which a permission had to be gained (AWG, §52). This permission was issued by the provinces of Upper Austria and was valid in the whole country.

However, the issued permissions did not cover the discharge of the cleaned water back into the waterway, for which the **Austrian Water Right** (WRG) had to be considered. In contrast to the waste management procedures, which are issued once and then are valid for the whole country, the water right foresees a decentralised approach[5]. Subsequently, the three provinces of Upper Austria, Lower Austria and Vienna were informed and consulted. In Vienna and Lower Austria it was possible to complete the requested procedures within the time frame and obtain the necessary permissions. In Upper Austria no permission could be gathered during the timeframe foreseen for the preparation of the pilot actions.

[5] Exemptions exist. In some cases, the Federal Ministry for Environment can be the responsible authority; however, this was not the approach chosen by the authorities.

During the consultation processes, several experts assessed the planned pilot trials. Moreover, in Lower Austria, a public hearing was held which had about 20 participants. After some requests and clarifications, certain requirements for the pilot trials were imposed, however, all in all the aim of the pilot actions was supported by the authorities.

Concerns mainly were stated with regards two limit values (COD and TOC) , for which the onboard treatment technology could not guarantee the foreseen limit values, which are in fact foreseen for onshore treatment plants. However, no harmful impacts to the ecosystem of the Danube were expected, rather, the treatment onboard was expected to have positive impacts compared to a situation, where no disposal services are available.

In case, the bilge water vessel wanted to go beyond the national border without any delivery of collected wastes before, the provisions of "**EEC Regulation on movement**" (EEC 1013/2006) is striking and a so called "notification" has to be gained. However, the BEG decided to hand over the collected waste every time before passing a national border. Hence no notification process was necessary.

Furthermore also the **Commercial Law of Navigation** and the **Trade Law** had to be considered. For the limited duration of the pilot actions no separate permissions were necessary.

In **Hungary**, three kinds of permissions have to be considered when implementing pilot action for ship waste management by a waste collection vessel.

- **Notification of transboundary shipment of dangerous wastes:** This notification has to be obtained if dangerous waste is transported across borders. A request has to be made and a charge has to be paid by a Hungarian legal person responsible for the transportation, stating all data of the shipment and the collection of wastes (types, estimated amounts, etc.). The authority in charge is the **National Inspectorate for Environment, Nature and Water** (OKTVF). By the decision of the project partners in charge (via donau and KTI) not to ship the collected waste from Hungary to the Slovak Republic (and Austria or Germany) this notification hadn't had to come into force.
- **Permission for waste management:** In order to implement the operation of a mobile collection vessel, permission from the national or regional inspectorate for environment is required. However, due to the fact that this was the first mobile waste collection on the Hungarian Danube stretch, the authorities will use the pilot action as a case study as basis for future resolution of competences and internal procedures for this kind of activities.
- **Permission for navigation and carrying out pilot action for ship waste management along the Danube:** Providing all information related to the shipment (data and documents of the vessel, journey etc.) and paying the charge, the **National Transport Authority** (NKH) granted the permission and published a Notice to Skippers (for further explanation see also Output 5.19 (RIS) about the operation of 'Bilgenentöler 8' in Hungary. In the second permission, it was stated that a waste collection vessel may use the ser-

vices of the Green Terminal in the National Public Port of Baja, which made the combination of two WANDA pilot actions possible.

4 OUTCOMES / RESULTS

Within the following section data of the implemented mobile bilge water service on the Upper Danube stretch should be given, aiming to provide a basic data input for future concepts and development of a harmonized ship waste management system.

Figure 2 shows the total number of services, amounts of collected bilge water and waste oil (m^3) during the two runs of pilot action in June and September 2011. In total approximately 400m^3 of bilge water and 50m^3 of waste oil were collected.

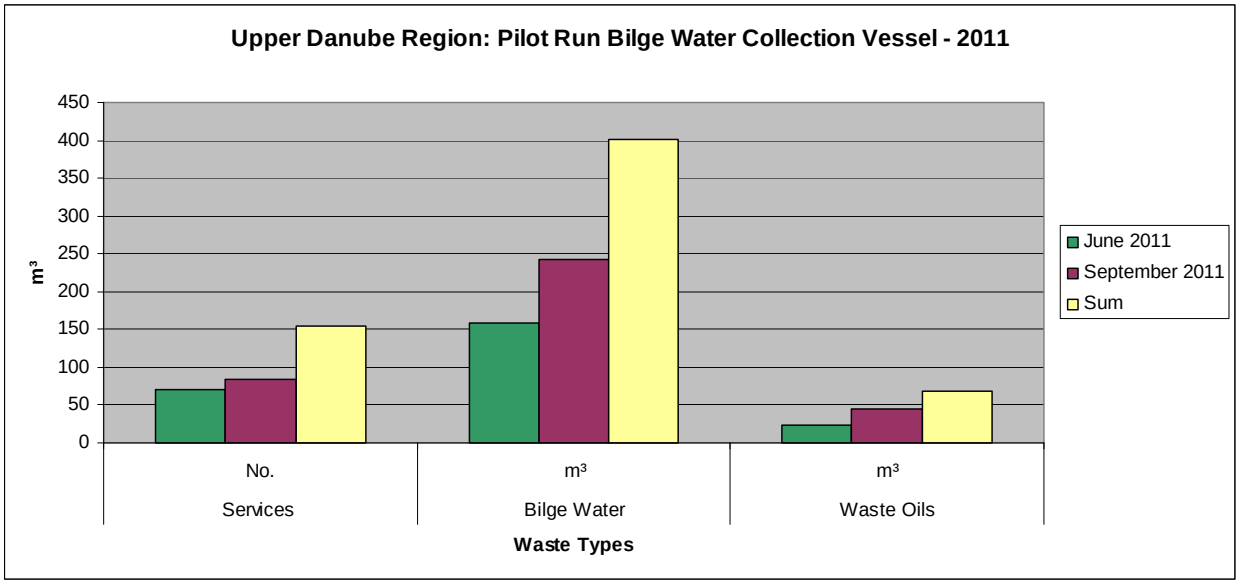

Figure 2: Upper Danube Region: Pilot Run Bilge Water Collection Vessel - 2011

As also shown in Table 4 in total 155 services for mobile bilge water collection were employed during the pilot activities – 70 during the first and 85 during the second run. Besides the collected bilge oil and waste oil also solids were accepted with a total amount of approximately 3,4 tonnes. It can be seen that the amounts of waste of the second run were higher compared to the first run.

Table 4: Comparison of first and second pilot implementation

	1st run	2nd run
No. of services	70	85
Total amount of bilge water [l]	157.800	242.350
Separated bilgeoil [l]	23.520	45.150
Solids [kg]	approx. 1.270	approx. 2.111

Regarding the location of service the following amounts (shown in Table 5) were collected:

Table 5: Comparison of collected waste according country section

Austria	**1st run**	**2nd run**
No. of services	45	58
Duration [d]	16	13
Total amount of bilge water [l]	97.250	161.850
Separated bilgeoil [l]	14.500	33.100
Solids [kg]	approx. 870	approx. 1.600

Hungary	**1st run**	**2nd run**
No. of services	25	27
Duration [d]	5	11
Total amount of bilge water [l]	60.550	80.500
Separated bilgeoil [l]	9.020	12.050
Solids [kg]	approx. 400	approx. 510

Concerning the country a higher demand can be noticed during the 2nd pilot run. In Austria services were used 13 times more often in the 2nd than in the first run, whereas the numbers in Hungary can be seen as almost constant. Nevertheless referring to the collected waste amounts in Hungary, in general 20 percent more waste was collected during the 2nd run. Austria registered a plus of more than 40 percent.

