Port Reception Facility Study at Croatia

(EuropeAid/125614/D/SER/HR)

NEA reference number: 31029

Annex to the PRF system concept

Port Waste Management of Annex I and Annex V Wastes

LIST OF ABBREVIATIONS

AP	Action Plan
AOX	Absorbable Organic halogen compounds[1]
BAT	Best Available Techniques
BATNEEC	Best Available Techniques Not Entailing Excessive Costs
BTEX	Acronym for **Benzene, Toluene, Ethyl benzene** and **Xylene**
CARDS	Community Assistance, Reconstruction, Development and Stabilisation
CCE	Croatian Chamber of Economy
CE	Central-East
CEA	Croatian Environmental Agency
CEPEEF	Croatian Environmental and Energy Efficiency Fund
CFCA	Central Financing and Contracting Authority
CHIP	Chemicals Hazard Information & Packaging
COSHH	Control of Substances Hazardous to Health
CSB	Croatian Statistical Bureau
DS	Dangerous Substances
EAR	European Agency for Reconstruction
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EIA	Environmental Impact Assessment
ESC	Environmental Steering Committee
€	Euro
EU	European Union
GIS	Geographic Information System
GoC	Government of Croatia
GPS	Global Positioning System
GTZ	Gesellschaft fuer Technische Zusammenarbeit (Society for Technical Cooperation for Sustainable Development)
HOK	Croatian Chamber of Trade and Crafts
HWL	Hazardous Waste List
HW	Hazardous Waste
HZWM	Hazardous Waste Management
IFI	International Financial Institution
ISC	Inter-ministerial Steering Committee
ISPA	Instrument for Structural Policies for Pre-accession
IPPC	Integrated Pollution Prevention and Control
ISIC	International Standard of Industrial Classification Rev. 2 1968 (UNIDO)
KfW	Kreditanstalt für Wiederaufbau (German Bank for Reconstruction)
LoW	List of Wastes
LSG	Local Self Government
LWM	Law on Waste Management
MBT	Mechanical Biological Treatment plant

[1] X = halogen compounds such as F, Cl, Br, J

Mg	Megagram (=1.000 kg = 10^3 kg = 10^6 gram)
MEPPPC	Ministry of Environmental Protection; Physical Planning and Construction
MoH	Ministry of Health
MoF	Ministry of Finance
MoE	Ministry of Economy
MoTC	Ministry of Transport and Communication
NACE	The EC statistical office (Eurostat) classification scheme of economic activities. ('Nomenclature générale des Activités économiques dans les Communautés Européennes' [General Industrial Classification of Economic Activities within the European Communities])
NE	North-East
NEAP	National Environmental Action Plan
NWMP	National Waste Management Plan
REC	Regional Environmental Centre for Central and Eastern Europe
PAH	Poly Aromatic Hydrocarbons
PIU	Project Implementation Unit
POPs	Persistent Organic Pollutants
REReP	Regional Environmental Reconstruction Program for South Eastern Europe
PPP	Public Private Partnership
SC	Steering Committee
SMEs	Small and Medium Size Enterprises
SoEs	State owned entities
SW	Solid Waste
SWM	Solid Waste Management
TA	Technical Assistance
TCLP	Toxicity Characteristic Leaching Procedure
TNA	Training Needs Analysis
ToR	Terms of Reference
TPH	Total Petroleum Hydrocarbons
UNEP	United Nation Environmental Programme
VOC	Volatile Organic Compounds
WHO	World Health Organization
WG	Working Group
WWT	Waste Water Treatment

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Disclaimer

The opinions expressed in this Report are those of the authors and do not necessarily reflect the opinions of the EU Delegation or any other organisation mentioned in the Report. As a result, this will be verified before implementation of any of the recommendations contained herein.

1 Introduction

This report reflects the current delivered and future projected solid waste generation from various ports, the required management of port reception facilities and identifies the required facilities to be provided by contracted companies.

A second chapter reflects the current liquid hazardous waste delivery (mainly waste oil and bilge waters) in various ports. Taking long distances between the ports into account, it made it necessary to identify critical distances under a reasonable tariff situation and provided storage and/or pre-treatment.

The report further includes a perspective and potential role of the usage of future Regional Waste Management Centres in question of intermediate storage and pre-treatment of liquid wastes.

In addition this report contains a plant concept for various pre-treatment of liquid wastes and a description of required installations and operational procedures, supported by flow-schemes to illustrate the operational flow. An optioneering allows combining various options to site-specific requirements and demonstrates the required investments.

The gap on consistent information and data, reported and recorded by various port authorities and management facilities is crucial, while required input data have been calculated by interpolation or have been replaced by empiric figures or well-known benchmarks. Those data/figures have been highlighted with yellow.

2 Baselining

The baselining has been carried out regarding submitted documents, data and standard calculations.

2.1 Ports of Observation[2]

I - Port(s) of Pula

II – Port(s) of Rijeka

III – Port(s) of Senj

IV – Port(s) of Zadar

V – Port(s) of Sibenik

VI – Port(s) of Split

VII – Port(s) of Ploce

VIII – Port(s) of Dubrovnik

Figure 1_Ports of Observation

[2] Listed from Northwest to Southeast

2.2 Waste Generation Figures

The figures have been consolidated due to an inconsistence and gap on data reported and recorded from various port authorities and management facilities.

In order to achieve a baseline of calculation those recorded figures have been taken into consideration and those, which have been missing, benchmarked with average results from Croatia.

General comment is that most of the figures can be assumed as much too low and do not reflect the reality. Figures given by port authorities and management facilities are not consistent with those received from reception facilities (treatment companies). The figures reported by the port authority / management were taken into consideration.

Benchmarks are the ships (type) and the arrivals per year. The pre-announcements cannot be taken into consideration due to a significant discrepancy between pre-announcements and wastes delivered (Example – year 2007)

Table 1 Arrivals per ship type for main ports, 2004 -2008

	Ships					**Arrivals**[3]				
Ship type	**2004**	**2005**	**2006**	**2007**	**2008**	**2004**	**2005**	**2006**	**2007**	**2008**
Oil tanker	139	149	166	172	149	1.236	1.307	1.402	1.309	1.251
Chemical tanker	38	47	29	44	38	347	312	303	311	82
Bulk carrier	232	244	215	238	226	1.195	1.328	1.368	1.173	1.099
Container ship	33	25	26	50	73	97	75	159	260	332
Other cargo ship	453	481	513	522	572	1.497	1.502	1.713	1.747	1.896
Passenger ship	258	256	263	274	292	13.090	13.355	12.793	12.898	13.480
ro-ro	88	90	82	79	66	9.570	8.947	8.607	8.819	8.681
Other	191	188	209	183	167	2.255	2.247	1.915	1.866	1.812
Ship not specified	39	28	33	47	0	411	456	411	303	0
	1.471	**1.508**	**1.536**	**1.609**	**1.583**	**29.698**	**29.529**	**28.671**	**28.686**	**28.633**

Arrivals per ship, type and tendency are taken into consideration for further waste generation forecasts (REMPEC and FIS calculation model – see chapter 7.1)

[3] Arrivals is defined as days that a particular ship entered a particular port. So, a ferry entering a port 10 times on one day, is counted as one arrival.

Table 2 Volumes of waste expected in Croatian ports according pre-arrival waste notifications in 2007

Pre-arrival notifications **2007 [m3]**		Pula	Rijeka	Senj	Zadar	Sibenik	Split	Ploce	Dubrovnik	Total
Oily waste	sludge		540		84	15	32			**671**
	bilge water		450		73	41	39			**603**
	other		202		7	9	4			**222**
Garbage	food-waste	89	137		94	37	669	97		**1.123**
	plastic	60	199		143	50	448	113		**1.013**
	other	82	178		192	54	452	138		**1.096**
Cargo-related waste			742				0,2			**0,2**
Cargo-residues		2	329							**331**

Table 3_Delivered wastes in Croatian ports

ship-generated – annex I	**Pula**	**Rijeka**	**Senj**	**Zadar**	**Sibenik**	**Split**	**Ploce**	**Dubrovnik**	**Total**
SUM Bilge Water	4,14	358,26	27,01	557,45	322,57	1651,65	197,83	169,35	3337,68
SUM Waste Oil	18,96	1035,17	9,99	6,45	2,33	183,10	73,17	4,57	1284,33
SUM Annex I	**23,1**	**1393,43**	**37**	**563,9**	**324,9**	**1834,756**	**271**	**173,92**	**4.622**
solid waste – annex V	**Pula**	**Rijeka**	**Senj**	**Zadar**	**Sibenik**	**Split**	**Ploce**	**Dubrovnik**	**Total**
Food waste	45	212,5							258
Plastic	60	417							477
Other	145	818,1		730	504	8.022	506,1	6.769	17.494
Oily rags, oil filters, absorbents	0,78			1,7				0,12	3
Solvents	0,35								0
Packing	4								4
(oil) contaminated packing	0,625				9,1				10
cargo-related – annex I and V	**Pula**	**Rijeka**	**Senj**	**Zadar**	**Sibenik**	**Split**	**Ploce**	**Dubrovnik**	**Total**
Dunning, lining, strapping etc)	45				10				55
Metals	617,2				2				619
Others (antifreeze, edible oil etc)	1,7			783		0,002	0,18		784
SUM	**919,655**	**1447,552**	**0**	**1514,3**	**525,0909**	**8022,002**	**506,28**	**6769,1212**	**19703,98**

While no records regarding the delivery of pre-announced sludges have been delivered, the amount of bilged waters in all ports, except Rijeka, is much too low than those delivered. The comparison of pre-announced and real delivered (recorded and reported) amount does not merge at all and shall therefore not been taken into consideration. Same scenario can be identified for the situation for the period of 2008.

Table 4 Volumes of waste expected in Croatian ports according pre-arrival waste notifications in 2008

Pre-arrival notifications 2008 m3	**Oily waste**			**Garbage**			**Cargo-related waste**	**Cargo-residues**
	sludge	Bilge water	other	food-waste	plastic	other		
Pula	14	12	4	130	108	132		
Rijeka	374	242	56	117	271	374	780	850
Zadar	20	24	79	85	166	189	1026	70
Sibenik	36	63	2	54	70	112		
Split	61	64	14	570	498	432		
Ploce	28	37	3	129	158	106	32	0
Dubrovnik								
Total	**534**	**443**	**158**	**1.085**	**1.270**	**1.345**	**1.837**	**919**

Table 5_Ships on main and other ports in relation to arrivals for benchmarking purposes

2007	Pula	Rijeka	Senj	Zadar	Sibenik	Split	Ploce	Dubrovnik	Total
Ships Main ports	209	903	37	268	200	556	271	259	2703
Arrivals Main ports	1770	3677	783	6145	1002	10950	1132	4010	29469
Average Arrival per ship	8,5	4,1	0,0	22,9	5,0	19,7	4,2	15,5	10
Factor Main ports	**0,22**	**0,14**		**0,23**	**0,24**	**0,19**	**0,20**	**0,70**	**0,17**
Ships All Ports	277,00	923,00	41,00	310,00	297,00	591,00	276,00	298,00	**3013**
Arrivals All Ports	6526,00	17005,00	2415,00	11678,00	3380,00	32264,00	1263,00	14006,00	**88537**
Average Arrival per ship	**23,56**	**18,42**	**58,90**	**37,67**	**11,38**	**54,59**	**4,58**	**47,00**	**29,38**
% of ships of Main port	75,45%	97,83%	90,24%	86,45%	67,34%	94,08%	98,19%	86,91%	89,71%
% of arrivals of Main port	27,12%	21,62%	32,42%	52,62%	29,64%	33,94%	89,63%	28,63%	33,28%

The majority of ships are in the main ports, while the approximate only 33% of arrivals are in main ports, which shows, that the surrounding ports have a higher fluctuation of arrivals per ship. The ships in main ports are within 67 and 98% with an average of 89%.

The data for Senj and Ploce for main ports have been missing, while a calculation taking into consideration the average figures of ships and arrivals was carried out.

Those results in relation with various waste generations of Annex I and Annex V wastes will help to calculate missing data.[4]

[4] due to an high inconsistence and missing data can a statistical variance of data within 2 σ not achieved

3 Annex I and Annex V generated Wastes

3.1 Baselining[5]

The data base of 2007 was taken into consideration for further calculations. Those data highlighted in yellow have been calculated in relation to ships and arrivals in % per main port to total ships and arrivals of all ports.

The primary data have been summarized into waste stream analyses, processed with STAN software for every port.

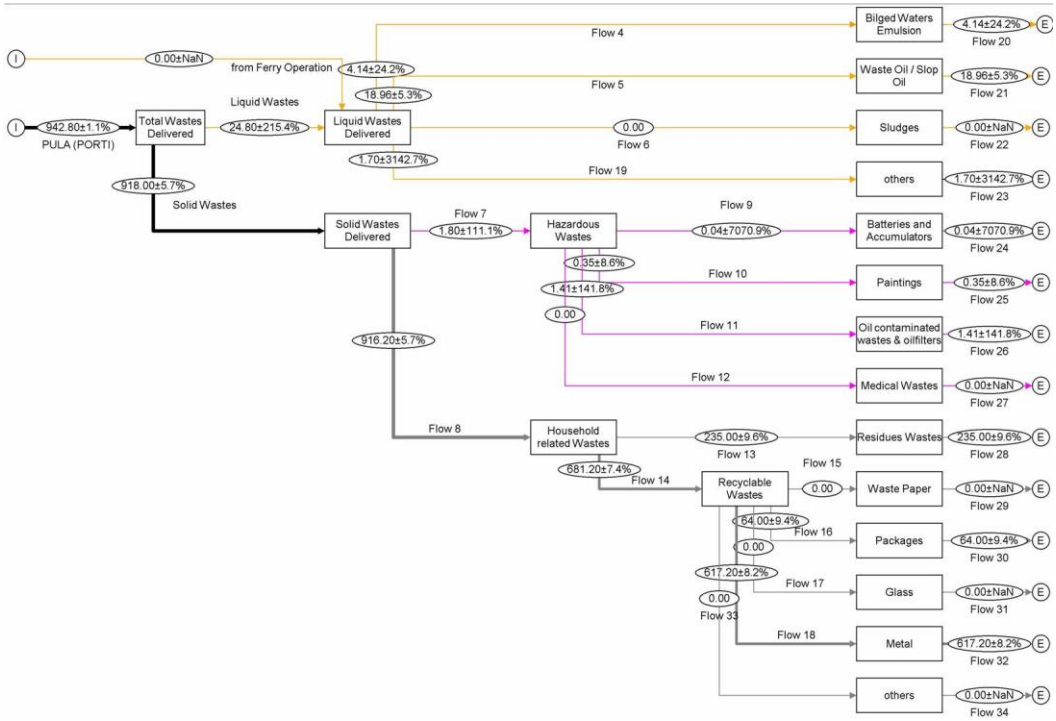
Table 6_Wastes generated within the period 2007 on all main ports

ship-generated – annex I	Pula	Rijeka	Senj	Zadar	Sibenik	Split	Ploce	Dubrovnik	Total
Bilge water	4,14	186	27,01	302,4	179,6	970,2	197,83	93,4	1.961
used oil / waste oil	18,96	537,43	9,99	3,5	1,3	107,6	73,17	2,52	754,43
bilge water + used oil Jadrolinia		670		258	144	757		78	1.907
Bilge water from Jadrolinija	0	172	0	255	143	681	0	76	1377,10
Waste Oil from Jadrolinija	0	498	0	3	1	76	0	2	529,90
SUM Bilge Water	4,14	358,26	27,01	557,45	322,57	1651,65	197,83	169,35	3337,68
SUM Waste Oil	18,96	1035,17	9,99	6,45	2,33	183,10	73,17	4,57	1284,33
SUM Annex I	**23,1**	**1393,43**	**37**	**563,9**	**324,9**	**1834,756**	**271**	**173,92**	**4.622**
% Bilge Water	17,92%	25,71%	73,00%	98,86%	99,28%	90,02%	73,00%	97,37%	72,21%
% Waste Oil	82,08%	74,29%	27,00%	1,14%	0,72%	9,98%	27,00%	2,63%	27,79%
solid waste – annex V	**Pula**	**Rijeka**	**Senj**	**Zadar**	**Sibenik**	**Split**	**Ploce**	**Dubrovnik**	**Total**
Food waste	45	212,5							258
Plastic	60	417							477
Other	145	818,1		730	504	8.022	506,1	6.769	17.494
Oily rags, oil filters, absorbents	0,78			1,7				0,12	3
Solvents	0,35								0
Packing	4								4
(oil) contaminated packing	0,625				9,1				10
cargo-related – annex I and V	**Pula**	**Rijeka**	**Senj**	**Zadar**	**Sibenik**	**Split**	**Ploce**	**Dubrovnik**	**Total**
Dunning, lining, strapping etc)	45				10				55
Metals	617,2				2				619
Others (antifreeze, edible oil etc)	1,7			783		0,002	0,18		784
SUM	**919,655**	**1447,552**	**0**	**1514,3**	**525,0909**	**8022,002**	**506,28**	**6769,1212**	**19703,98**
Grouping according Annex	**Pula**	**Rijeka**	**Senj**	**Zadar**	**Sibenik**	**Split**	**Ploce**	**Dubrovnik**	**Total**
Annex V - solid to be disposed	235	1.031	0	730	514	8.022	506	6.769	17.807
Annex V - solid to be recycled	681	417	0	0	2	0	0	0	1.100
Annex I - solids to be treated or disposed	3,5	0,0	0,0	784,3	9,1	0,0	0,2	0,1	797,1
SUM (control)	**919,7**	**1.447,6**	**0,0**	**1.514,3**	**525,1**	**8.022,0**	**506,3**	**6.769,1**	**19.704,0**
Bilge water / ship	**0,020**	**0,206**	**0,730**	**1,128**	**0,898**	**1,745**	**0,730**	**0,361**	**0,725**
used oil / waste oil / ship	**0,091**	**0,595**	**0,270**	**0,013**	**0,007**	**0,193**	**0,270**	**0,010**	**0,279**
Annex I / ship	**0,111**	**1,543**	**1,000**	**2,104**	**1,625**	**3,300**	**1,000**	**0,672**	**1,710**

[5] Baselining data have been consolidated from the interim report and related Annexes to the 5th monthly report

3.2 Waste stream analyses and interpretation

Figure 2_Waste stream flow chart for the port of PULA according the data 2007



Annex I

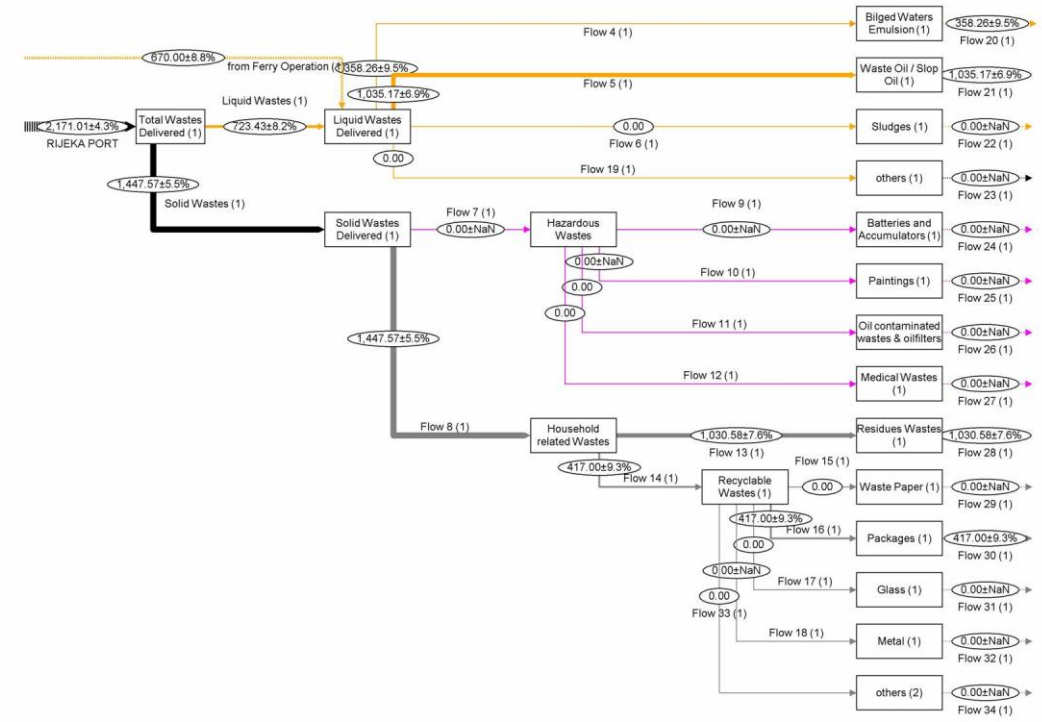
The waste oil and bilge water are reported with 23,1 m³ for the year 2007.

Annex V

190m³ of residues can be recorded. In addition collected are 64m³ recyclables (plastics) and 617,2m³ of metals, which have been separated. Included in the solid waste stream is an amount of 3,5m³ hazardous components (2m³ fluids), which have to be separated from household and household similar wastes.

235 m³ are for disposal, 681m³ for recycling and 3,5 m³ (Annex I) to be treated or disposed separately.

Figure 3_Waste stream flow chart for the port of Rijeka according the data 2007



Annex I

The waste oil and bilge water are reported with 1393,4 m³ (proportion – 25% bilge water / 75% waste oil) for the year 2007.

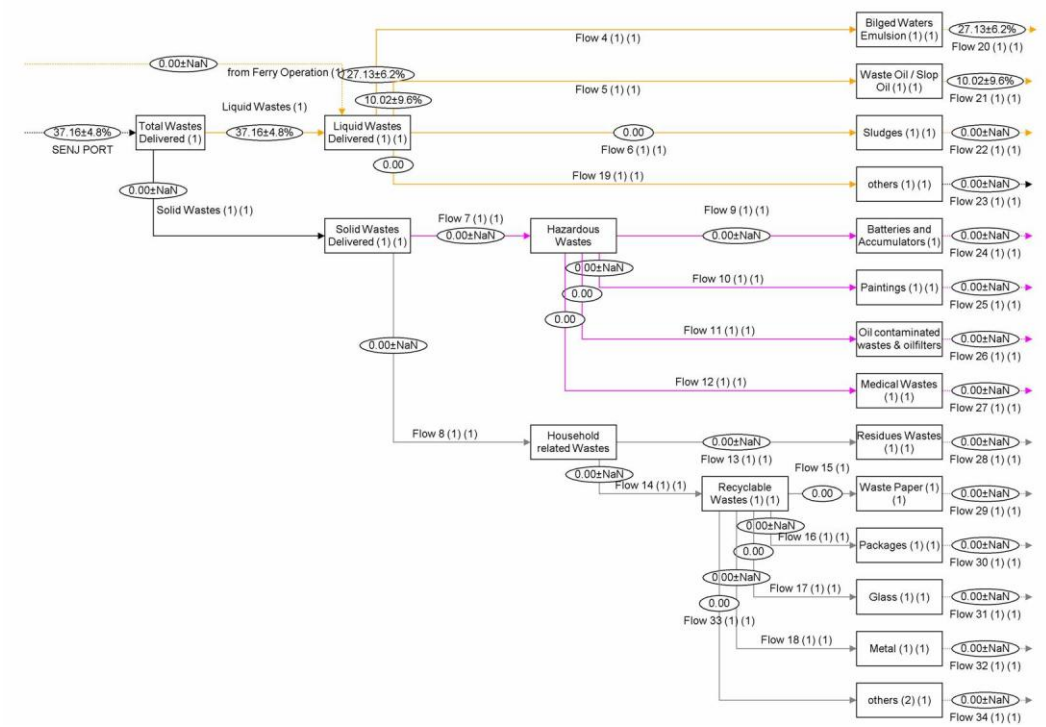
Annex V

1031 m³ of residues can be recorded. In addition collected are 417m³ recyclables (plastics), which have been separated.

1031 m³ are for disposal, 417m³ for recycling and 0 m³ (Annex I) to be treated or disposed separately.

The missing amount of hazardous substances within the household and household similar wastes allows the assumption of insufficient recording. An amount of 1% till 1.5% can be estimated.

Figure 4_Waste stream flow chart for the port of Senj according the data 2007



Annex I

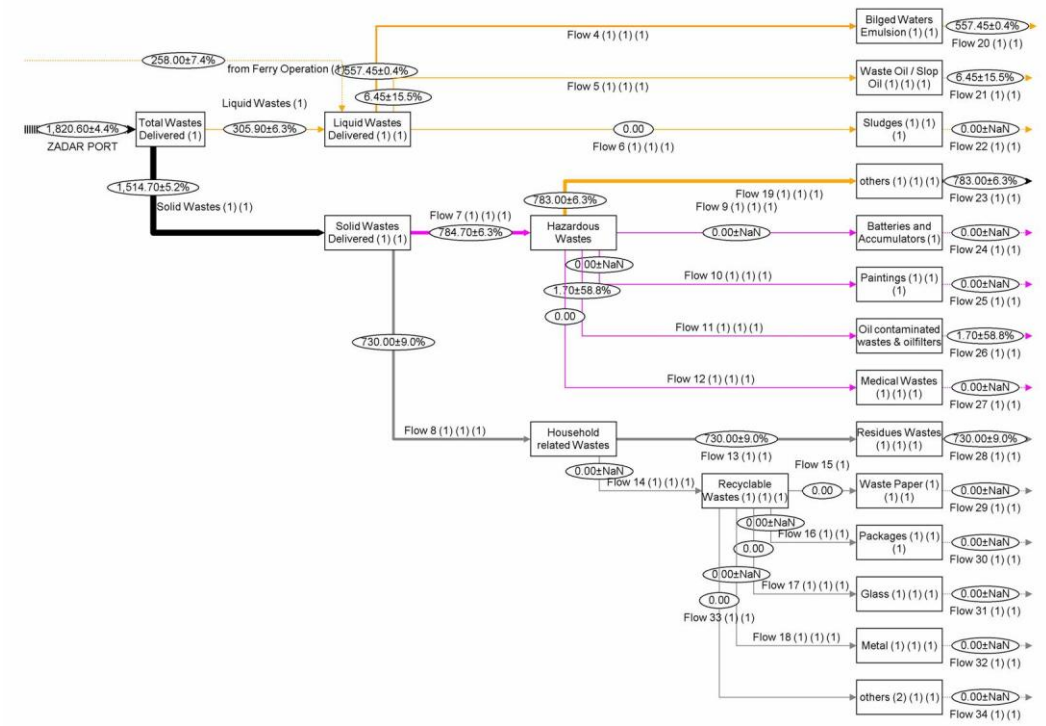
The waste oil and bilge water are calculated with 37 m³ (proportion – 73% bilge water / 27% waste oil) for the year 2007.

Annex V

No data are available for residues can be recorded and recyclables.

The household and household similar wastes will be estimated within chapter Annex V waste. The missing amount of hazardous substances within the household and household similar wastes allows the assumption of insufficient recording. An amount of 1% till 1,5% can be estimated.

Figure 5_Waste stream flow chart for the port of Zadar according the data 2007



Annex I

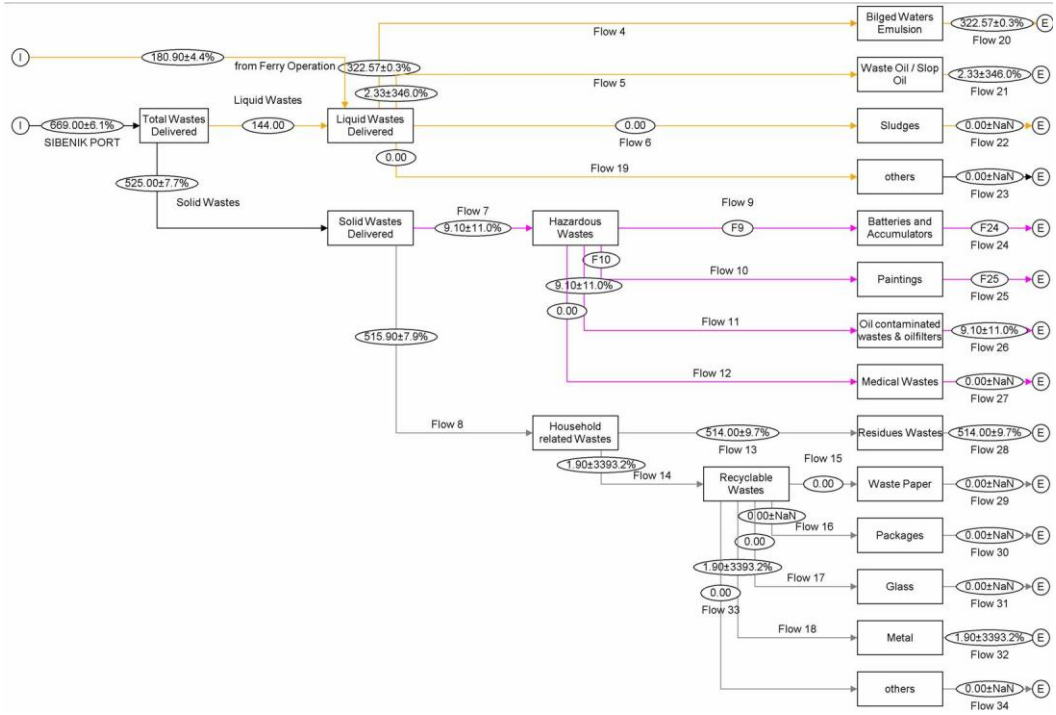
The waste oil and bilge water are reported with 563.9 m³ (proportion – 99% bilge water / 1% waste oil) for the year 2007.

Annex V

No amount of residues was recorded. In addition, collected are 730 m³ recyclables (plastics), which have been separated.

730 m³ are for disposal, 0 m³ for recycling and 783 m³ (Annex I) to be treated or disposed separately. The amount of 783 m³ consists mainly of edible oils and has to be collected separately. The missing amount of further related hazardous substances within the household and household similar wastes allows the assumption of insufficient recording. A amount of 1% till 1,5% can be estimated.