4.1 NUMBER OF USED DISPOSAL SERVICES

As shown in Figure 3 cabin vessels had the largest number of disposals during the pilot activities in June 2011 (1st run) with 25 services, followed by motorized cargo vessels with 16. In September 2011 (2nd run) also cabin vessels had the largest number of services with 34, but were followed by tankers with 14.

During the pilot activities 50 percent of waste disposals were undertaken by passenger vessels (including cabin vessels and passenger liners). While according to the BEG the proportion of passenger vessels in the Rhine region amounted to 10 percent in 2010. Hence, the proportion of passenger vessels is far less in the Rhine region than in the Danube region, which indicates, that the requirements of passenger vessels also should be taken into consideration for planning future waste disposal services.

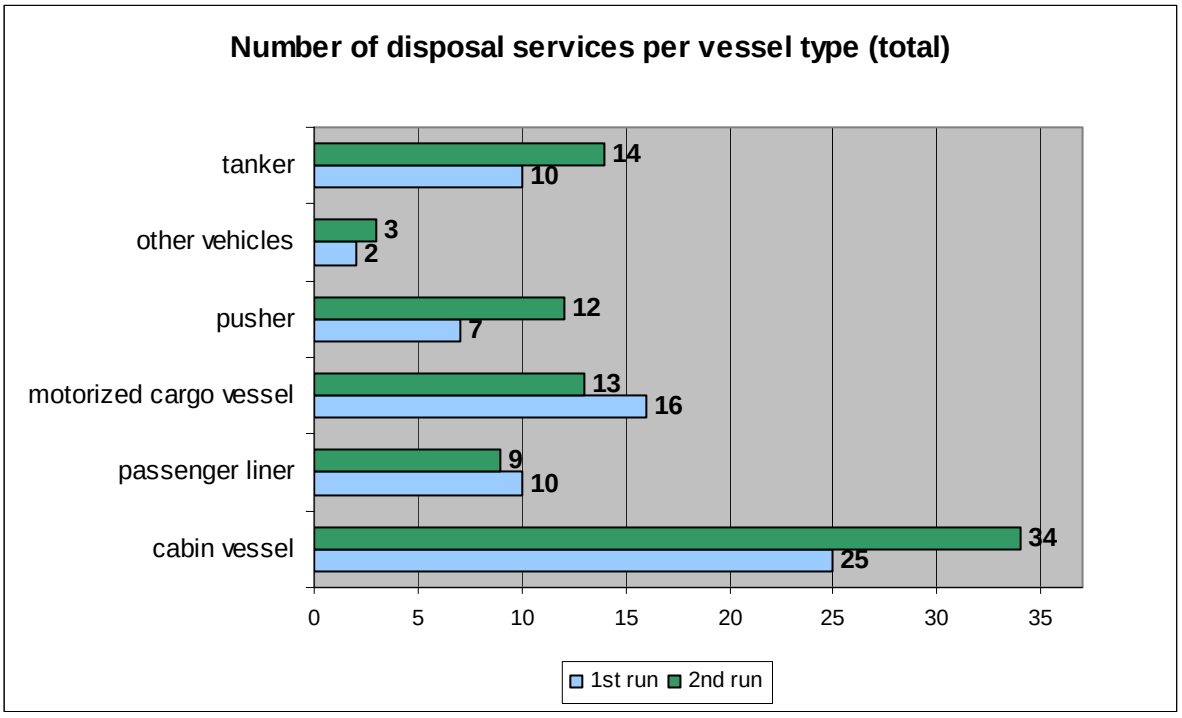

Figure 3: Number of disposal services per vessel type (total)

4.2 AMOUNTS PER CATEGORIES OF WASTE AND VESSEL TYPE

The types of waste accepted were bilge water, waste oil, solids such as bins and filter and other greasy substances.

During the first run motorized cargo vessels handed off the largest quantity of bilge water (approx. 59 m³), followed by pushers and tankers (approx. 30 m³). The highest amount of waste oil was disposed by cabin vessels with approximately 17 m³ (see Figure 4), which might be due to the fact that newer vessels collect waste oil separately. According other oily and greasy substances as well as solids, cabin vessels brought in the highest quantity with approx. 175 kg of rags, as well as 327 filters.

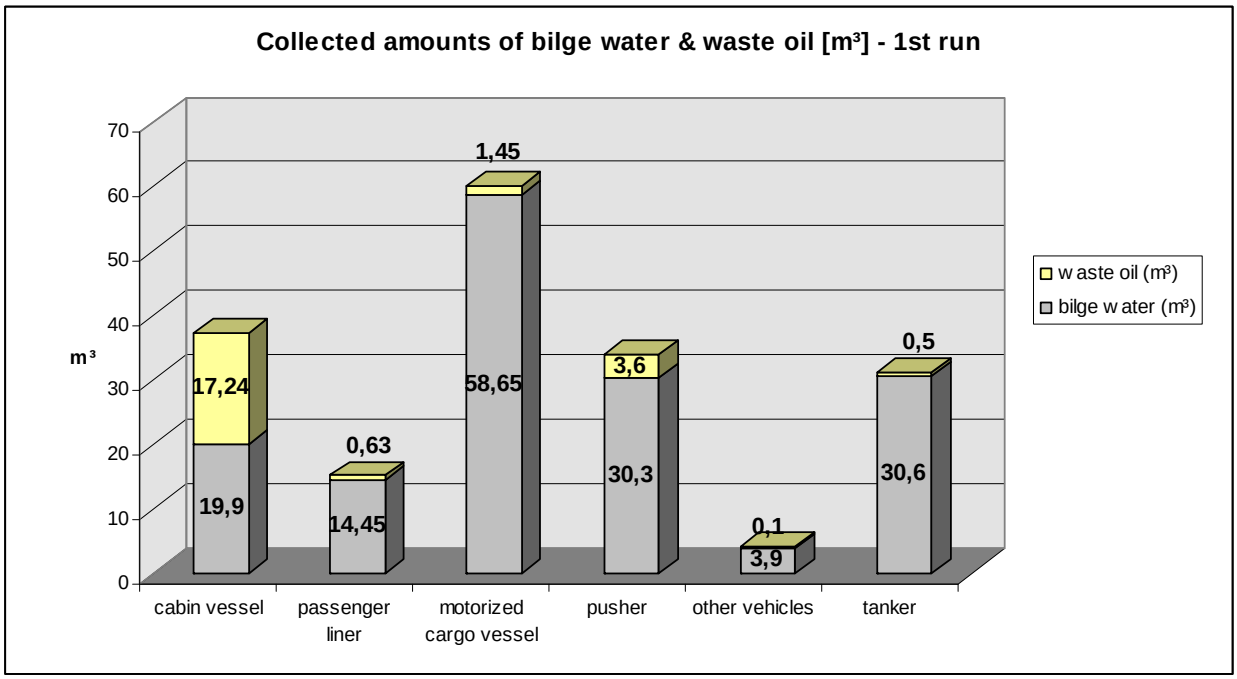

Figure 4: Collected amounts of bilge water and waste oil [m³] – 1st run

During the second run cabin vessels released the highest quantity of bilge water (approx. 53 m³), followed by pushers (approx. 50 m³), motorized cargo vessels (approx. 46m ³) and tankers (approx. 35 m³). Further 35 m³ of waste oil were disposed by cabin vessels, which amounted to the highest disposal quantity of any other type of vessel (see Figure 5). Furthermore cabin vessels also disposed the highest amount of filters (611 pieces) and other oily and greasy substances (435 kg), followed by pushers with 93 filters and 350 kg of oily and greasy substances.