Figure 6_Waste stream flow chart for the port of Sibenik according the data 2007



Annex I

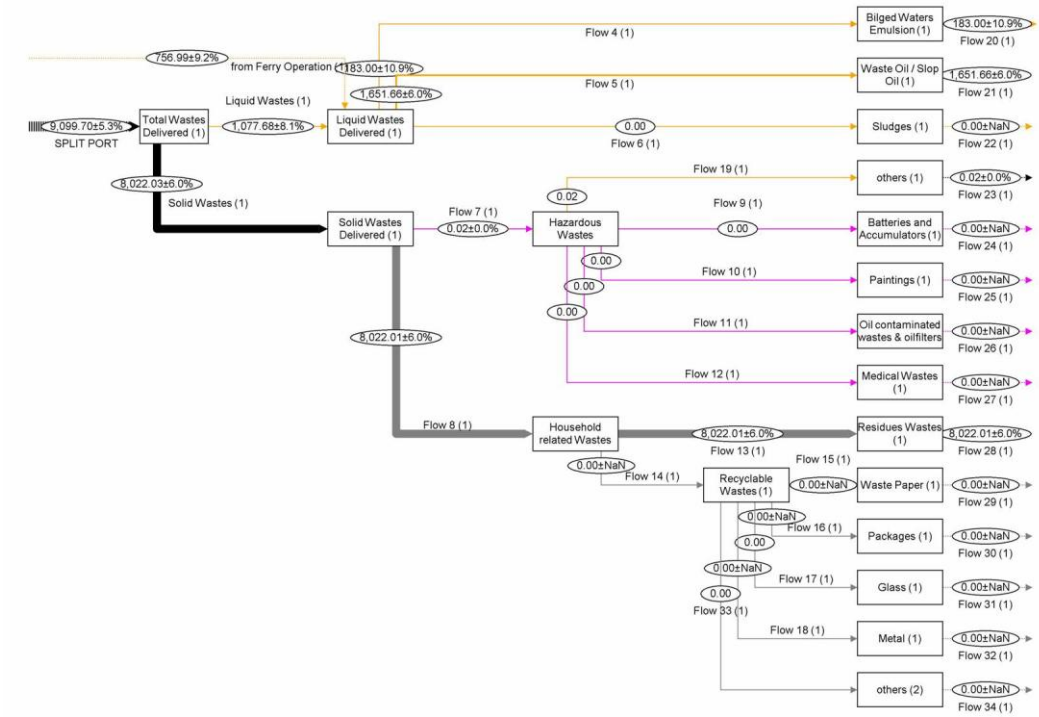
The waste oil and bilge water are reported with 324.9 m³ (proportion – 99% bilge water / 1% waste oil) for the year 2007.

Annex V

514 m³ of residues can be recorded. In addition collected are 2m³ recyclables (metals), which have been separated.

514 m³ are for disposal, 2 m³ for recycling and 9.1 m³ (Annex I) to be treated or disposed separately.

Figure 7_Waste stream flow chart of the port of Split according the data 2007



Annex I

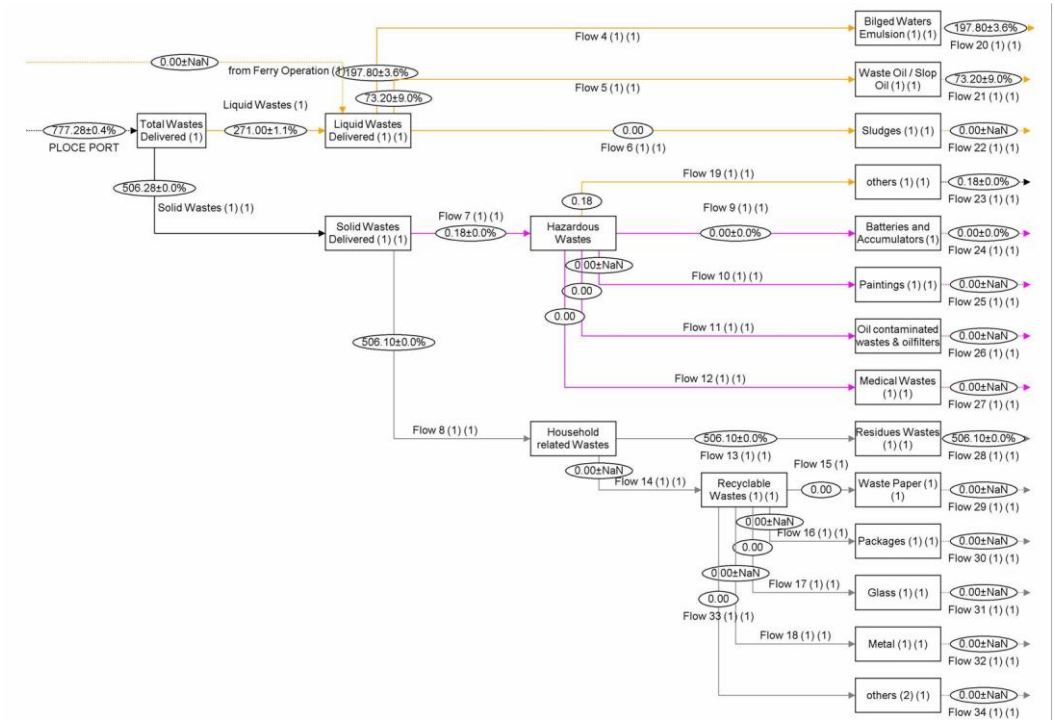
The waste oil and bilge water are reported with 1834.7 m³ (proportion - 90% bilge water / 10% waste oil) for the year 2007.

Annex V

8022 m³ of residues can be recorded. No recyclables (plastics) have been reported.

8022 m³ are for disposal, 0m³ for recycling and 0.02 m³ (Annex I) to be treated or disposed separately.

Figure 8_Waste stream flow chart for the port of Ploce according the data 2007



Annex I

The waste oil and bilge water are calculated with 271 m³ (proportion – 73% bilge water / 27% waste oil) for the year 2007.

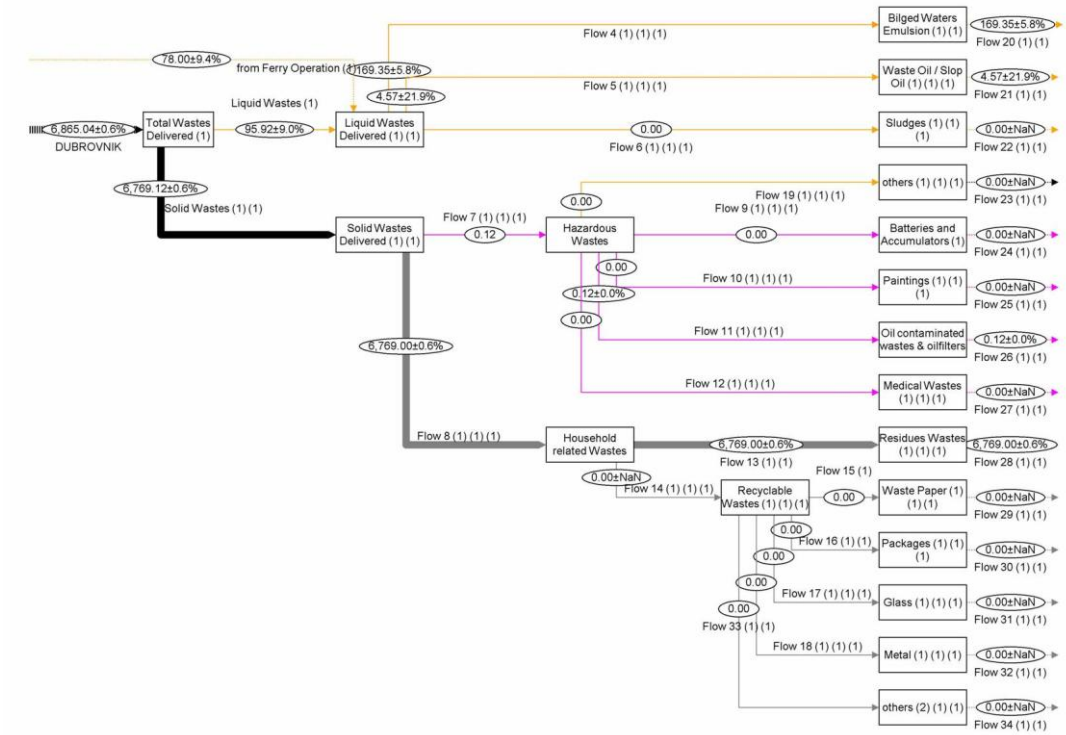
Annex V

506 m³ of residues can be recorded. No recyclables have been reported.

506 m³ are for disposal, 0m³ for recycling and 0.18 m³ (Annex I) to be treated or disposed separately.

The missing amount of hazardous substances within the household and household similar wastes allows the assumption of insufficient recording. An amount of 1% till 1.5% can be estimated.

Figure 9_Waste stream flow chart for the port of Dubrovnik according the data 2007



Annex I

The waste oil and bilge water are reported with 173.9 m³ (proportion – 97% bilge water / 3% waste oil) for the year 2007.

Annex V

6769 m³ of residues can be recorded. No recyclables have been reported.

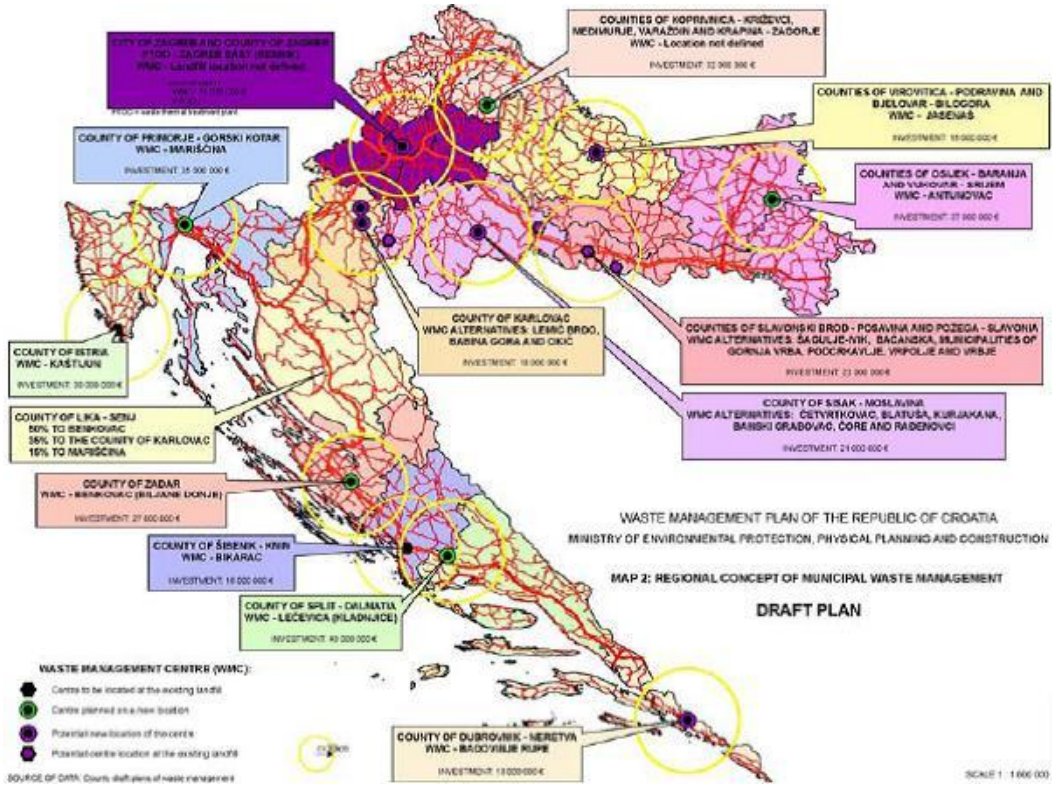
6769 m³ are for disposal, 0m³ for recycling and 0.12 m³ (Annex I) to be treated or disposed separately.

The missing amount of hazardous substances within the household and household similar wastes allows the assumption of insufficient recording. An amount of 1% till 1.5% can be estimated.

3.3 Role of future Regional Waste Management Centres

The strategy of the Republic of Croatia follows the establishment of Regional Waste Management Centres (RWMC) which are shown in the following figure.

Figure 10_Concept of regional waste management centres



13 centres are planned all over Croatia, partly on existing and partly on new locations.

Pula port(s) – Istria WMC in Kastijun

Rijeka port(s) – WMC in Marescina

Senj port(s) – 50% to Benkovac, 35% to County of Karlovac, 15% to Mariscina

Sibenik port(s) – WMC Bikarac

Split port(s) – WMC Lecevica

Ploce port(s) – either to WMC Lecevica or to WMC Neretva

Dubrovnik port(s) – WMC Neretva

In order to recover of dispose the municipal waste and non-hazardous industrial waste Regional and/or County Waste Management Centres will be established. Waste treatment operations carried out in the WMC prior to the permanent deposition of wastes to a landfill for non-hazardous waste, which is at the same time a constituent part of the WMC, are as follows:

- acceptance, treatment of sorted or unsorted waste;
- collection of reusable or recyclable waste and collection and further transferring of hazardous waste;
- collection and distribution of waste that may be used for other purposes;
- energy recovery of certain waste fractions and

- deposition of treated waste.

In the WMC a combined technique will be used: Mechanical Biological Treatment (MBT). The MBT technology combines two key processes: mechanical (M) and biological (B) treatment of waste, whereby various elements of M and B processes may be configured in different ways to cover a wide range of specific goals:

- Maximisation of recyclable raw material amounts (glass, plastics, paper, etc.);
- Composting;
- Production of energy-rich refuse-derived fuel (RDF) of defined properties;
- Production of biologically stable material that can be landfilled and
- Production of biogas to be used to generate heat and/or electricity.

All regional facilities will be operated by a licensed regional company (POE) and will be responsible for the collection, treatment, recycling and disposal of household and household similar wastes. Annex V wastes, free of hazardous wastes, will have to be disposed on future legal and controlled sanitary landfills, which are part of the Regional Waste Management Centres.

Table 7_Proportion of Annex V wastes to county generated domestic wastes

County	Amount of collected domestic waste in 2004	Extra-polation for 2007	Calculated volume in m^3 of domestic waste in 2007	Main ports	Volume of annex V waste	%
Istarska	64.900	72.705	218.116	Pula	250	**0,1%**
Primorsko-goranska	92.200	103.289	309.866	Rijeka	1.448	**0,5%**
Zadarska	38.200	42.794	128.383	Zadar	730	**0,6%**
Šibensko-kninska	25.200	28.231	84.692	Sibenik	504	**0,6%**
Splitsko-dalmatinska	101.400	113.595	340.785	Split	8.022	**2,4%**
Dubrovačko-neretvanska	33.200	37.193	111.579	Ploce, Dubrovnik	7.275	**6,5%**

The proportion of ship and port related Annex V wastes to county generated domestic wastes shows insignificant amount of 6.5 until 0.1%. An average pre-segregation efficiency of 40% recyclables will decrease the factor linearly, depending on the follow up of the recycling strategy by the local collection entity. The recycling rates shall be in close conjunction with the national strategy on recycling and recovery and shall also meet international guide- and deadlines.

3.4 Treatment and Disposal activities

3.4.1 Annex V – Wastes

Most of Annex V wastes is collected and disposed by the local waste management entities, which are owned by the municipalities (POEs – public owned enterprises)

3.4.2 Annex I – Wastes

The following table shows that licensed companies serve all ports.

Table 6: Companies providing port reception facilities and concession agreements with relevant Port Authorities, for operating in major Croatian ports

Port Authority ⇨ / ⇩ Concession	Pula	Rijeka	Zadar	Šibenik	Split	Ploče	Dubrovnik
Adriatic Blizna							
Cian							
Dezinsekcija							
Ecooperativa							
Ind-Eko							
Pomorski servis						*	
Rijeka Tank							

4 Annex V – Wastes

4.1 Waste Composition

On the basis of the existing data the waste quantities for the ports of Dubrovnik, Ploce, Pula, Rijeka, Senj, Sibenik, Split and Zadar were derived. The waste quantities were determined for:

- Food waste
- Plastic waste
- Glass
- Paper and cardboard
- Other waste
- Total household similar waste (comprising the sum of the above mentioned items)
- Oily rags, oil filters, absorbents
- Solvents
- Packaging
- (Oil) contaminated packing
- Dunnage, lining, strapping etc.
- Metals
- Batteries, lead acid batteries
- Other hazardous waste etc. (paints, acids, leys, end of life electrical equipment, toner cartridges, etc.)

Only for the ports of Pula and Rijeka the household similar waste was differentiated in food waste, plastic and other.

For the ports of Dubrovnik, Ploce, Senj, Sibenik, Split and Zadar only the figures of 'other' were available. For these ports the average percentage of food waste and plastic of Pula and Rijeka were utilised to determine a probable figure for the respective harbours and materials.

As there were no reliable passenger numbers available, the figures of glass (15.6%) and paper/cardboard (28.3%) were estimated on the basis of the 'Waste Management Plan in the Republic of Croatia for the period from 2007 to 2015'. The percentage refers either to the figure for 'other' (Dubrovnik, Ploce, Senj, Sibenik, Split and Zadar), or to the sum of food waste, plastic and other waste (Pula and Rijeka).

Only for Dubrovnik, Pula and Zadar were figures available for oily rags, oil filters and absorbents. For an estimate the average of the proportion between oily rags/oil filters/absorbents and total household similar waste of Pula and Zadar was used to determine the respective figures for the rest of the ports.

(Oil) Contaminated packing was estimated at 80% of oily rags etc., except where data were available (Pula and Sibenik).

For solvents, only a figure for Pula was available. The figure was calculated at 50% of the volume of oily rags, oil filters and absorbents.

The figure for dunnage, lining, strapping etc. was calculated on the basis of this waste class in Pula and Sibenik in proportion to the landings, i.e. 0.006m³ per landing.

For scrap metal the figures for Pula and Sibenik were differentiated between ports with shipyards and ports without shipyards. For ports with shipyards 0.08m³ (80l) per landing, for ports without shipyards 0.0003m³ (0.3l) per landing were assumed.

Batteries (household and lead/acid) as well as other hazardous waste (paints, acids, leys, end of life electrical equipment, toner cartridges, etc.) were estimated at 0.1% of total household similar waste.

4.2 Waste types

Waste types accounted for in this analysis are already mentioned in the chapter above. In this chapter, the requirements applying to the various types of waste are discussed.

4.2.1 Food Waste

Food waste comprises the waste from raw or cooked food materials disposed of before, during or after food preparation and consumption. It contains vegetable peelings, meat leftovers, spoiled or excess ingredients, including excess or spoiled food.

To avoid the spreading of plant, animal and human diseases and/or pests, food waste from outside the EU is to be controlled on entry into the EU. These food wastes require special treatment, e.g. incineration or sterilisation.

The proportion of international food waste in the total port waste is unclear. Nevertheless, dedicated containers should be installed for international food waste, to be delivered to a Regional Waste Management Centre for further treatment within a MBA plant. Special precautions such as handling advice and identification are to be taken for the respective containers.

Food waste should be collected at least weekly, as flies, rats, mould etc. will feed, grow and multiply on the waste and represent a nuisance if not a health hazard to port staff and public involved in port activities.

EU food waste can either be composted or used for energy generation (biogas).

4.2.2 Recyclables

4.2.2.1 Plastic Waste

There is no distinction between the composition of plastic wastes within the port waste (e.g. PET, PE, PU, PVC etc.). Therefore a generalised approach for collection of plastic waste has been used, requiring later separation in waste management centres, if the plastic waste is not to be used for energy generation. In the latter case, either additional containers should be planned to collect chlorinated plastics (PVC), or it should be assured that the incineration plants dispose of an adapted technology to break up dioxins/furans.

If a higher quality of recycling is to be achieved, a dedicated study and a respective breakdown of container capacities would have to be carried out.

4.2.2.2 Packaging

Packaging waste comprises all those materials used to contain, protect, handle, deliver and present any kind of goods, from raw materials to processed goods, along the chain from producer to end user/consumer.

According to European Parliament and Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste packaging material has to be collected separately.

Most of the packaging waste can be recycled, composted, or incinerated (‘energetic recovery’).

4.2.2.3 Glass

Recyclable glass quality ranges from white glass to green glass and brown glass, in order of diminishing quality. If a mixture of all three qualities is delivered, the lowest quality (brown glass) will result in the recycling process.

The quality of recyclable glass has not been assessed sufficiently to plan for a separated collection system. In the concept therefore a unified collection system is assumed.

If a higher quality of recycling is to be achieved, a dedicated study and a respective breakdown of necessary container capacities would have to be carried out.

4.2.2.4 Paper and Cardboard

Paper and cardboard result from either packaging, magazines/newspapers distributed on board, or from office work on board. In small quantities, containers or wheelie bins are the option or chose, in larger quantities compactors are the better option.

There is always a risk of vandalism or accidental fires, therefore container quantities should be kept small and the disposal should at least take place monthly.

4.2.2.5 Scrap Metal

Scrap metals are differentiated between ports comprising shipyards and ports without shipyards. Usually, in ports with shipyards the amount of scrap metal is by far higher than in ports without shipyards. Figures were only available for Pula (617m³, shipyard) and Sibenik (1m³, no shipyards).

As scrap metal is a source of remuneration, in ports with shipyards the wharves probably will sell their scrap metal, thus reducing the necessity of collecting scrap metal on a large scale. This will have to be evaluated during the start of the actual port waste management project.

On the other hand, tourist ships like ferries, or ro-ro ships, may produce notable amounts of aluminium from cans etc.

The quantity of containers for this purpose should be flexible, as there is no secure basis of the data that would be necessary to carry out a proper calculation.

4.2.3 Other Waste

Other waste comprises the waste not included in the above mentioned but being included in the category of household similar waste. It should be treated like food waste, i.e. as non recyclable, attracting vectors, and does not generate revenues if separated or recycled.

4.2.3.1 Dunnage, lining, strapping etc.

'Dunnage' the term used for materials used in ships' and trucks' cargo holds and inside containers to protect packaging and goods from moisture, contamination and/or mechanical damage. Dunnage may include plastic sheets and foils ('bubble foil'), jute coverings, tarpaulins, wood, rice mats, non-woven, liner bags, etc.

Most of the dunnage waste can be recycled, composted, or incinerated ('energetic recovery'). In ports with a high amount of bulk loads a high proportion of dunnage is to be expected.

4.2.4 Hazardous wastes

4.2.4.1 Oily rags, oil filters, absorbents

This type of waste is usually generated during maintenance of the ships arriving in the ports. It should be collected in containers that are sealed against rainwater or positioned underneath a roof to prevent rainwater leaching the oil. The most preferable option is to position the containers close to the office of the Harbour Master.

Staff handling this waste should be skilled in handling of hazardous waste and dispose of sufficient personal protective equipment.

The waste can be utilised as a secondary fuel if not contaminated by polychlorinated biphenyl(s) (PCBs).

4.2.4.2 Solvents

Solvents are usually organic liquids that are utilised to dissolve organic (i.e. carbon containing) substances, and comprise mostly organic solvents. Most solvents have a low boiling point and evaporate easily, thus constituting a health and safety hazard-

Organic solvents are to be collected separately, and be accepted in the respective packaging. They should never be mixed, as chemical reactions are not foreseeable.

Staff handling this waste should be skilled in handling of hazardous waste and dispose of sufficient personal protective equipment.

Organic solvents and inorganic solvents should be collected separately, as should be chlorinated and un-chlorinated solvents. Solvents should never be mixed.

4.2.4.3 (Oil) Contaminated packing

Contaminated packaging is packaging materials contaminated by substances that render the packaging material useless for the normal recycling, composting or energy recovery process, e.g. motor oil contaminated cardboard boxes from boat repair workshops etc.

Most of the material will go into controlled incineration, and therefore has to be collected separately.

Staff handling this waste should be skilled in handling of hazardous waste and dispose of sufficient personal protective equipment.

4.2.4.4 Batteries, lead-acid batteries, accumulators

Waste batteries result from their use in electrical and electronic devices such as MP3 players, CD players, digital cameras etc. They usually contain zinc and manganese, but may also contain silver and other heavy metals.

Waste lead-acid batteries accrue during the operation of repair workshops for cars etc. As the name indicates, they contain lead plates in a sulphuric acid, and at the end of their life also contain lead oxide sludge. All these components are either corrosive or toxic. The lead components are recyclable and constitute a certain value.

Staff handling this waste should be skilled in handling of hazardous waste and dispose of sufficient personal protective equipment.

It is estimated that this type of waste occurs at 0.1% of the total amount of household similar waste.

4.2.4.5 Other hazardous waste

Other hazardous waste should be collected separately and sorted according to categories such as paints, acids, lyes, end of life electrical equipment, toner cartridges, etc.

Another type of waste that needs special care are medical wastes from ships, such as sharps and needles, bandages, waste pharmaceuticals, etc.

Staff handling this waste should be skilled in handling of hazardous waste and dispose of sufficient personal protective equipment.

4.3 Collection Systems

4.3.1 Container Types and Collection Schedules

For collection purposes different container types were chosen. The respective container capacity was chosen to match the expected growth rate of 3% during the following 5 years.

In some cases the container sizes and empty schedules do not match but exceed the estimated waste volumes. In these cases it was assumed that containers are placed in various locations of the ports to provide shorter distances from the ships to the containers.

4.3.1.1 Wheelie Bins

Wheelie bins or "mobile garbage bins" [MGB] are waste containers usually used for household waste in private households, as well as commercial and industrial waste disposal. Smaller bins are in sizes of 60, 120, 240 and 360 litres, industrial types with 500, 660, 770, 1,000, 1,100 or 1,280 litres capacity. 1,100 litres capacity is the most common type. Smaller bins are moved on two wheels, the larger ones on four wheels. They require specially equipped waste collection vehicles.

Industrial size wheelie bins are produced either in steel or in high density polyethylene (PEHD), the latter being prone to arson and often causing toxic fumes when set on fire.

The specifications of wheelie bins are ruled by the European Standard EN840.

Figure 11_ Wheelie bin

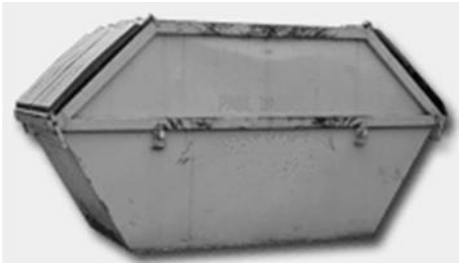
4.3.1.2 Skip Containers

Skip containers are large open-topped container designed for loading onto a special type of truck. Full skips are replaced by empty ones (if at all) and then tipped at a waste landfill or dumpsite. One end of the skip may comprise a door to allow manual loading or unloading. Skips are usually made from steel and are durable to withstand rough use.

When being transported to the waste landfill or waste management centre, the skip should be covered by plastic sheets or nets to prevent dust (e.g. from C&D waste) or light waste (e.g. plastics) from being blown away.

Sizes vary from 4.6m³, 6.1 m³, 9.2 m³, 10.7 m³ and upwards to 30.6 m³.

Figure 12_Skip Container and Skip Truck



4.3.1.3 Rear end loader

The rear end loader is a lidded skip with the same attributes as an open skip. By closing the lids, waste can be secured against theft, arson, or access by vectors.

4.3.1.4 Roll On / Roll Off Systems

Roll-off containers are also known as open top dumpsters, which are rolled into place on wheels. The containers are designed to be transported by special roll-off trucks. Typical container sizes vary from 7.5m³ to 30.6m³.

When being transported, nets or tarpaulins to prevent dust and/or waste to be blown away during transport should cover the roll-off container.

Figure 13_Roll on / Roll off container and Truck

4.3.1.5 Waste Compactors

Waste compactors consist basically of a baler press and a container. There are stationary systems in which the press is stationary and only the container is replaced, and also mobile systems in which the complete system including baler press is exchanged when the container is full. Both systems have their advantages (lower transport costs in the first, less complex procedure to connect/disconnect baler press and container).

Waste compactors come in different sizes of up to 24 m³ and can be transported by skip lift vehicle or roll-on-off vehicle.

Figure 14_mobile waste compactor

4.3.1.6 Port Hazardous Waste Collection

The hazardous waste collection centre should be installed centrally in a container, probably close to the harbour master's office, and should be easily accessible. It should be assured that the container is accessible at all times during port operation hours to prevent the dumping of hazardous wastes in other (e.g. household waste) containers.

The housing consists of a standard 20ft sea container (L x W x H: 6,000 x 2,225 x 2,225mm) for reception facility under the responsibility of the harbour master or 10 ft sea container only for intermediate storages. In this case shall a 20 ft container be installed in the Regional Waste Management Centre.

The sealed and lockable container should have a double floor construction to avoid leakages from spilled fluids. If necessary the container can be transferred to other adequate locations in the port easily.

The 20ft container is equipped with standard 200 litre polyethylene drums according to Basel Convention, in which solid and liquid hazardous Waste can be stored. The drums are sealable with clip top covers, which are closed tightly with an L-shaped metal ring.

All drums are to be labelled according to international standards (UN GHS). The system is applicable for collection, intermediate storage, transport (export) and disposal.

Figure 15_20ft sea container for intermediate storage purposes

The containers are to be equipped with standard safety equipment, such as

- Fire extinguisher
- Eye rinse bottles
- Fire protection coat
- Oil absorptive material
- First aid kit
- Emergency labels and
- Necessary small tools

Due to the use of standardized and low price components in a simplified yet EU standard compatible manner, the system can be extended by installing similar components in case of higher demand. The system can be copied in other ports effortlessly.

Each worker is to be trained on the handling of hazardous wastes, and is to be equipped with individual personal protective equipment (PPE) such as acid and oil resistant safety boots, protective gloves, safety goggles, and acid resistant clothing.

Figure 16_200l UN – bins for liquid and solid wastes

The number of drums depends on the estimated waste amounts and provides excess capacity in case that unexpectedly large amount of hazardous material is delivered.

4.3.1.7 Labelling and Safety and Precautionary statements

The new UN GHS system, also adapted by EU since January 2009, has to be used. Every single bin has to be labelled and singed in order to ensure a hazardous waste communication, reporting and recording system. Inventory of every bin, size, content, running number, weight (and/or volume) and CAS code,

Figure 17_Example for the labelling of accumulators and acid containing batteries

4.3.1.8 Incinerators/Steam Autoclaves

The European Union has a restrictive policy of importing food from countries outside the EU. These food items should not be mixed with the standard waste but incinerated to prevent the introduction of invasive species into Europe.

Food items from non-EU countries therefore should not be mixed with food waste that is to be landfilled, composted or to be converted to biogas. Instead, the non-EU food waste should be incinerated or sterilised by steam on site, i.e. directly in the port area, on a daily basis.

The necessary capacity of waste incinerators/steam autoclaves for sterilisation purposes to be installed for non-EU food items can only be evaluated on the basis of arrivals and food/organic waste quantities delivered by ships coming from ports outside the EU.

4.3.2 Emptying Schedules

For ease of coordination, there are only three different emptying schedules to be applied for the respective waste types:

- daily,
- (weekly),
- monthly, and
- as required

Daily schedules are applicable, where a nuisance by smell or a health risk by vectors (flies, rats) is imminent. For example, maximum temperatures in Pula may reach up to 28-30°C, while the development cycle of flies from egg to fly at 30°C has a duration of nine days. For this reason, food waste and other waste should be collected at least on a weekly basis.

Weekly schedules are applied to waste types, which are categorized under residues, but do not contain food wastes or those components which might cause odour and vector risk.

Other wastes such as glass, packaging, dunnage etc. can be collected on a monthly basis or as required. The option 'as required' implies that controls of the waste containers be carried out on a daily or bi-daily basis by a harbour master's office staff person, and in case of necessity that the respective containers be emptied the day of or following the notification.