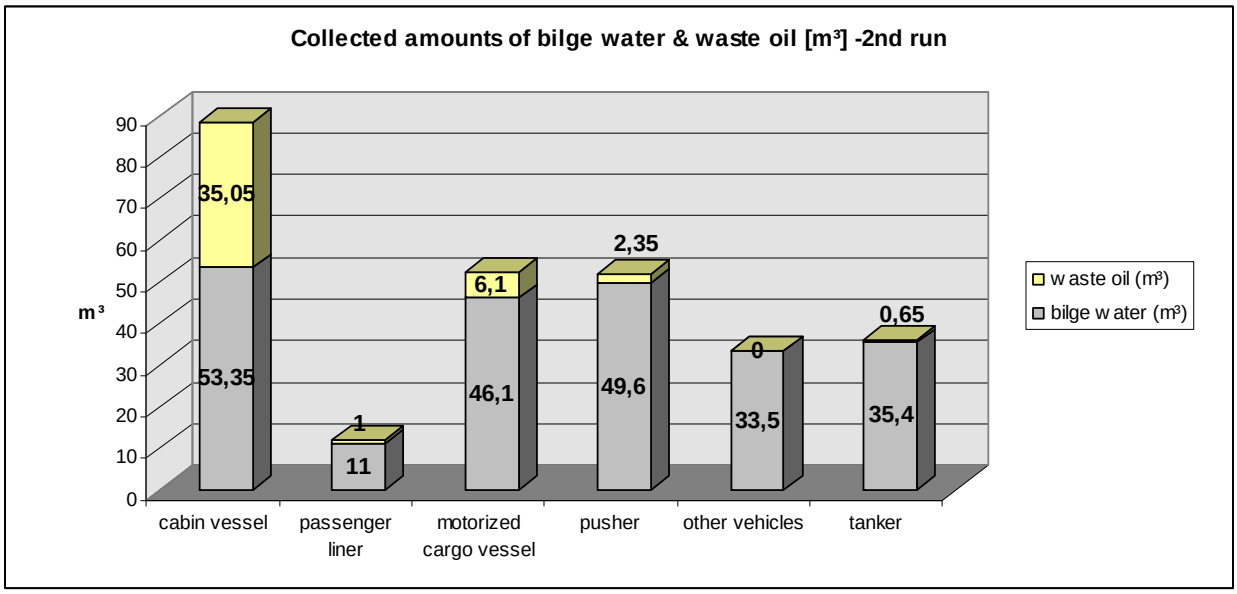

Figure 5: Collected amounts of bilge water and waste oil [m³] – 2nd run

In general bilge water always accounted for the largest percental amount of total disposed waste per vessel type. As shown in Figure 6 the total amounts of collected bilge water (including 1st and 2nd run) were highest for motorized cargo vessels (104,8 m³), pushers (79,9m³) and cabin vessels (73,3m³).

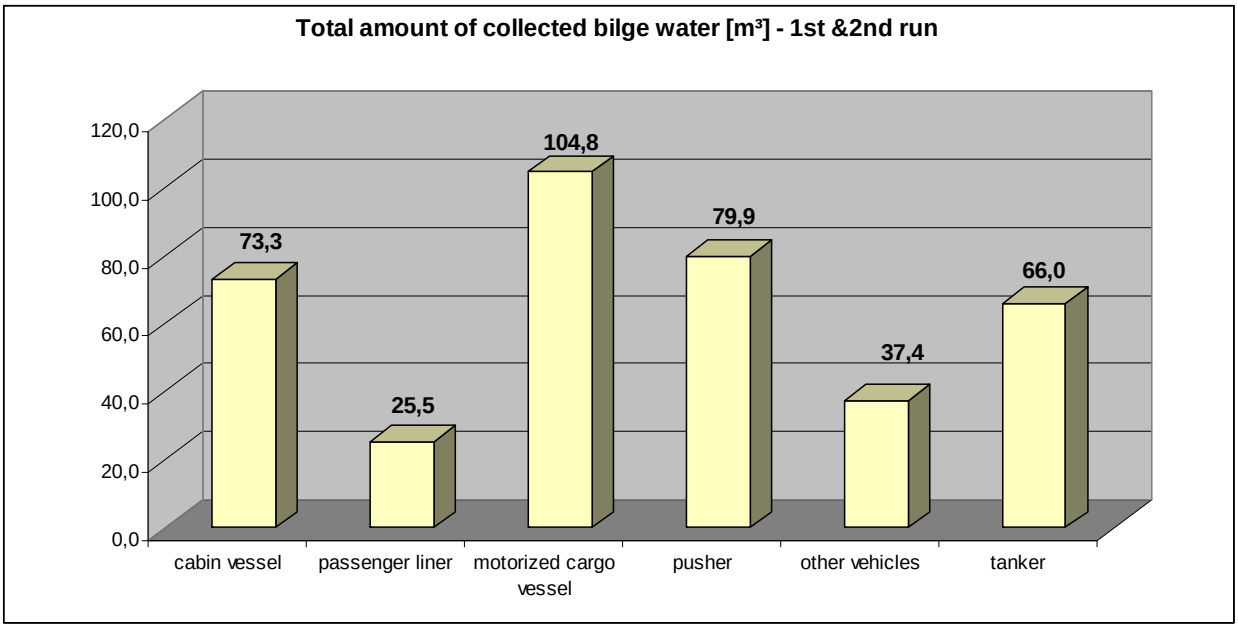

Figure 6: Total amount of collected bilge water [m³] incl. 1st & 2nd run

4.3 AVERAGE AMOUNTS OF DISPOSED WASTE

As shown in Table 6 the following average amounts were disposed during the pilot activities in 2011:

Table 6: Average amount of discharge per disposal (total)

Average amount of discharge per disposal (total)							
	bilge water [l]	separated bilgeoil [l]	waste oil [l]	Bins [pieces]	rags [kg]	grease [kg]	filter [pieces]
1st run	2254,3	389,4	336	1	8,2	2	6
2nd run	2851,2	550	531,2	2	10,8	2,2	10

In general bilge water amounted in the largest fraction of disposed waste within the mobile bilge water service.

4.3.1 Average amount of bilge water

In total more than 400.000 l of bilge oil were collected during the pilot activities in 2011. The total amount of collected bilge water during the first run was 157.800 l and 242.350 l during the second run. As shown in Figure 7 cargo vessels have a much larger average amount of disposed bilge water compared to cabin/passenger vessels[6].

[6] Due to a very low number of "other vehicles", these are excluded in this analysis.