In general it has to be stated that due to the limited data basis on waste types and quantities most of the figures used for calculation are estimates on the basis of very little data. To be able to calculate the quantities and sizes of containers, as well as the emptying schedules, a dedicated study of waste types and amounts in the respective ports would have to be carried out.

If this approach is not possible, e.g. due to lack of time, flexible contracts with the waste collection service providers should be negotiated.

4.3.3 Regional Waste Management Centres

All waste collected in the ports are either to be transported to appropriate recycling centres (glass, metal, etc.) or to appropriate landfill sites, composting facilities, or centres equipped for the treatment of hazardous wastes.

The documentation available does not contain any information about waste management centres, and available information about waste composition and quantities is relatively unreliable. In addition, transport costs and waste recycling/treatment/disposal options are calculated differently by every company. Therefore the costs for waste collection, recycling, treatment and disposal should be determined and compared on the basis of a tender procedure.

Usually the closest waste management centre/recycling centre/landfill is the most cost efficient option.

4.4 Waste Generation in various ports

Table 8_Basic Data for the forecast of future waste generation

Division of total household similar waste, average of Pula and Rijeka	Basis for waste generation forecast
Food waste	16,3%
Plastic	26,4%
Other	13,4%
Oily rags, oil filters, absorbents (0.35%of total household similar waste)	0,35%
Solvents	50% of oily rags etc. (estimate)
Packing	10% of plastic waste (estimate)
(Oil) contaminated packing	80% of oily rags etc., except where data available
Dunning, lining, strapping etc)	0.006m³ per landing
Metals: m³/arrival (shipyard/no shipyard)	0,08

In average is solid wastes (household related) containing 16.3% food wastes, 26.4% plastics and packages, 0.35% of oily rags and 13.4% of other residues components. The hazardous wastes containing on average of 0.35% solvents, paintings and other fluids, 80% of contaminated packages. Dunnings have been calculated with 0.006m³ per arrival (= landing) and metals with 0.08m³.

Table 9_Waste distribution forecast

All units in m³	**Pula**	**Rijeka**	**Senj**	**Zadar**	**Sibenik**	**Split**	**Ploce**	**Dubrovnik[6]**
Food waste	45	212,5	72	119	82	1.308	82	1.103
Plastic	60	417,0	116	193	133	2.118	134	1.787
Glass (15.6%)[7]	39	226	68	114	79	1.251	79	1.056
Paper and cardboard (28.3%)[7]	71	410	124	207	143	2.270	143	1.916
Other	35	183	59	98	68	1.075	68	907
Total household similar waste	**250**	**1.448**	**439**	**730**	**504**	**8.022**	**506**	**6.769**
Oily rags, oil filters, absorbents	0,78	5,0	2	3	1,8	27,9	2	24
Solvents	0,35	2,5	1	1	0,9	13,9	1	12
Packing	4	42	12	19	13	212	13	179
(Oil) contaminated packing	0,625	4,0	1	2	10	22,3	1	19
Dunnage, lining, strapping etc	45	10	13	48	10	21	244	106
Metals	617,2	1.549	1	4	1	2.436	0	5
Batteries, lead acid batteries[8]	0,25	1,4	0	1	0,5	8,0	1	7

[6] Dubrovnik had an average of 15000 landings between 2004 and 2008; Split had an average of 30000 landings between 2004 and 2008; Rijeka had an average of 16800 landings between 2004 and 2008; Zadar had an average of 12000 landings between 2004 and 2008; 40kg would be about 0.2m³, which is about 10% of the absolute amount of Ploce, which only has 10% of the landings of Dubrovnik. Therefore the ships landing in Dubrovnik would only produce 1% of oil-contaminated rags etc. than ships landing in Ploce, which is not plausible; Ploce can be considered comparable because it has the same ratio of household similar waste/landing; For estimation purposes we use the proportion which is used in the other ports.

[7] Waste Management Plan in the Republic of Croatia for the period from 2007 to 2015

[8] Estimated at 0.1% of total household similar waste

Other hazardous waste[9]	0,3	1,4	0	1	0,5	8,0	1	7
Plausibility Check: Average landings 2008	**8.035**	**17.208**	**2.196**	**13.299**	**3.433**	**30.454**	**1308**	**16.879**
Plausibility Check: m³ per landing	**0,03**	**0,08**	**0,20**	**0,05**	**0,15**	**0,26**	**0,39**	**0,40**

A prognosis of compositions was based on average calculations and benchmark calculations of wastes, based on current generation in order to identify collection volumes. Those separate collections are based legally on EU directives, by the waste management plan of Croatia (2007 –2015) and by the waste frame law of Croatia on how to handle household and household similar wastes.

In the following tables are all generated wastes investigated according to current waste generation, taking recyclables into consideration and split into months in accordance to arrivals of Dubrovnik and Split per months.

These calculations allow to identify the required collection system and volume in regard to a minimum required collection interval. Further are long term prognosis calculations carried out in order to understand the possible tendency and required future system adaption.

The footnotes 10[10] are valid for each of the following tables.

[9] Paints, acids, leys, end of life electrical equipment, toner cartridges, etc.

[10] * Waste Management Plan in the Republic of Croatia for the period from 2007 to 2015

** estimated at 0.1% of total household similar waste

*** paints, acids, lyes, end of life electrical equipment, toner cartridges, etc.

d=daily, w=weekly, m=monthly; a.r. = as required

Table 10_ Yearly and monthly waste generation _Port of Pula

Pula		**Month**												
all units in m³, waste amounts 2008, partially estimated		**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
food waste		45	1,1	1,2	1,2	1,9	4,3	6,3	9,0	8,8	6,5	2,6	1,2	1,0
container type and size	*3 wheelie bins, 1,100l*		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
empty schedule	*weekly*		*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*
plastic		60	1,4	1,5	1,6	2,6	5,7	8,4	12,0	11,8	8,6	3,5	1,5	1,3
container type and size	*1 rear end loader, lid, 4.6m³*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*monthly*		*m*	*m*	*m*	*m*	*m*	*w*	*w*	*w*	*w*	*m*	*m*	*m*
glass (15.6%)*		39	0,9	1,0	1,1	1,7	3,7	5,5	7,8	7,7	5,6	2,3	1,0	0,8
container type and size	*4 wheelie bins, 1,100l*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
paper and cardboard (28.3%)*		71	1,7	1,8	1,9	3,0	6,8	9,9	14,1	13,9	10,1	4,1	1,8	1,5
container type and size	*2 rear end loaders, lid, 4.6m³*		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
other		35	0,8	0,9	1,0	1,5	3,4	4,9	7,0	6,9	5,1	2,0	0,9	0,8
container type and size	*4 wheelie bins, 660l*		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
empty schedule	*weekly*		*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*
total household similar waste (HSW)		**250**	**6**	**6**	**7**	**11**	**24**	**35**	**50**	**49**	**36**	**14**	**6**	**5**
oily rags, oil filters, absorbents		0,8	0,02	0,02	0,02	0,03	0,1	0,1	0,2	0,2	0,1	0,05	0,02	0,02
container type and size	*2 clip top drums, 200l*		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
solvents		0,4	0,01	0,01	0,01	0,01	0,03	0,05	0,1	0,1	0,1	0,02	0,01	0,01
container type and size	*4 clip top drum, 200l*		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
packing		4	0,1	0,1	0,1	0,2	0,4	0,6	0,8	0,8	0,6	0,2	0,1	0,1

container type and size	*2 wheelie bins, 660l*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
(oil) contaminated packing		0,6	0,01	0,02	0,02	0,03	0,1	0,1	0,1	0,1	0,1	0,04	0,02	0,01
container type and size	*2 clip top drums, 200l*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
otpad od tereta (dunnage, lining, strapping etc.)		45,0	1,1	1,2	1,2	1,9	4,3	6,3	9,0	8,8	6,5	2,6	1,2	1,0
container type and size	*1 open skip, 4.6m³*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
metals		617	14,5	15,9	16,9	26,3	59,0	86,6	123,1	121,3	88,5	35,7	15,9	13,4
container type and size	*1 roll-on-roll-off container, 30.6m³*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
batteries, lead acid batteries (0.1% of HSW)		0,3	0,01	0,01	0,01	0,01	0,02	0,04	0,05	0,05	0,04	0,01	0,01	0,01
container type and size	*1 plastic box, 500l*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
other hazardous waste (0.1% of HSW)**'***		0,3	0,01	0,01	0,01	0,01	0,02	0,04	0,05	0,05	0,04	0,01	0,01	0,01
container type and size	*1 standard 20ft sea container*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
container type and size	*10 clip top drums, 200l*		*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*

arrivals per month, 2008														
Month		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
LK DUBROVNIK		189	207	220	343	768	1128	1603	1579	1152	465	207	174	8035
% of total		2,4%	2,6%	2,7%	4,3%	9,6%	14,0%	20,0%	19,7%	14,3%	5,8%	2,6%	2,2%	100%

Table 11_Tendency of waste generation until 2020_Port of Pula

assumed growth rate 3%/year	**Unit**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
food waste	m³/year	45	46	48	49	51	52	54	55	57	59	60	62	64
plastic	m³/year	60	62	64	66	68	70	72	74	76	78	81	83	86
glass (15.6%)*	m³/year	39	40	41	43	44	45	47	48	49	51	52	54	56
paper and cardboard (28.3%)*	m³/year	71	73	75	77	80	82	84	87	90	92	95	98	101
other	m³/year	35	36	37	39	40	41	42	43	45	46	47	49	50
total household similar waste	m³/year	**250**	**258**	**265**	**273**	**281**	**290**	**299**	**307**	**317**	**326**	**336**	**346**	**356**
oily rags, oil filters, absorbents	m³/year	0,8	0,8	0,8	0,9	0,9	0,9	0,9	1,0	1,0	1,0	1,0	1,1	1,1
solvents	m³/year	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,5	0,5	0,5	0,5
packing	m³/year	4	4	4	4	5	5	5	5	5	5	5	6	6
(oil) contaminated packing	m³/year	0,6	0,6	0,7	0,7	0,7	0,7	0,7	0,8	0,8	0,8	0,8	0,9	0,9
otpad od tereta (dunnigs, lining, strapping etc)	m³/year	45	46	48	49	51	52	54	55	57	59	60	62	64
metals	m³/year	617,2	635,7	654,8	674,4	694,7	715,5	737,0	759,1	781,9	805,3	829,5	854,3	880,0
batteries, lead acid batteries	m³/year	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,4
other hazardous waste	m³/year	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,4

Table 12_Yearly and monthly waste generation Rijeka

Rijeka		Month												
all units in m³, waste amounts 2008, partially estimated		**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
food waste		213	8,2	8,5	10,2	12,4	21,7	25,8	34,8	36,2	23,2	13,8	10,0	7,6
container type and size	*3 rear end loaders, 4.6m³, lid*		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
empty schedule	*weekly*		w	w	w	w	w	w	w	w	w	w	w	w
plastic		417	16,0	16,7	20,1	24,3	42,6	50,6	68,3	71,1	45,5	27,1	19,7	15,0
container type and size	*2 mobile compactors, 8m³*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.
glass (15.6%)*		226	8,7	9,1	10,9	13,2	23,1	27,4	37,0	38,5	24,7	14,7	10,6	8,1
container type and size	*2 rear end loaders, 6.1m³, lid*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*monthly/weekly*		m	m	m	w	w	w	w	w	w	w	m	m
paper and cardboard (28.3%)*		410	15,8	16,4	19,7	23,9	41,9	49,7	67,1	69,9	44,7	26,6	19,3	14,7
container type and size	*1 mobile compactor, 12m³*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.
other		183	7,0	7,3	8,8	10,6	18,7	22,2	30,0	31,2	20,0	11,9	8,6	6,6
container type and size	*1 rear end loaders, 10.7m³, lid*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*monthly/weekly*		m	m	m	m	w	w	w	w	w	m	m	m
total household similar waste (HSW)		**1.448**	**56**	**58**	**70**	**84**	**148**	**176**	**237**	**247**	**158**	**94**	**68**	**52**
oily rags, oil filters, absorbents		5,0	0,2	0,2	0,2	0,3	0,5	0,6	0,8	0,9	0,5	0,3	0,2	0,2
container type and size	*1 wheelie bin, 1,100l, steel*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.
solvents		2,5	0,1	0,1	0,1	0,1	0,3	0,3	0,4	0,4	0,3	0,2	0,1	0,1
container type and size	*4 clip top drums, 200l*		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
empty schedule	*as required*		a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.

packing		42	1,6	1,7	2,0	2,4	4,3	5,1	6,8	7,1	4,6	2,7	2,0	1,5
container type and size	*1 rear end loader, 10.7m³, lid*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*monthly*		m	m	m	m	w	w	w	w	w	m	m	m
(oil) contaminated packing		4,0	0,2	0,2	0,2	0,2	0,4	0,5	0,7	0,7	0,4	0,3	0,2	0,1
container type and size	*1 wheelie bin, 1,100l, steel*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.
otpad od tereta (dunnage, lining, strapping etc.)		10,5	0,4	0,4	0,5	0,6	1,1	1,3	1,7	1,8	1,1	0,7	0,5	0,4
container type and size	*1 open skip, 10.7m³*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.
metals		1.549	60	62	75	90	158	188	254	264	169	101	73	56
container type and size	*3 roll-on-roll-off containers, 30.6m³*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.
batteries, lead acid batteries (0.1% of HSW)		1,4	0,06	0,06	0,07	0,08	0,15	0,18	0,24	0,25	0,16	0,09	0,07	0,05
container type and size	*2 plastic boxes, 500l*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.
other hazardous waste (0.1% of HSW)**:***		1,4	0,06	0,06	0,07	0,08	0,15	0,18	0,24	0,25	0,16	0,09	0,07	0,05
container type and size	*1 standard 20ft sea container*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
container type and size	*20 clip top drums, 200l*		*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*

arrivals per month, 2008													
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
LK DUBROVNIK	662	690	829	1002	1758	2089	2819	2934	1879	1118	811	617	17208
% of total	3,8%	4,0%	4,8%	5,8%	10,2%	12,1%	16,4%	17,1%	10,9%	6,5%	4,7%	3,6%	100%

Table 13_Tendency of waste generation until 2020_Port of Rijeka

assumed growth rate 3%/year	**Unit**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
food waste	m³/year	213	219	225	232	239	246	254	261	269	277	286	294	303
plastic	m³/year	417	430	442	456	469	483	498	513	528	544	560	577	595
glass (15.6%)*	m³/year	226	233	240	247	254	262	270	278	286	295	304	313	322
paper and cardboard (28.3%)*	m³/year	410	422	435	448	461	475	489	504	519	535	551	567	584
other	m³/year	183	188	194	200	206	212	218	225	232	239	246	253	261
total household similar waste	m³/year	**1.448**	**1.491**	**1.536**	**1.582**	**1.630**	**1.679**	**1.729**	**1.781**	**1.834**	**1.889**	**1.946**	**2.004**	**2.065**
oily rags, oil filters, absorbents	m³/year	5,0	5,2	5,3	5,5	5,7	5,8	6,0	6,2	6,4	6,6	6,8	7,0	7,2
solvents	m³/year	2,5	2,6	2,7	2,8	2,8	2,9	3,0	3,1	3,2	3,3	3,4	3,5	3,6
packing	m³/year	42	43	44	46	47	48	50	51	53	54	56	58	59
(oil) contaminated packing	m³/year	4,0	4,1	4,3	4,4	4,5	4,7	4,8	5,0	5,1	5,3	5,4	5,6	5,7
otpad od tereta (dunnigs, lining, strapping etc)	m³/year	10	11	11	11	12	12	12	13	13	14	14	14	15
metals	m³/year	######	1595,2	1643,0	1692,3	1743,1	1795,4	1849,3	1904,7	1961,9	2020,7	2081,4	2143,8	2208,1
batteries, lead acid batteries	m³/year	1,4	1,5	1,5	1,6	1,6	1,7	1,7	1,8	1,8	1,9	1,9	2,0	2,1
other hazardous waste	m³/year	1,4	1,5	1,5	1,6	1,6	1,7	1,7	1,8	1,8	1,9	1,9	2,0	2,1

Table 14_Yearly and monthly waste generation Senj

Senj		Month												
all units in m³, waste amounts 2008, partially estimated		**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
food waste		72	3,8	3,5	4,9	6,5	8,3	7,8	8,4	10,2	6,4	4,4	3,8	3,6
container type and size	*4 wheelie bins, 1,100l*		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
empty schedule	*weekly*		w	w	w	w	w	w	w	w	w	w	w	w
plastic		116	6,2	5,6	8,0	10,4	13,5	12,6	13,7	16,5	10,3	7,1	6,1	5,9
container type and size	*2 rear end loaders, lid, 9.2m³*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*monthly*		m	m	m	m	m	m	m	m	m	m	m	m
glass (15.6%)*		68	3,6	3,3	4,7	6,2	8,0	7,4	8,1	9,8	6,1	4,2	3,6	3,5
container type and size	*4 wheelie bins, 1,100l*		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
empty schedule	*as required*		a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.
paper and cardboard (28.3%)*		124	6,6	6,0	8,5	11,2	14,5	13,5	14,7	17,7	11,1	7,6	6,6	6,3
container type and size	*1 rear end loader, lid, 9.2m³*		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
empty schedule	*as required*		a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.
other		59	3,1	2,8	4,0	5,3	6,9	6,4	6,9	8,4	5,3	3,6	3,1	3,0
container type and size	*3 wheelie bins, 1,100l*		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
empty schedule	*weekly*		w	w	w	w	w	w	w	w	w	w	w	w
total household similar waste (HSW)		**439**	**23**	**21**	**30**	**40**	**51**	**48**	**52**	**63**	**39**	**27**	**23**	**22**
oily rags, oil filters, absorbents		1,5	0,1	0,1	0,1	0,1	0,2	0,2	0,2	0,2	0,1	0,1	0,1	0,1
container type and size	*2 clip top drums, 200l*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.
solvents		0,8	0,04	0,04	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,05	0,04	0,04
container type and size	*4 clip top drums, 200l*		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
empty schedule	*as required*		a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.

packing		12	0,6	0,6	0,8	1,0	1,4	1,3	1,4	1,7	1,0	0,7	0,6	0,6
container type and size	*2 wheelie bins, 1,100l*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*monthly*		m	m	m	m	m	m	m	m	m	m	m	m
(oil) contaminated packing		1,2	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,2	0,1	0,1	0,1	0,1
container type and size	*2 clip top drums, 200l*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.
otpad od tereta (dunnage, lining, strapping etc.)		13,2	0,7	0,6	0,9	1,2	1,5	1,4	1,6	1,9	1,2	0,8	0,7	0,7
container type and size	*1 open skip, 4.6m³*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.
metals		0,7	0,04	0,03	0,05	0,06	0,08	0,07	0,08	0,09	0,06	0,04	0,03	0,03
container type and size	*1 wheelie bin, 1,100l*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.
batteries, lead acid batteries (0.1% of HSW)		0,4	0,02	0,02	0,03	0,04	0,05	0,05	0,05	0,06	0,04	0,03	0,02	0,02
container type and size	*1 plastic box, 500l*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.	a.r.
other hazardous waste (0.1% of HSW)**;***		0,4	0,02	0,02	0,03	0,04	0,05	0,05	0,05	0,06	0,04	0,03	0,02	0,02
container type and size	*1 standard 20ft sea container*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
container type and size	*10 clip top drums, 200l*		*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*

arrivals per month, 2008													
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
LK SENJ	117	106	151	198	256	238	259	313	196	134	116	112	2196
% of total	5,3%	4,8%	6,9%	9,0%	11,7%	10,8%	11,8%	14,3%	8,9%	6,1%	5,3%	5,1%	100%

Table 15_Tendency of waste generation until 2020_Port of Senj

assumed growth rate 3%/year	**Unit**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
food waste	m³/year	72	74	76	78	81	83	85	88	91	93	96	99	102
plastic	m³/year	116	119	123	127	130	134	138	143	147	151	156	160	165
glass (15.6%)*	m³/year	68	71	73	75	77	79	82	84	87	89	92	95	98
paper and cardboard (28.3%)*	m³/year	124	128	132	136	140	144	148	153	157	162	167	172	177
other	m³/year	59	61	62	64	66	68	70	72	75	77	79	81	84
total household similar waste	m³/year	**439**	**452**	**466**	**480**	**494**	**509**	**524**	**540**	**556**	**573**	**590**	**608**	**626**
oily rags, oil filters, absorbents	m³/year	1,5	1,6	1,6	1,7	1,7	1,8	1,8	1,9	1,9	2,0	2,1	2,1	2,2
solvents	m³/year	0,8	0,8	0,8	0,8	0,9	0,9	0,9	0,9	1,0	1,0	1,0	1,1	1,1
packing	m³/year	12	12	12	13	13	13	14	14	15	15	16	16	17
(oil) contaminated packing	m³/year	1,2	1,3	1,3	1,3	1,4	1,4	1,5	1,5	1,5	1,6	1,6	1,7	1,7
otpad od tereta (dunnigs, lining, strapping etc)	m³/year	13	14	14	14	15	15	16	16	17	17	18	18	19
metals	m³/year	0,7	0,7	0,7	0,7	0,7	0,8	0,8	0,8	0,8	0,9	0,9	0,9	0,9
batteries, lead acid batteries	m³/year	0,4	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,6	0,6	0,6	0,6	0,6
other hazardous waste	m³/year	0,4	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,6	0,6	0,6	0,6	0,6

Table 16_Yearly and monthly waste generation Sibenik

Sibenik		**Month**												
all units in m³, waste amounts 2008, partially estimated		**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
food waste		82	5,0	5,2	6,4	7,3	7,8	7,9	10,3	11,3	7,1	4,4	4,6	4,8
container type and size	*4 wheelie bins, 1,100l*		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
empty schedule	*weekly*		*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*
plastic		133	8,0	8,4	10,4	11,9	12,6	12,8	16,7	18,4	11,5	7,2	7,4	7,8
container type and size	*2 rear end loaders, lid, 9.2m³*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*monthly*		*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*
glass (15.6%)*		79	4,7	5,0	6,2	7,0	7,5	7,6	9,8	10,9	6,8	4,2	4,4	4,6
container type and size	*4 wheelie bins, 1,100l*		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r*
paper and cardboard (28.3%)*		143	8,6	9,0	11,2	12,7	13,5	13,8	17,9	19,7	12,3	7,7	8,0	8,3
container type and size	*1 rear end loader, lid, 9.2m³*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r*
other		68	4,1	4,3	5,3	6,0	6,4	6,5	8,5	9,3	5,8	3,6	3,8	3,9
container type and size	*3 wheelie bins, 1,100l*		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
empty schedule	*weekly*		*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*
total household similar waste (HSW)		**504**	**30**	**32**	**39**	**45**	**48**	**49**	**63**	**70**	**43**	**27**	**28**	**29**
oily rags, oil filters, absorbents		1,8	0,1	0,1	0,1	0,2	0,2	0,2	0,2	0,2	0,2	0,1	0,1	0,1
container type and size	*2 clip top drums, 200l*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r*
solvents		0,9	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,05	0,05	0,1
container type and size	*4 clip top drums, 200l*		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r*

packing		13	0,8	0,8	1,0	1,2	1,3	1,3	1,7	1,8	1,1	0,7	0,7	0,8
container type and size	*2 wheelie bins, 1,100l*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*monthly*		*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*
(oil) contaminated packing		10,0	0,6	0,6	0,8	0,9	0,9	1,0	1,3	1,4	0,9	0,5	0,6	0,6
container type and size	*3 clip top drums, 200l*		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r*
otpad od tereta (dunnage, lining, strapping etc.)		10,0	0,6	0,6	0,8	0,9	0,9	1,0	1,3	1,4	0,9	0,5	0,6	0,6
container type and size	*1open skip, 4.6m³*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r*
metals		1,0	0,06	0,06	0,08	0,09	0,09	0,10	0,13	0,14	0,09	0,05	0,06	0,06
container type and size	*1 wheelie bin, 1,100l*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r*
batteries, lead acid batteries (0.1% of HSW)		0,5	0,03	0,03	0,04	0,04	0,05	0,05	0,06	0,07	0,04	0,03	0,03	0,03
container type and size	*1 plastic box, 500l*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r*
other hazardous waste (0.1% of HSW)**;***		0,5	0,03	0,03	0,04	0,04	0,05	0,05	0,06	0,07	0,04	0,03	0,03	0,03
container type and size	*1 standard 20ft sea container*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
container type and size	*10 clip top drums, 200l*		*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r*

arrivals per month, 2008													
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
LK DUBROVNIK	207	217	269	306	326	331	430	474	296	185	192	200	3433
% of total	6,0%	6,3%	7,8%	8,9%	9,5%	9,6%	12,5%	13,8%	8,6%	5,4%	5,6%	5,8%	100%

Table 17_Tendency of waste generation until 2020_Port of Sibenik

assumed growth rate 3%/year	**Unit**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
food waste	m³/year	82	85	87	90	92	95	98	101	104	107	110	114	117
plastic	m³/year	133	137	141	145	150	154	159	164	169	174	179	184	190
glass (15.6%)*	m³/year	79	81	83	86	88	91	94	97	100	103	106	109	112
paper and cardboard (28.3%)*	m³/year	143	147	151	156	161	165	170	175	181	186	192	197	203
other	m³/year	68	70	72	74	76	78	81	83	86	88	91	93	96
total household similar waste	m³/year	**504**	**519**	**535**	**551**	**567**	**584**	**602**	**620**	**638**	**658**	**677**	**698**	**719**
oily rags, oil filters, absorbents	m³/year	1,8	1,8	1,9	1,9	2,0	2,0	2,1	2,2	2,2	2,3	2,4	2,4	2,5
solvents	m³/year	0,9	0,9	0,9	1,0	1,0	1,0	1,0	1,1	1,1	1,1	1,2	1,2	1,2
packing	m³/year	13	14	14	15	15	15	16	16	17	17	18	18	19
(oil) contaminated packing	m³/year	10,0	10,3	10,6	10,9	11,3	11,6	11,9	12,3	12,7	13,0	13,4	13,8	14,3
otpad od tereta (dunnigs, lining, strapping etc)	m³/year	10	10	11	11	11	12	12	12	13	13	13	14	14
metals	m³/year	1,0	1,0	1,1	1,1	1,1	1,2	1,2	1,2	1,3	1,3	1,3	1,4	1,4
batteries, lead acid batteries	m³/year	0,5	0,5	0,5	0,6	0,6	0,6	0,6	0,6	0,6	0,7	0,7	0,7	0,7
other hazardous waste	m³/year	0,5	0,5	0,5	0,6	0,6	0,6	0,6	0,6	0,6	0,7	0,7	0,7	0,7

Table 18_Yearly and monthly waste generation Sibenik

Split	Split	**Month**												
all units in m³, waste amounts 2008, partially estimated		**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
food waste		1.308	66,4	65,4	71,0	73,6	112,3	150,8	194,0	206,8	159,0	85,7	62,7	59,9
container type and size	*6 rear end loaders, 10.7m³, lid*		*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*
empty schedule	*weekly*		*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*
plastic		2.118	107,5	105,9	115,0	119,3	181,9	244,3	314,2	335,0	257,4	138,7	101,5	97,0
container type and size	*2 mobile compactors, 24m³*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
glass (15.6%)*		1.251	63,5	62,6	68,0	70,5	107,5	144,4	185,7	197,9	152,1	82,0	60,0	57,3
container type and size	*8 rear end loaders, 10.7m³, lid*		*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*
empty schedule	*monthly/weekly*		*m*	*m*	*m*	*m*	*w*	*w*	*w*	*w*	*w*	*m*	*m*	*m*
paper and cardboard (28.3%)*		2.270	115,2	113,5	123,3	127,8	195,0	261,9	336,8	359,1	276,0	148,7	108,8	104,0
container type and size	*2 mobile compactors, 24m³*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
other		1.075	54,6	53,8	58,4	60,5	92,3	124,0	159,5	170,0	130,7	70,4	51,5	49,2
container type and size	*2 mobile compactors, 24m³*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
total household similar waste (HSW)		**8.022**	**407**	**401**	**436**	**452**	**689**	**925**	**1.190**	**1.269**	**975**	**526**	**385**	**367**
oily rags, oil filters, absorbents		27,9	1,4	1,4	1,5	1,6	2,4	3,2	4,1	4,4	3,4	1,8	1,3	1,3
container type and size	*2 wheelie bins, 1,100l, steel*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*monthly/weekly*		*m*	*m*	*m*	*m*	*w*	*w*	*w*	*w*	*w*	*m*	*m*	*m*
solvents		13,9	0,7	0,7	0,8	0,8	1,2	1,6	2,1	2,2	1,7	0,9	0,7	0,6
container type and size	*8 clip top drums, 200l*		*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*	*8*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
packing		212	10,8	10,6	11,5	11,9	18,2	24,4	31,4	33,5	25,7	13,9	10,2	9,7

container type and size	*1 mobile compactor, 8m³*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
(oil) contaminated packing		22,3	1,1	1,1	1,2	1,3	1,9	2,6	3,3	3,5	2,7	1,5	1,1	1,0
container type and size	*2 wheelie bins, 1,100l, steel*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*monthly/weekly*		*m*	*m*	*m*	*m*	*w*	*w*	*w*	*w*	*w*	*m*	*m*	*m*
otpad od tereta (dunnage, lining, strapping etc.)		20,6	1,0	1,0	1,1	1,2	1,8	2,4	3,1	3,3	2,5	1,3	1,0	0,9
container type and size	*1 mobile compactor, 8m³*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
metals		2.436	124	122	132	137	209	281	361	385	296	160	117	112
container type and size	*5 roll-on-roll-off containers, 30.6m³*		*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
batteries, lead acid batteries (0.1% of HSW)		8,0	0,41	0,40	0,44	0,45	0,69	0,93	1,19	1,27	0,98	0,53	0,38	0,37
container type and size	*2 plastic boxes, 500l*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
other hazardous waste (0.1% of HSW)**;***		8,0	0,41	0,40	0,44	0,45	0,69	0,93	1,19	1,27	0,98	0,53	0,38	0,37
container type and size	*1 standard 20ft sea container*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
container type and size	*20 clip top drums, 200l*		*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*

arrivals per month, 2008														
Month		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
LK DUBROVNIK		1546	1523	1654	1715	2616	3513	4518	4817	3702	1995	1460	1395	30454
% of total		5,1%	5,0%	5,4%	5,6%	8,6%	11,5%	14,8%	15,8%	12,2%	6,6%	4,8%	4,6%	100%