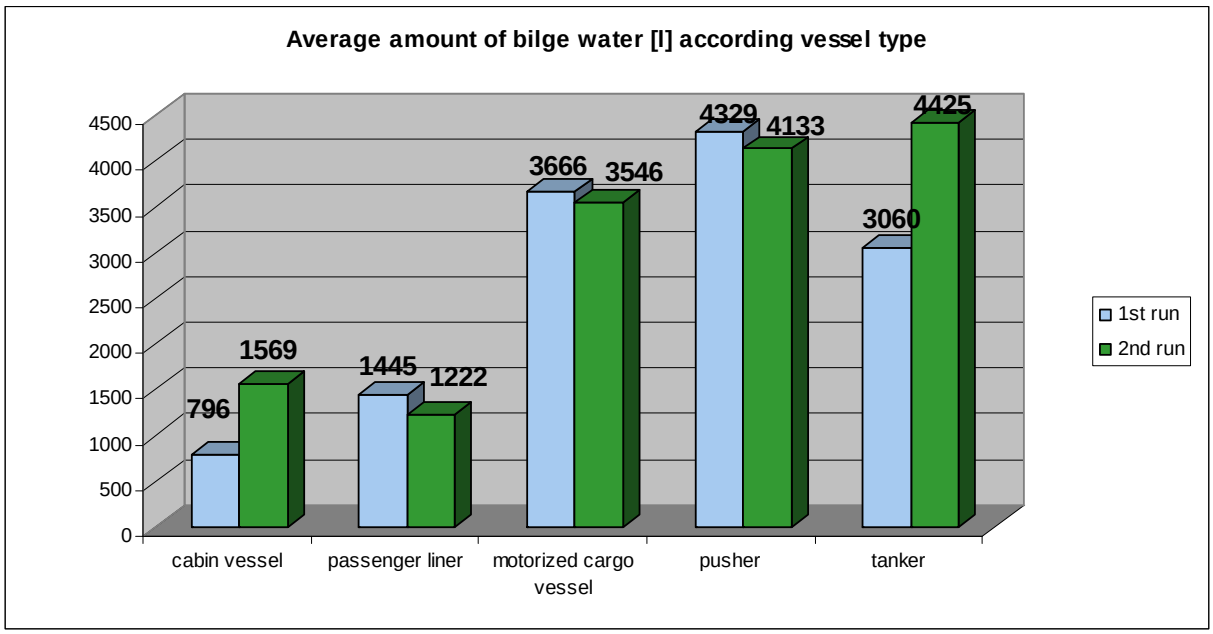

Figure 7: Average amount of bilge water [l] according vessel type

As shown in Table 7 the experienced average amounts of bilge water of the Rhine Region are in general similar to the results of the pilot activity on the Danube. Only push boats had approx. 20 percent more average bilge water in the Danube Region than in the Rhine Region. Regarding amounts of passenger liners also different numbers can be observed.

Table 7: Comparison of average amounts of bilge water for Rhine and Danube Region (BEG, 2003; via donau 2011)

Type of vessel	**Average amount of bilge water [m³/service]**	
	Rhine Region	Upper Danube Region (Pilot Activities)
Motorized cargo vessel	3,7	3,6
Tanker ship	4,0	3,7
Push boat	3,5	4,2
Passenger liner	1,8	1,3

For economic reasons the content of bilge oil that can be separated from the total amount of bilge water can be of important interest. During the 2nd run the proportion of separated bilge oil amounted in 19 percent of the total cleaned water (see Figure 8).

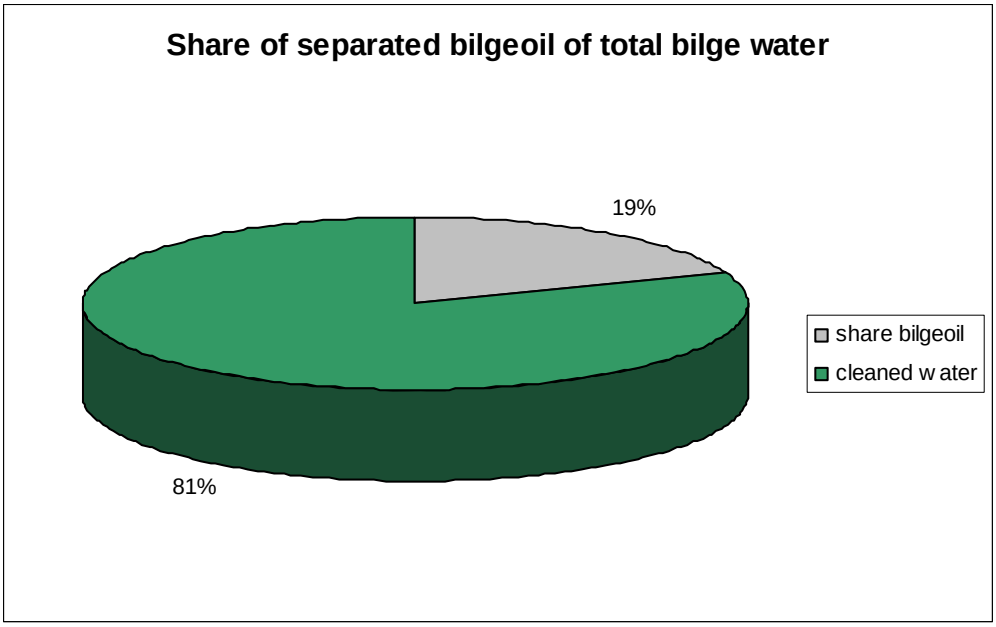

Figure 8: Share of separated bilgeoil of total bilge water – 2nd run Sept 2011

Figure 9 shows the rate of separated bilge oil from the total amount of bilge water collected according to type of vessel. In general the rate of separated bilge oil ranges from 12 to 25%. Only pushers represent an outlier with an amount of 34 percent of separated bilge oil during the 2nd run.

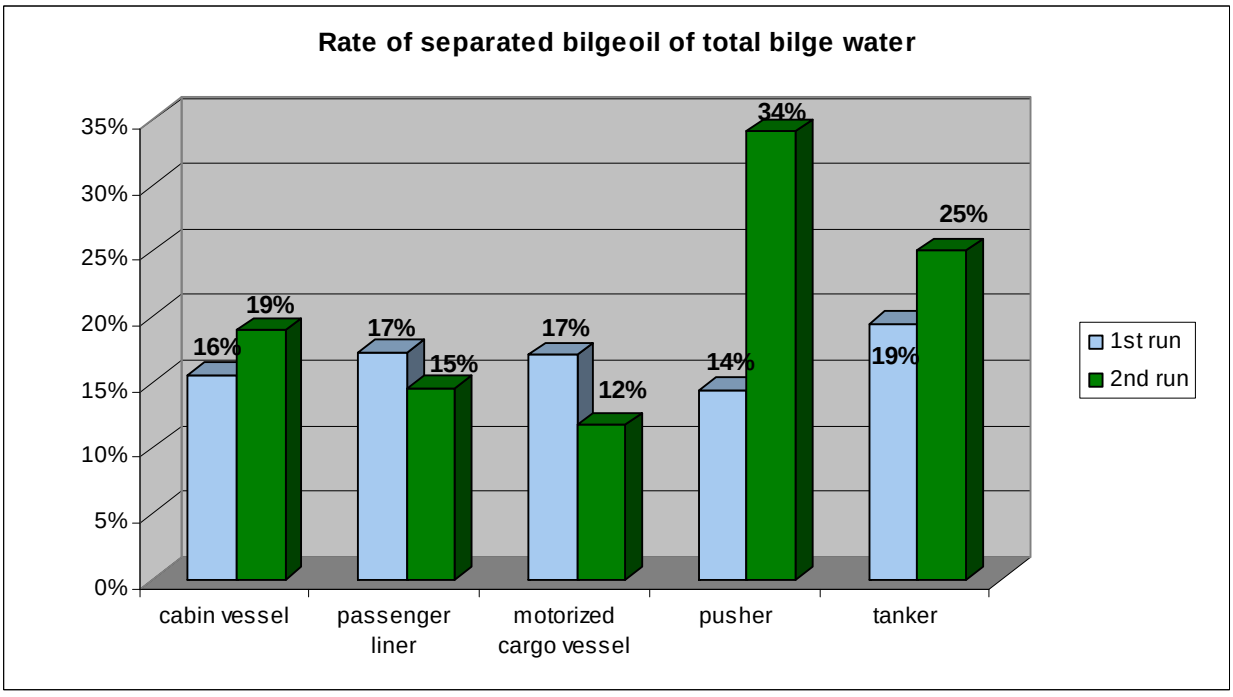

Figure 9: Rate of separated bilge oil per type of vessel

The results from the pilot activities demonstrate that in general approximately 20 percent of bilge oil can be separated from the total amount of collected bilge water. Compared to the Rhine Region, where the oil content of the bilge water averages at 14.3 % (push boats: 16.7 %), with a fluctuation range from 5 % und 15 %, a slightly higher content of separated oil was achieved in the Danube Region.

4.4 WASTE DISPOSAL PER SECTION

As shown in Figure 10 a wide range of **demanded services per section** existed. During the two pilot runs the leading section – regardless of vessel type - was between Vienna and lock Greifenstein with 26 (2nd run) and 18 (1rst run) respectively, demanded/ used services. Also the sections between Esztergom and Budapest International Port, as well as Linz (below lock Ottensheim) and Abwinden represented important areas for disposal services.

Referring to the **amount of disposal per vessel and section** it has to be mentioned that in general there is a balanced proportional distribution. Only cabin vessels can be seen as a statistical outlier in the section between Vienna and lock Greifenstein, where more than 50 percent of all cabin vessel disposals have been unloaded during the second run and more than 40 percent during the first run. During the first run the route between Esztergom and Budapest International Port – which is one of the most important touristic routes - should also be mentioned as an important section for disposal, where more than 40 percent of cabin vessels engaged the services of waste collection/disposal.

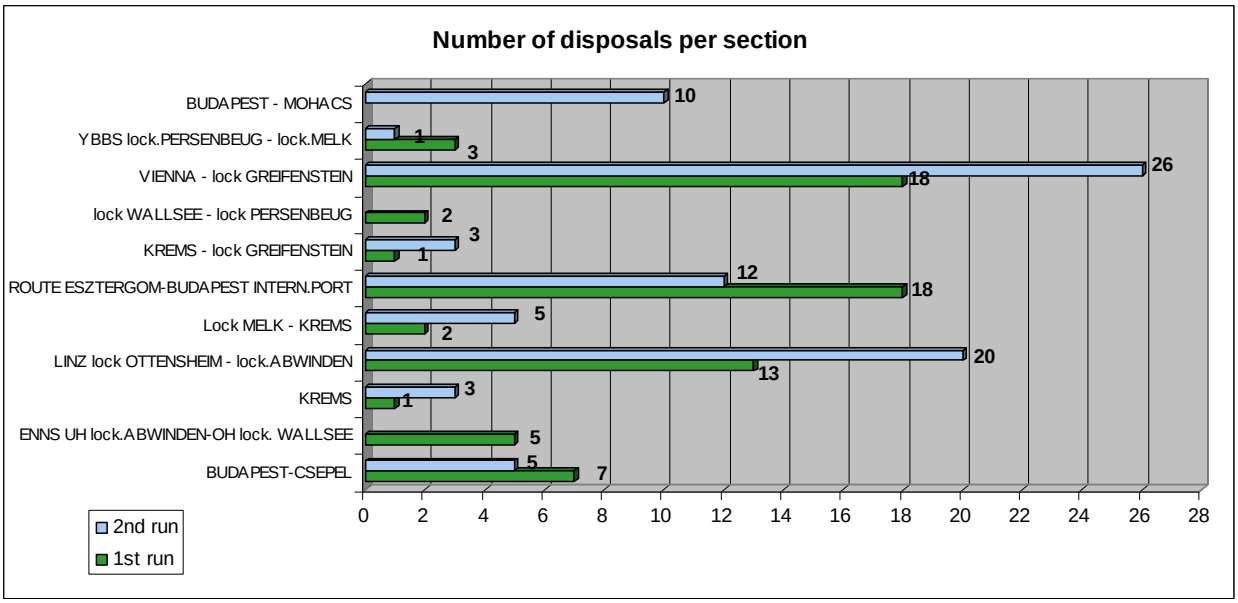

Figure 10: Number of disposals per section

Due to the fact that the implementation of the 1st pilot run took place between Linz and Budapest, it has to be considered that the section between Budapest and Mohács may be underrepresented. Furthermore additional information about the Slovak section, where pilot actions couldn't be completed are missing.

4.5 REPRESENTED NATIONALITIES

While undertaking the pilot activities on the Austrian and Hungarian Danube stretch down to Mohács vessels of all different flags were reported. As shown in Table 8 the following nationalities were represented:

Table 8: Numbers of used waste collection service per nationality (flag)

	1 run	2nd run	Total
Austria	11	10	21
Belgium	4	0	4
Bulgaria	1	1	2
Germany	19	27	46
France	4	3	7
Luxembourg	2	5	7
Netherlands	8	11	19
Austria	11	10	21
Romania	2	2	4
Switzerland	2	2	4
Serbia	0	1	1
Slovakia	3	2	5
Slovenia	3	8	11
Ukraine	2	3	5
Hungary	9	10	19
Total number of services	70	85	

Vessels under German flag most frequently used the mobile waste collection service with a total number of 46 services during the pilot activities, followed by Austria with 21 disposals, the Netherlands and Hungary with 19 each (see Figure 11).