Table 19_Tendency of waste generation until 2020_Port of Split

assumed growth rate 3%/year	**Unit**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
food waste	m³/year	1.308	1.347	1.387	1.429	1.472	1.516	1.561	1.608	1.656	1.706	1.757	1.810	1.864
plastic	m³/year	2.118	2.181	2.247	2.314	2.384	2.455	2.529	2.605	2.683	2.763	2.846	2.932	3.019
glass (15.6%)*	m³/year	1.251	1.289	1.328	1.367	1.408	1.451	1.494	1.539	1.585	1.633	1.682	1.732	1.784
paper and cardboard (28.3%)*	m³/year	2.270	2.338	2.408	2.481	2.555	2.632	2.711	2.792	2.876	2.962	3.051	3.143	3.237
other	m³/year	1.075	1.107	1.140	1.175	1.210	1.246	1.284	1.322	1.362	1.403	1.445	1.488	1.533
total household similar waste	m³/year	**8.022**	**8.263**	**8.511**	**8.766**	**9.029**	**9.300**	**9.579**	**9.866**	**10.162**	**10.467**	**10.781**	**11.104**	**11.437**
oily rags, oil filters, absorbents	m³/year	27,9	28,7	29,6	30,5	31,4	32,3	33,3	34,3	35,3	36,4	37,5	38,6	39,8
solvents	m³/year	13,9	14,4	14,8	15,2	15,7	16,2	16,7	17,2	17,7	18,2	18,7	19,3	19,9
packing	m³/year	212	218	225	231	238	246	253	260	268	276	285	293	302
(oil) contaminated packing	m³/year	22,3	23,0	23,7	24,4	25,1	25,9	26,7	27,4	28,3	29,1	30,0	30,9	31,8
otpad od tereta (dunnigs, lining, strapping etc)	m³/year	21	21	22	23	23	24	25	25	26	27	28	29	29
metals	m³/year	2.436,3	2509,4	2584,7	2662,2	2742,1	2824,4	2909,1	2996,4	3086,3	3178,8	3274,2	3372,4	3473,6
batteries, lead acid batteries	m³/year	8,0	8,3	8,5	8,8	9,0	9,3	9,6	9,9	10,2	10,5	10,8	11,1	11,4
other hazardous waste	m³/year	8,0	8,3	8,5	8,8	9,0	9,3	9,6	9,9	10,2	10,5	10,8	11,1	11,4

Table 20_Yearly and monthly waste generation Zadar

Zadar		Month												
all units in m³, waste amounts 2008, partially estimated		**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
food waste		119	7,4	8,0	8,8	9,4	10,5	10,9	12,7	13,6	11,0	9,6	8,6	8,5
container type, size and number:	*4 wheelie bins, 1,100l*		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
empty schedule	*weekly*		*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*
plastic		193	12,0	12,9	14,3	15,3	16,9	17,6	20,5	22,0	17,9	15,5	13,9	13,8
container type and size	*3 rear end loaders, lid, 9.2m³*		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
empty schedule	*monthly*		*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*
glass (15.6%)*		114	7,1	7,6	8,4	9,0	10,0	10,4	12,1	13,0	10,6	9,2	8,2	8,1
container type and size	*4 wheelie bins, 1,100l*		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
empty schedule	*weekly*		*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*
paper and cardboard (28.3%)*		207	12,9	13,9	15,3	16,4	18,2	18,9	22,0	23,6	19,2	16,7	14,9	14,8
container type and size	*3 rear end loaders, lid, 9.2m³*		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
empty schedule	*monthly*		*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*
other		98	6,1	6,6	7,2	7,7	8,6	9,0	10,4	11,2	9,1	7,9	7,1	7,0
container type and size	*3 wheelie bins, 1,100l*		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*
empty schedule	*weekly*		*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*
total household similar waste (HSW)		**730**	**46**	**49**	**54**	**58**	**64**	**67**	**78**	**83**	**68**	**59**	**53**	**52**
oily rags, oil filters, absorbents		2,8	0,2	0,2	0,2	0,2	0,2	0,3	0,3	0,3	0,3	0,2	0,2	0,2
container type and size	*2 clip top drums, 200l*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
solvents		1,4	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,2	0,1	0,1	0,1	0,1
container type and size	*4 clip top drums, 200l*		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
packing		19	1,2	1,3	1,4	1,5	1,7	1,8	2,1	2,2	1,8	1,6	1,4	1,4

container type and size	*2 wheelie bins, 1,100l*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*monthly*		*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*m*
(oil) contaminated packing		2,2	0,1	0,2	0,2	0,2	0,2	0,2	0,2	0,3	0,2	0,2	0,2	0,2
container type and size	*1 clip top drum, 200l*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
otpad od tereta (dunnage, lining, strapping etc.)		48,2	3,0	3,2	3,6	3,8	4,2	4,4	5,1	5,5	4,5	3,9	3,5	3,4
container type and size	*1open skip, 9.3m³*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
metals		4	0,2	0,3	0,3	0,3	0,4	0,4	0,4	0,5	0,4	0,3	0,3	0,3
container type and size	*1 wheelie bin, 1,100l*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
batteries, lead acid batteries (0.1% of HSW)		0,7	0,05	0,05	0,05	0,06	0,06	0,07	0,08	0,08	0,07	0,06	0,05	0,05
container type and size	*1 plastic box, 500l*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
other hazardous waste (0.1% of HSW)**;***		0,7	0,05	0,05	0,05	0,06	0,06	0,07	0,08	0,08	0,07	0,06	0,05	0,05
container type and size	*1 standard 20ft sea container*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
container type and size	*10 clip top drums, 200l*		*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*	*10*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*

arrivals per month, 2008													
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
LK DUBROVNIK	830	893	985	1053	1169	1217	1418	1517	1233	1072	962	950	13299
% of total	6,2%	6,7%	7,4%	7,9%	8,8%	9,2%	10,7%	11,4%	9,3%	8,1%	7,2%	7,1%	100%

Table 21_Tendency of waste generation until 2020_Port of Zadar

assumed growth rate 3%/year	**Unit**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
food waste	m³/year	119	123	126	130	134	138	142	146	151	155	160	165	170
plastic	m³/year	193	199	204	211	217	223	230	237	244	251	259	267	275
glass (15.6%)*	m³/year	114	117	121	124	128	132	136	140	144	149	153	158	162
paper and cardboard (28.3%)*	m³/year	207	213	219	226	233	239	247	254	262	270	278	286	295
other	m³/year	98	101	104	107	110	113	117	120	124	128	131	135	139
total household similar waste	m³/year	**730**	**752**	**774**	**798**	**822**	**846**	**872**	**898**	**925**	**952**	**981**	**1.010**	**1.041**
oily rags, oil filters, absorbents	m³/year	2,8	2,9	3,0	3,1	3,2	3,2	3,3	3,4	3,5	3,7	3,8	3,9	4,0
solvents	m³/year	1,4	1,4	1,5	1,5	1,6	1,6	1,7	1,7	1,8	1,8	1,9	1,9	2,0
packing	m³/year	19	20	20	21	22	22	23	24	24	25	26	27	27
(oil) contaminated packing	m³/year	2,2	2,3	2,4	2,4	2,5	2,6	2,7	2,8	2,8	2,9	3,0	3,1	3,2
otpad od tereta (dunnigs, lining, strapping etc)	m³/year	48	50	51	53	54	56	58	59	61	63	65	67	69
metals	m³/year	4,0	4,1	4,2	4,4	4,5	4,6	4,8	4,9	5,1	5,2	5,4	5,5	5,7
batteries, lead acid batteries	m³/year	0,7	0,8	0,8	0,8	0,8	0,8	0,9	0,9	0,9	1,0	1,0	1,0	1,0
other hazardous waste	m³/year	0,7	0,8	0,8	0,8	0,8	0,8	0,9	0,9	0,9	1,0	1,0	1,0	1,0

Table 22_Yearly and monthly waste generation Dubrovnik

Dubrovnik		Month												
all units in m³, waste amounts 2008, partially estimated		**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
food waste		1.103	56,9	56,3	57,0	62,4	87,5	130,1	144,1	149,0	144,3	86,9	66,2	62,6
container type and size	*6 rear end loaders, 10.7m³, lid*		*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*
empty schedule	*weekly*		*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*	*w*
plastic		1.787	92,2	91,2	92,3	101,1	141,8	210,8	233,3	241,4	233,7	140,7	107,1	101,4
container type and size	*2 mobile compactors, 16m³*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
glass (15.6%)*		1.056	54,5	53,9	54,6	59,7	83,8	124,6	137,9	142,6	138,1	83,1	63,3	59,9
container type and size	*6 rear end loaders, 10.7m³, lid*		*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*
empty schedule	*monthly/weekly*		*m*	*m*	*m*	*m*	*w*	*w*	*w*	*w*	*w*	*w*	*m*	*m*
paper and cardboard (28.3%)*		1.916	98,9	97,7	99,0	108,4	152,0	226,0	250,1	258,8	250,5	150,8	114,9	108,7
container type and size	*2 mobile compactors, 16m³*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
other		907	46,8	46,3	46,9	51,3	72,0	107,0	118,4	122,5	118,6	71,4	54,4	51,5
container type and size	*2 mobile compactors, 8m³*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
total household similar waste (HSW)		**6.769**	**349**	**345**	**350**	**383**	**537**	**798**	**884**	**914**	**885**	**533**	**406**	**384**
oily rags, oil filters, absorbents		23,5	1,2	1,2	1,2	1,3	1,9	2,8	3,1	3,2	3,1	1,9	1,4	1,3
container type and size	*2 wheelie bins, 1,100l, steel*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*monthly/weekly*		*m*	*m*	*m*	*m*	*m*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*m*	*m*	*m*
solvents		11,8	0,6	0,6	0,6	0,7	0,9	1,4	1,5	1,6	1,5	0,9	0,7	0,7
container type and size	*4 clip top drums, 200l*		*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*
empty schedule	*as required*		*m*	*m*	*m*	*m*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*m*	*m*

packing		179	9,2	9,1	9,2	10,1	14,2	21,1	23,3	24,1	23,4	14,1	10,7	10,1
container type and size	*1 mobile compactor, 8m³*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
(oil) contaminated packing		18,8	1,0	1,0	1,0	1,1	1,5	2,2	2,5	2,5	2,5	1,5	1,1	1,1
container type and size	*2 wheelie bins, 1,100l, steel*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*monthly/weekly*		*m*	*m*	*m*	*m*	*m*	*m*	*a.r.*	*a.r.*	*a.r.*	*m*	*m*	*m*
otpad od tereta (dunnage, lining, strapping etc.)		106,4	5,5	5,4	5,5	6,0	8,4	12,5	13,9	14,4	13,9	8,4	6,4	6,0
container type and size	*1 open skip, 10.7m³*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
metals		5,1	0,3	0,3	0,3	0,3	0,4	0,6	0,7	0,7	0,7	0,4	0,3	0,3
container type and size	*1 wheelie bin, 1,100l*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
batteries, lead acid batteries (0.1% of HSW)		6,8	0,35	0,35	0,35	0,38	0,54	0,80	0,88	0,91	0,89	0,53	0,41	0,38
container type and size	*2 plastic boxes, 500l*		*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*	*2*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*
other hazardous waste (0.1% of HSW)******		6,8	0,35	0,35	0,35	0,38	0,54	0,80	0,88	0,91	0,89	0,53	0,41	0,38
container type and size	*1 standard 20ft sea container*		*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
empty schedule	*20 clip top drums, 200l*		*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*	*20*
empty schedule	*as required*		*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*	*a.r.*

arrivals per month, 2008													
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
LK DUBROVNIK	871	861	872	955	1339	1991	2204	2280	2207	1329	1012	958	16879
% of total	5,2%	5,1%	5,2%	5,7%	7,9%	11,8%	13,1%	13,5%	13,1%	7,9%	6,0%	5,7%	100%

Table 23_Tendency of waste generation until 2020_Port of Dubrovnik

assumed growth rate 3%/year	**Year**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
food waste	m³/year	1.103	1.136	1.171	1.206	1.242	1.279	1.317	1.357	1.398	1.440	1.483	1.527	1.573
plastic	m³/year	1.787	1.841	1.896	1.953	2.011	2.072	2.134	2.198	2.264	2.332	2.402	2.474	2.548
glass (15.6%)*	m³/year	1.056	1.088	1.120	1.154	1.188	1.224	1.261	1.299	1.338	1.378	1.419	1.462	1.506
paper and cardboard (28.3%)*	m³/year	1.916	1.973	2.032	2.093	2.156	2.221	2.287	2.356	2.427	2.499	2.574	2.652	2.731
other	m³/year	907	934	962	991	1.021	1.052	1.083	1.116	1.149	1.183	1.219	1.256	1.293
total household similar waste (HSW)	m³/year	**6.769**	**6.972**	**7.181**	**7.397**	**7.619**	**7.847**	**8.083**	**8.325**	**8.575**	**8.832**	**9.097**	**9.370**	**9.651**
oily rags, oil filters, absorbents	m³/year	24	24,2	25,0	25,7	26,5	27,3	28,1	29,0	29,8	30,7	31,6	32,6	33,6
solvents	m³/year	12	12,1	12,5	12,9	13,2	13,6	14,1	14,5	14,9	15,4	15,8	16,3	16,8
packing	m³/year	179	184	190	195	201	207	213	220	226	233	240	247	255
(oil) contaminated packing	m³/year	19	19,4	20,0	20,6	21,2	21,8	22,5	23,2	23,9	24,6	25,3	26,1	26,9
otpad od tereta (dunnigs, lining, strapping etc)	m³/year	106	110	113	116	120	123	127	131	135	139	143	147	152
metals	m³/year	5	5,2	5,4	5,5	5,7	5,9	6,0	6,2	6,4	6,6	6,8	7,0	7,2
batteries, lead acid batteries	m³/year	7	7,0	7,2	7,4	7,6	7,8	8,1	8,3	8,6	8,8	9,1	9,4	9,7
other hazardous waste	m³/year	7												

4.5 Summary of required collection systems, volumes and intervals

4.5.1 Port of Pula

Solid wastes require 3 pieces of 1100 litre wheel container system by weekly emptying, plastics one lid container of 4.6 m³, monthly emptying, glass one wheel bin with a capacity of 1.1m³ (1100 litre) with an empty scheduling as required, paper and cardboard two lid containers with an empty scheduling as required, other wastes (mainly residues) four pieces of wheel bins with a capacity of 660l each and an weekly emptying schedule, for dunnage and others one open top skip with a volume of 4.6m³ and metals require one roll on-roll off container (30m³) with and emptying schedule as required.

Hazardous substances are mainly collected in 200 l UN bins, which shall be delivered from the ships in an exchange modus. Every deliverer shall collect hazardous substances separated in 200 l UN standard bins while minimum requirement is the separation of

- Oil contaminated materials in open top bin,
- Fluid wastes such as solvents and paintings in a fluid bin
- Empty contaminated packages from paintings in an open top bin
- Other chemical containing packages in an open top bin
- Batteries (acid containing – wet batteries) in an open top bin

Therefore the port requires the following amount of bins on exchange:

- For oil filters, absorbents two times 200 litre open top UN bins (clip top drums)
- For solvents four fluid UN-bins
- For contaminated packages (packing) 2 wheel bins each 660 litre
- For oil contaminated packing two pieces of open top UN bins
- For batteries either one plastic box (PE hardbox) or two open top UN-bins
- For other hazardous wastes, not specified within above list 10 reserve UN open top bins.

The collection-discharge (emptying) schedule is as required. The board shall have 20 open top UN-bins and 10 fluid UN-bins permanent in store for exchange purposes.

The sufficient container size for an intermediate storage at a reception facility at the board is 20 ft.

Non-labelled bins will not bee allowed to be received. A protocol with the amount of bins, amount of each hazardous waste categories and safety and precautionary status has to be handed over.