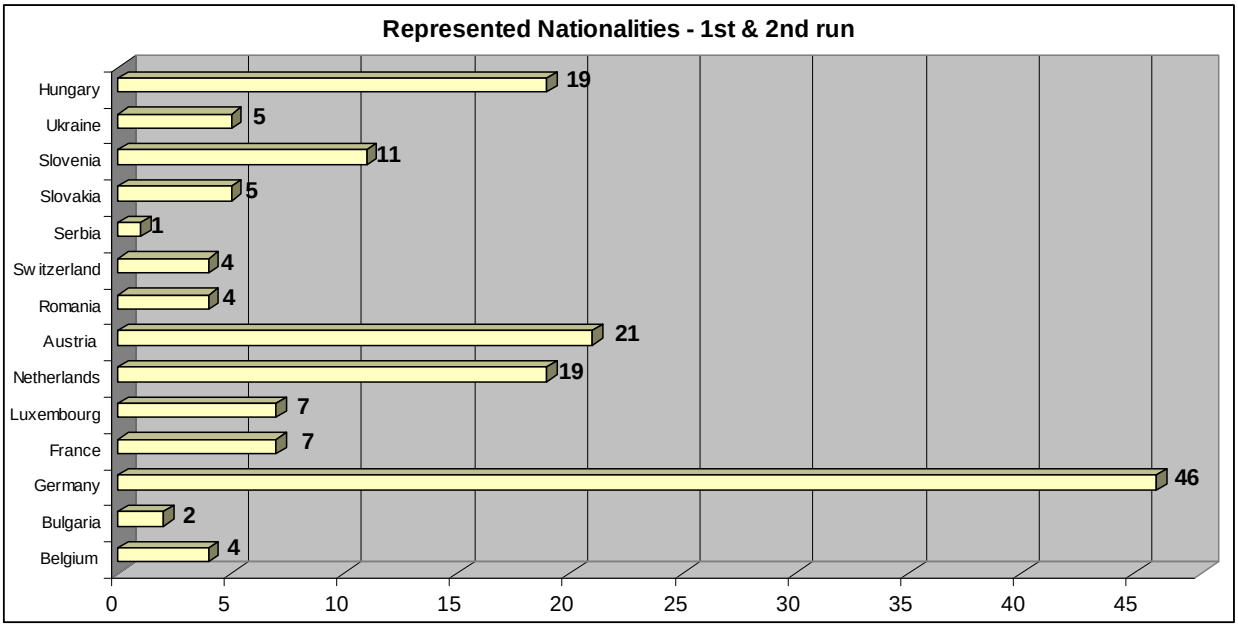

Figure 11: Number of services used by nationality

Comparing the regions of vessel origin a separation into Rhine region (including Switzerland and France), Germany, Upper Danube Region, Middle Danube Region (including Slovenia) and Lower Danube Region was made. As obvious in Figure 12 Rhine region, Germany and the Upper Danube Region each contribute to approximately 30 percent.

Figure 11 shows, that disposal services were used by vessels of various nationalities; it has to be noted, that the portion of vessels from the Rhine Region is rather high. This might be due to the fact, that bilge collection vessels such as the 'Bilgenentöler 8' operate there for decades; However, it also shows, that the Danube ship waste management system and the Rhine Region system have to be made compatible also with regards to financing issues.

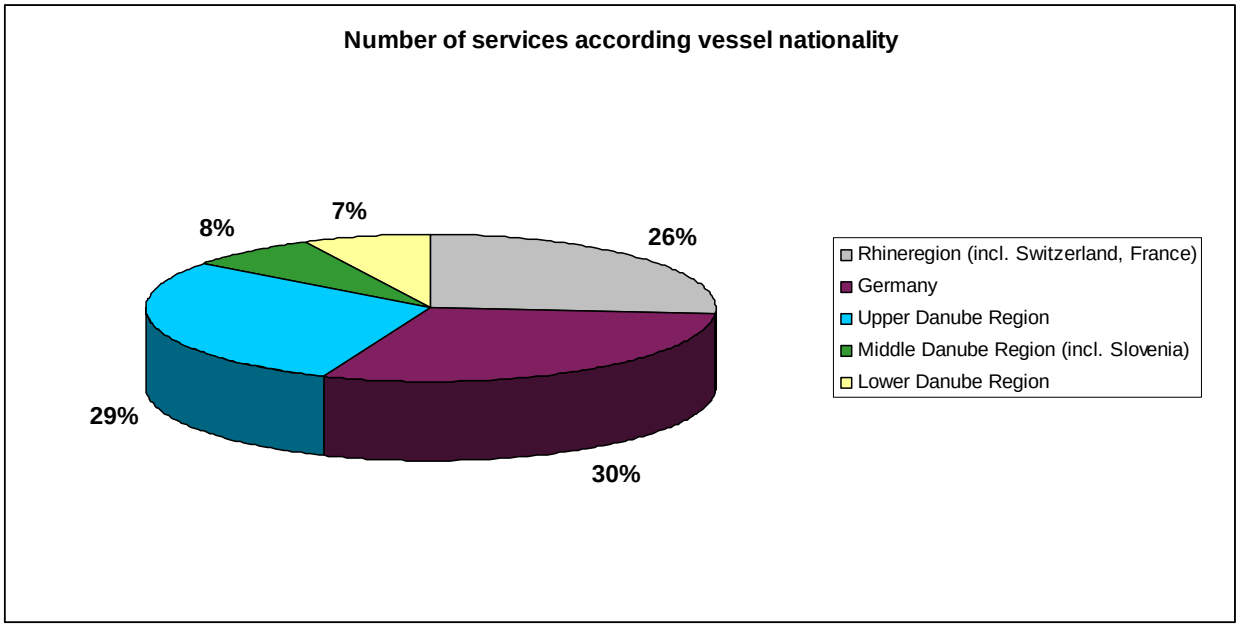

Figure 12: Number of services according vessel nationality

4.6 QUESTIONNAIRE EVALUATION

While implementing pilot activities with a mobile bilge water collection vessel, skippers were also asked to fill in a questionnaire, which was aiming to analyze the willingness of skippers to use ship waste reception facilities, their expectations regarding the ship waste management system on the Danube and to create user-friendly disposal services on the Danube.

Of 36 respondents[7] more than one third had disposed oily and greasy waste within the last three months and nearly 50 percent of the vessels within the last six month. Only 11 % had used disposal services within the last year (see Figure 13). More than 30 percent usually bunker in Hungary, 22 percent in Austria and 16 percent in Germany.

Nevertheless, no skipper delivered proper information about the costs for the waste disposal services. More than 60 percent of interviewee couldn't remember what amount they had spent for their last bilge water disposal, while more than one third answered that the service was free of charge. Asking if there is a need to also dispose other types of ship waste the majority of respondents agreed. About 50 percent mentioned that they would like to also dispose of Paints, Resolvents and Electronic Devices and about one third mentioned residuals. In general, more than 60 percent of vessels would highly appreciate a 'full service', in means of delivering all types of waste they have onboard.

[7] This equals a return rate of app. 12 %.

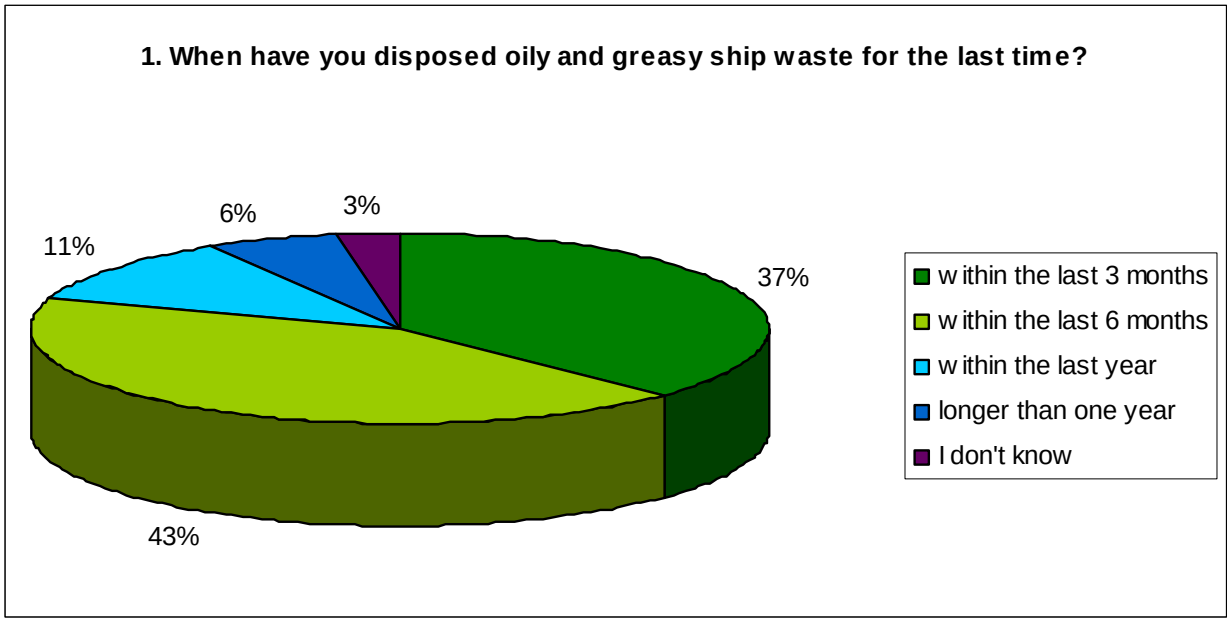

Figure 13: When have you disposed oily and greasy ship waste fort he last time?

Aiming at detecting important key factors for user-friendly waste collection, skippers were asked to evaluate service extent, waiting times and prior service arrangement. According to the service extend, approx. 70 percent of all respondents mentioned the high importance of a full service. In general more than 90 percent find it important to deliver all types of waste they have onboard within one waste collection service (Figure 14). Furthermore more than 90 percent of vessels argue in favour of prior service arrangement, where approx. 47% think it is very important to fix a service in advance and further 50% that it is important.

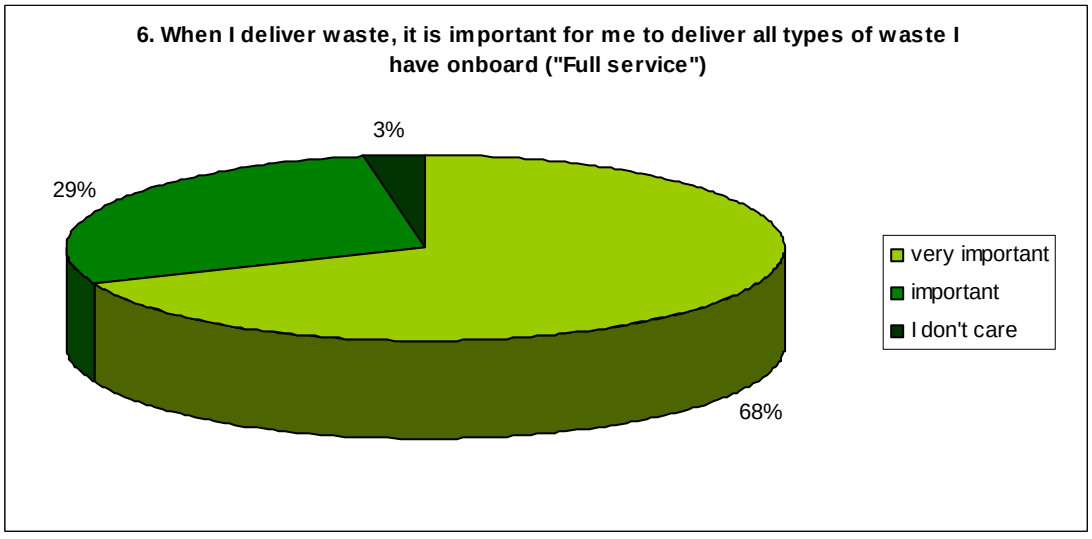

Figure 14: When I deliver waste, it is important for me to deliver all types of waste I have onboard?

Also time management can be mentioned as an important key factor. More than 50 percent think it is very important and almost one third that it is important to not have extensive waiting times for their collection service (Figure 15). 20 percent of all respondents would accept a waiting time of less than half an hour; further 50 percent would also wait up to an hour, while 31 percent would accept a waiting time of more than an hour.

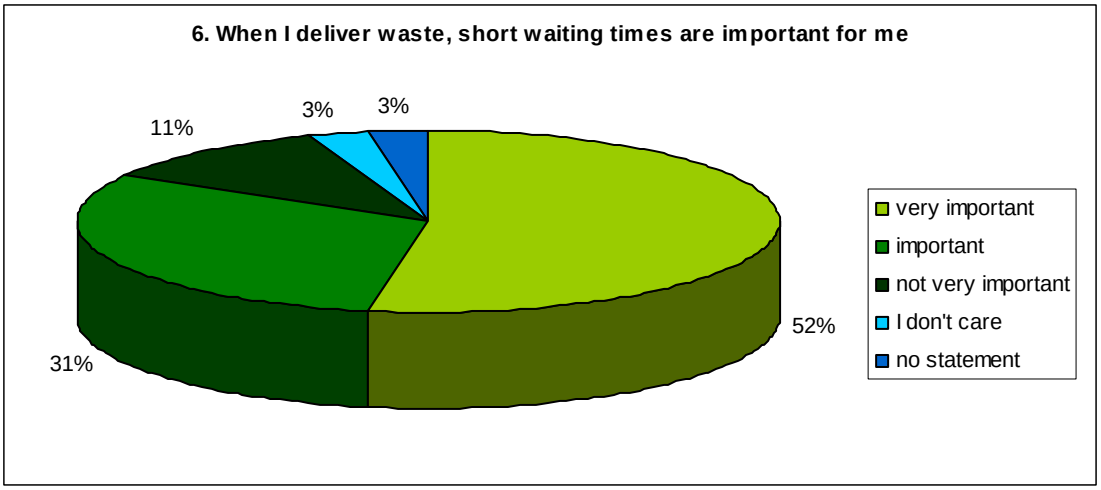

Figure 15: When I deliver waste, short waiting times are important form me.

Pilot tests during the WANDA Project of stationary facilities in Hungary (port of Baja) (see also Output 4.41), which included additional time for delivery of ship waste (approach, service time, etc.) showed less capacity utilisation compared to the mobile waste collection vessel. This may show a “tendency of underestimation of the value of time” by the skippers themselves, whose theoretically willingness to go to a port/ an onshore waste disposal facility may be higher than in reality. Furthermore it has to be mentioned that the relatively low usage rate of the Green Terminal may derive from the low traffic frequency of its location.

5 RESIDUAL WATER SAMPLING

For implementing pilot activities on the Upper Danube section using a mobile bilge water vessel several permissions had to be obtained (see also Chapter 3 'Legal Framework'). According to the Austrian Water Right (WRG) a licence had to be requested and finally comprised the following terms:

- Discharge of treated waste water (after gravity based oil separation and Ultrafiltration) in an extent of max. 1l/s in the time of pilot activity realization with the following discharge concentrations:
  - Total Hydrocarbons: 10 mg/l
  - Non-volatile lipophilic substances: 20mg/l

Within this licence an authorized expert assessed that regarding discharge of wastewater, the total amount of hydrocarbons, non-volatile lipophilic substances and the chemical oxygen demand (COD) have to be considered as central parameters. According to the given assessment the cleaning plant installed on the vessel is state of the art regarding hydrocarbons and lipophilic substances and can be seen as eligible to separate oily and greasy substances from the bilge water. Furthermore the used Ultrafiltration plant accomplishes more than the demanded cleaning capacity by the Austrian Water Right (WRG) (see also Chapter 3 'Legal Framework'). Therefore, referring to this no harm is expected. Nevertheless it is known that the parameter COD can not be appreciably decrease by the used treatment technologies (gravity based oil separation and Ultrafiltration). Experiences from Germany show emissions up to 1.100mg/l, whereas the Austrian Water Right gives a limit of 120 mg/l. Nevertheless for the pilot activities an exception was made, due to the short duration, minimal discharge amounts (max. 1l/s) and high rates of dilution.
For control reasons self- and external monitoring of the discharged water after treatment on the mobile bilge water vessel was undertaken, examining data such as pH, COD, water temperature, carbons etc. An extract of the results of water samples taken during the implementation of pilot activities in summer 2011 is represented in Table 9.

Table 9: Water samples undertaken during 1st and 2nd run

Parameter	Process	Result		Unit
		1st run	2nd run	
Hydrocarbons [total]	ÖN M 6608	0,27	0,19	mg/l
Total Phosphor	EN ISO 11885	1,30	5,45	mg/l
COD	DIN ISO 15705	258	1145	mg/l
TOC	DIN EN 1484	69	288	mg/l
Lipophilic substances	DEV H 56	4,9	3,4	mg/l

As it had been foreseen, the hydrocarbons and lipophilic substances were far below the limit values. With regards to the COD, the limit values were slightly exceeded during the first run, however, during the second run, a limit value comparable to those in Germany was reached. The reason for such high content of COD can occur, if other substances like tensids originating from cleaning supplies are put into the bilge. This practise, although forbidden, seems to be used by skippers.

6 DISCUSSION AND CONCLUSION

In the following section the realized pilot action should be assessed according to environmental impacts, costs, user friendliness and future practicability.

6.1 POTENTIAL ENVIRONMENTAL IMPACTS OF A MOBILE BILGE WATER SERVICE

The utilisation capacity of the mobile service on the Danube was app. 40 percent. Notwithstanding the specific circumstances of the pilot run – such as short time for information before the 1st run in May and the circumstance, that it was available for the 1st time ever on the AT and HU Danube, the implementation can be seen as successful, especially since the number of used services increased significantly during the second run.

However, if a mobile bilge water collection vessel with direct discharge into the waterway shall be used in the future, some adaptations of the legal framework – such as an exemption of limit values within the Austrian Water Right or an adaption of the system used have to be made.

Although the total released amounts of discharged waste water were low – compared to the water volume of the Danube, some concentrations (COD) were high. As mentioned in Chapter 5 'Residual Water Sampling' COD requirements can not be fulfilled with using the current technical equipment even though the current state of the art is applied. For future implementation different scenarios can be envisaged:

- Improvement of technologies to especially eliminate water-soluble organic compounds and therefore also decrease the rate of COD (chemical oxygen demand); however the space on board is limited and bilge water collection vessels shall not exceed certain dimensions (PHARE, 2000)
- Combining mobile bilge water services with stationary treatment plants to eliminate COD within a subsequent step and no direct discharge into the river system. This would also be possible for the current vessels of the BEG, some adaptations with regards to flanges and pumps would be necessary. Moreover, also points, where a sewage systems could be used, have to be defined.
- However, providing waste disposal services, such as the Bilgenentöler, in any case lead to lower environmental impacts than having no or insufficient services, which may increase the risk of illegal discharge. For a deeper assessment a comparison of environmental pollution due to illegal discharge with exceeding values of COD within a certain time limit is recommended. Furthermore, when implementing such a system a potential decrease of illegal discharge can be assumed due to better user friendliness, timesaving reasons and comfortableness].

6.2 COST ANALYSES

For a holistic financial analysis the costs of a mobile bilge water collection vessel with treatment onboard have to be compared with costs of stationary treatment facilities. It has to be mentioned that costs for onshore systems, such as suction costs, transport costs and administrative costs have to be considered. These costs need further investigation and comparison, e.g. in a cost-benefit analyses.

However, for a mobile bilge water collection vessel, cost per m³ of collected waste decrease with higher utilization capacity. Hence, cost efficiency of a mobile bilge water collection vessel is highly dependent on the quantity of collected bilge water, or the utilization capacity respectively. Furthermore also the proportion of separated waste oil of the collected bilge water is of importance for the efficiently operation of such a vessel. High rates of waste oil produce higher profits for the vessel operator and therefore decrease specific costs. As shown during the pilot activities in general the rate of separated bilge oil ranges from 12 to 25%, which can be regarded as a financial incentive for the waste collector. Assessment of User friendliness

Assessing the user friendliness of mobile bilge water service good ratings can be earned. Due to low acceptance of long waiting times – for more than 70 percent of interviewed vessels short waiting times are important and waiting for more than an hour won't be accepted (see also Chapter 4.6 'Questionnaire evaluation') – a mobile bilge water service can – if well planned and organized – be an effective solution for a timesaving waste disposal procedure. Instead of landing at a specific port, this way of waste collection can be undertaken while cruising. This is important, since the operation of a vessel can cost several thousand Euros per day and skippers try to minimize stops. Moreover, also transit vessels or vessels which do not ship into ports can use the services.

The main routes and most frequented ports are areas, where waste reception facilities can be used by the vessels without much loss of time. This pattern is also demonstrated by the results during the pilot activities, where the most frequently used sections for the mobile bilge water service were between Vienna and lock Greifenstein, Linz – lock Ottensheim and lock Abwinden, and Esztergom and Budapest International Port.

For practicable reasons skippers would wish to dispose all kinds of waste at the same time and therefore have a 'full service'. Thus, especially the collection of "other hazardous ship waste" – such as paints, resolvents and the like should be provided by the same operator, may it be stationary or mobile.

6.3 FUTURE PRACTICABILITY AND DEVELOPMENT

Examining the future development of freight and passenger transport, a prospective increase can be assumed. This trend also leads to increased waste amounts. Subsequently, due to this growth, increasing environmental awareness and the demand of IWT for user-friendly ship waste disposal solutions can be expected. It is therefore recommended to further develop waste disposal facilities, may they are mobile, stationary or combined solutions in Austria and

Hungary, which are based on integrated, cross-border approaches and available for all vessels regardless of their flags to similar conditions.

7 LIST OF ABBREVIATIONS

Abbr.	Abbreviation
AWG	Waste Management Right
BEG	Bilgenentölungsgesellschaft (bilge water collection company)
BMLFUW	Federal Minister for land and forestry, environment and water management
COD	Chemical Oxygen Demand
DDSG	Donau-Dampfschiffahrts-GmbH
WRG	Austrian Water Right
WVO	Inland Waterway Regulation

8 TABLE INDEX

9 LIST OF FIGURES

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APPENDIX

Figure 16: Map of project area