4.5.2 Port of Rijeka

Solid wastes require 3 pieces of 4.6 m³ lid container system by weekly emptying, plastics two mobile compactors, each 8 m³, emptying as required, glass two lid containers with a capacity of 4.6m³ each, and an empty scheduling of weekly or monthly depending on the seasonal situation, paper and cardboard one mobile compactor with 12m³ and an empty scheduling as required, other wastes (mainly residues) one piece of lid container with a capacity of 10.7m³ and an weekly emptying schedule, for dunning and others one open top skip with a volume of 10.7 m³ and metals require three roll on, roll off container (30m³) with and emptying schedule as required.

Hazardous substances are mainly collected in 200 l UN bins, which shall be delivered from the ships in an exchange modus. Every deliverer shall collect hazardous substances separated in 200 l UN standard bins while minimum requirement is the separation of

- Oil contaminated materials in open top bin,
- Fluid wastes such as solvents and paintings in a fluid bin
- Empty contaminated packages from paintings in an open top bin
- Other chemical containing packages in an open top bin
- Batteries (acid containing – wet batteries) in an open top bin

Therefore the port requires the following amount of bins on exchange:

- For oil filters, absorbents one wheel bin (1.100 litre) or five times 200 litre open top UN bins (clip top drums)
- For solvents four fluid UN-bins
- For contaminated packages (packing) one wheel bin (1.100 litre) or five times 200 litre open top UN bins (clip top drums)
- For oil contaminated packing one wheel bin (1.100 litre) or five times 200 litre open top UN bins (clip top drums)
- For batteries either two plastic boxes (500 litre PE hardbox) or five open top UN-bins
- For other hazardous wastes, not specified within above list 20 reserve UN open top bins.

The collection-discharge (emptying) schedule is as required. The board shall have 40 open top UN-bins and 20 fluid UN-bins permanent in store for exchange purposes.

The sufficient container size for an intermediate storage at a reception facility at the board is 20 ft.

Non-labelled bins will not bee allowed to be received. A protocol with the amount of bins, amount of each hazardous waste categories and safety and precautionary status has to be handed over.

4.5.3 Port of Senj

Solid wastes require 4 pieces of 1100 litre wheel container system by weekly emptying, plastics two lid container with 9.2 m³, monthly emptying, glass four wheel bins with a capacity of 1,1m³ (1100 litre) with an empty scheduling as required, paper and cardboard two lid containers (4.6) or one lid container (9.2) with an empty scheduling as required, other wastes (mainly residues) four pieces of wheel bins with a capacity of 1100l each and an weekly emptying schedule, for dunnage and others one open top skip with a volume of 4.6m³ and metals require one wheel bin (1100l) with and emptying schedule as required.

Hazardous substances are mainly collected in 200 l UN bins, which shall be delivered from the ships in an exchange modus. Every deliverer shall collect hazardous substances separated in 200 l UN standard bins while minimum requirement is the separation of

- Oil contaminated materials in open top bin,
- Fluid wastes such as solvents and paintings in a fluid bin
- Empty contaminated packages from paintings in an open top bin
- Other chemical containing packages in an open top bin
- Batteries (acid containing – wet batteries) in an open top bin

Therefore the port requires the following amount of bins on exchange:

- For oil filters, absorbents two times 200 litre open top UN bins (clip top drums)
- For solvents four fluid UN-bins
- For contaminated packages (packing) 2 wheel bins each 1100 litre
- For oil contaminated packing two pieces of open top UN bins
- For batteries either one plastic box (PE hardbox) or two open top UN-bins
- For other hazardous wastes, not specified within above list 10 reserve UN open top bins.

The collection-discharge (emptying) schedule is as required. The board shall have 20 open top UN-bins and 10 fluid UN-bins permanent in store for exchange purposes.

The sufficient container size for an intermediate storage at a reception facility at the board is 20 ft.

Non-labelled bins will not bee allowed to be received. A protocol with the amount of bins, amount of each hazardous waste categories and safety and precautionary status has to be handed over.

4.5.4 Port of Zadar

Solid wastes require 4 pieces of 1100 litre wheel container system by weekly emptying, plastics three lid containers with 9.2 m³ each, monthly emptying, glass four wheel bins with a capacity of 1,1m³ (1100 litre) with an empty scheduling as required, paper and cardboard three lid containers (9.2) with an empty scheduling as required, other wastes (mainly residues) three pieces of wheel bins with a capacity of 1100l each and an weekly emptying schedule, for dunnage and others one open top skip with a volume of 9.2m³ and metals require one wheel bin (1100l) with and emptying schedule as required.

Hazardous substances are mainly collected in 200 l UN bins, which shall be delivered from the ships in an exchange modus. Every deliverer shall collect hazardous substances separated in 200 l UN standard bins while minimum requirement is the separation of

- Oil contaminated materials in open top bin,
- Fluid wastes such as solvents and paintings in a fluid bin
- Empty contaminated packages from paintings in an open top bin
- Other chemical containing packages in an open top bin
- Batteries (acid containing – wet batteries) in an open top bin

Therefore the port requires the following amount of bins on exchange:

- For oil filters, absorbents two times 200 litre open top UN bins (clip top drums)
- For solvents four fluid UN-bins
- For contaminated packages (packing) 2 wheel bins each 1100 litre
- For oil contaminated packing one piece of open top UN bin
- For batteries either one plastic box (PE hardbox) or two open top UN-bins
- For other hazardous wastes, not specified within above list 10 reserve UN open top bins.

The collection-discharge (emptying) schedule is as required. The board shall have 20 open top UN-bins and 10 fluid UN-bins permanent in store for exchange purposes.

The sufficient container size for an intermediate storage at a reception facility at the board is 20 ft.

Non-labelled bins will not bee allowed to be received. A protocol with the amount of bins, amount of each hazardous waste categories and safety and precautionary status has to be handed over.

4.5.5 Port of Sibenik

Solid wastes require 4 pieces of 1100 litre wheel container system by weekly emptying, plastics two lid containers with 9.2 m³ each, monthly emptying, glass four wheel bins with a capacity of 1.1m³ (1100 litre) with an empty scheduling as required, paper and cardboard one lid container (9.2m³) with an empty scheduling as required, other wastes (mainly residues) three pieces of wheel bins with a capacity of 1100l each and an weekly emptying schedule, for dunnage and others one open top skip with a volume of 4.6m³ and metals require one wheel bin (1100l) with and emptying schedule as required.

Hazardous substances are mainly collected in 200 l UN bins, which shall be delivered from the ships in an exchange modus. Every deliverer shall collect hazardous substances separated in 200 l UN standard bins while minimum requirement is the separation of

- Oil contaminated materials in open top bin,
- Fluid wastes such as solvents and paintings in a fluid bin
- Empty contaminated packages from paintings in an open top bin
- Other chemical containing packages in an open top bin
- Batteries (acid containing – wet batteries) in an open top bin

Therefore the port requires the following amount of bins on exchange:

- For oil filters, absorbents two times 200 litre open top UN bins (clip top drums)
- For solvents four fluid UN-bins
- For contaminated packages (packing) 2 wheel bins each 1100 litre
- For oil contaminated packing three pieces of open top UN bins
- For batteries either one plastic box (PE hardbox) or two open top UN-bins
- For other hazardous wastes, not specified within above list 10 reserve UN open top bins.

The collection-discharge (emptying) schedule is as required. The board shall have 20 open top UN-bins and 10 fluid UN-bins permanent in store for exchange purposes.

The sufficient container size for an intermediate storage at a reception facility at the board is 20 ft.

Non-labelled bins will not bee allowed to be received. A protocol with the amount of bins, amount of each hazardous waste categories and safety and precautionary status has to be handed over.

4.5.6 Port of Split

Solid wastes require 6 pieces of 10.7 m³ lid container system by weekly emptying, plastics two mobile compactors, each 24 m³, emptying as required, glass 8 lid containers with a capacity of 4.6m³ each, and an empty scheduling of weekly , paper and cardboard one mobile compactor with 24m³ and an empty scheduling as required, other wastes (mainly residues) two pieces of mobile compactors with a capacity of 24m³ and an weekly emptying schedule, for dunning and others one open top skip with a volume of 10,7 m³ and metals require five roll on, roll off container (30m³) with and emptying schedule as required.

Hazardous substances are mainly collected in 200 l UN bins, which shall be delivered from the ships in an exchange modus. Every deliverer shall collect hazardous substances separated in 200 l UN standard bins while minimum requirement is the separation of

- Oil contaminated materials in either two wheel bins (1100l) or 10 open top bins,
- Fluid wastes such as solvents and paintings in eight fluid bins
- Empty contaminated packages from paintings in an open top bin
- Other chemical containing packages in an open top bin
- Batteries (acid containing – wet batteries) in an open top bin

Therefore the port requires the following amount of bins on exchange:

- For oil filters, absorbents one wheel bin (1.100 litre) or five times 200 litre open top UN bins (clip top drums)
- For solvents four fluid UN-bins
- For contaminated packages (packing) one mobile compactor, 8m³ or 40 times 200 litre open top UN bins (clip top drums)
- For oil contaminated packing two wheel bins (1,100 litre) or 11 times 200 litre open top UN bins (clip top drums)
- For batteries either two plastic boxes (500 litre PE hardbox) or five open top UN-bins
- For other hazardous wastes, not specified within above list 20 reserve UN open top bins.

The collection-discharge (emptying) schedule is as required. The board shall have 60 open top UN-bins and 30 fluid UN-bins permanent in store for exchange purposes.

The sufficient container size for an intermediate storage at a reception facility at the board is 20 ft.

Non-labelled bins will not bee allowed to be received. A protocol with the amount of bins, amount of each hazardous waste categories and safety and precautionary status has to be handed over.

4.5.7 Port of Ploce

Solid wastes require 3 pieces of 1100 litre wheel container system by weekly emptying, plastics one mobile compactor with 8 m³, emptying according requirement, glass four wheel bins with a capacity of 1.1m³ (1100 litre) with an empty scheduling as required, paper and cardboard two lid containers (9.2m³) with an empty scheduling as required, other wastes (mainly residues) four pieces of wheel bins with a capacity of 1100l each and an weekly emptying schedule, for dunnage and others one open top skip with a volume of 9.2 m³ and metals require one wheel bin (360l) with and emptying schedule as required.

Hazardous substances are mainly collected in 200 l UN bins, which shall be delivered from the ships in an exchange modus. Every deliverer shall collect hazardous substances separated in 200 l UN standard bins while minimum requirement is the separation of

- Oil contaminated materials in open top bin,
- Fluid wastes such as solvents and paintings in a fluid bin
- Empty contaminated packages from paintings in an open top bin
- Other chemical containing packages in an open top bin
- Batteries (acid containing – wet batteries) in an open top bin

Therefore the port requires the following amount of bins on exchange:

- For oil filters, absorbents two times 200 litre open top UN bins (clip top drums)
- For solvents four fluid UN-bins
- For contaminated packages (packing) 2 wheel bins each 1100 litre or 10 open top UN bins
- For oil contaminated packing two pieces of open top UN bins
- For batteries either one plastic box (PE hardbox) or two open top UN-bins
- For other hazardous wastes, not specified within above list 10 reserve UN open top bins.

The collection-discharge (emptying) schedule is as required. The board shall have 20 open top UN-bins and 10 fluid UN-bins permanent in store for exchange purposes.

The sufficient container size for an intermediate storage at a reception facility at the board is 20 ft.

Non-labelled bins will not bee allowed to be received. A protocol with the amount of bins, amount of each hazardous waste categories and safety and precautionary status has to be handed over.

4.5.8 Port of Dubrovnik

Solid wastes require 6 pieces of 10.7 m³ lid container system by weekly emptying, plastics two mobile compactors, each 16 m³, emptying as required, glass 6 lid containers with a capacity of 4.6m³ each, and an empty scheduling of weekly, paper and cardboard one mobile compactor with 16m³ and an empty scheduling as required, other wastes (mainly residues) two pieces of mobile compactors with a capacity of 8m³ and an weekly emptying schedule, for dunning and others one open top skip with a volume of 10.7 m³ and metals one wheel bin (1100l) with and emptying schedule as required.

Hazardous substances are mainly collected in 200 l UN bins, which shall be delivered from the ships in an exchange modus. Every deliverer shall collect hazardous substances separated in 200 l UN standard bins while minimum requirement is the separation of

- Oil contaminated materials in either two wheel bins (1100l) or 10 open top bins,
- Fluid wastes such as solvents and paintings in eight fluid bins
- Empty contaminated packages from paintings in an open top bin
- Other chemical containing packages in an open top bin
- Batteries (acid containing – wet batteries) in an open top bin

Therefore the port requires the following amount of bins on exchange:

- For oil filters, absorbents two wheel bins (1.100 litre) or 11 times 200 litre open top UN bins (clip top drums)
- For solvents four fluid UN-bins
- For contaminated packages (packing) one mobile compactor, 8m³ or 40 times 200 litre open top UN bins (clip top drums)
- For oil contaminated packing two wheel bins (1.100 litre) or 11 times 200 litre open top UN bins (clip top drums)
- For batteries either two plastic boxes (500 litre PE hardbox) or five open top UN-bins
- For other hazardous wastes, not specified within above list 20 reserve UN open top bins.

The collection-discharge (emptying) schedule is as required. The board shall have 60 open top UN-bins and 30 fluid UN-bins permanent in store for exchange purposes.

The sufficient container size for an intermediate storage at a reception facility at the board is 20 ft.

Non-labelled bins will not bee allowed to be received. A protocol with the amount of bins, amount of each hazardous waste categories and safety and precautionary status has to be handed over.

5 Annex I – Wastes

The current practises have been described in Annex 5 to the 5th monthly report and repeat the characteristics of the current system and the practices of the Croatian ports and Port Authorities as follows:

- Ports and Port Authorities are not directly engaged in collection of oily wastes from ships and the services are provided by private sector (registered concessionaires);
- Fixed reception facilities in ports do not exist and the collection of oily wastes is carried out by mobile units (tank trucks and/or vessels);
- Treatment and disposal of oily wastes occur outside the ports' boundaries;
- Most of the providers of services (except a single company) do not have their own proper oily waste treatment plants and rely on third parties for the treatment of collected oily liquids.

Producers of Annex I – wastes are:

- Ships in main ports, without local ferries (all oily liquids)
- Local ferries in main and smaller (county and local) ports (all oily liquids)
- Other users of smaller (county and local) ports (all oily liquids)
- Users of marinas (oily waters)

Annex I - reception facilities:

There are no fixed oil/oily water reception facilities in Croatian ports.

The only exception is the oil terminal of INA Refinery Rijeka in Bakar, a fixed reception and treatment facility for dirty ballast, tank washings and other oily residues that serves not only those tankers engaged in its operation but also barges operated by the waste oils collection companies contracted by the Port Authority of Rijeka. It is apparent that this facility ensures so far the treatment and disposal of waste oils collected in the wider area of the port of Rijeka.

The facility provides two tanks of 2.000 m^3 capacity each, in which almost any kind of waste oils could be received, provided that their quality meets the following specifications:

Table 5_Specifications of waste oils and oily water mixtures received for treatment by INA Refinery Rijeka

Parameter	Permissible levels/concentrations
Sediments	<10%
pH (in water phase)	6.5-9.5
COD (in water phase)	<400 mg/l
Pb	<5 mg/l
As	<500 mg/l
Si	<10 mg/l
Na	<30 mg/l
Fe	<30 mg/l
N	<30 mg/l
Organic chloride substances	<60mg/l

Current practise is to collect Annex I – wastes through licensed and contracted companies

- CIAN d.o.o. (Split)
- DEZINSEKCIJA d.o.o. (Rijeka)

- ECOOPERATIVA d.o.o. (Matulji – near Rijeka)
- INA-INDUSTRIJA NAFTE d.d. - Refinery Rijeka (Urinj – near Rijeka)
- IND-EKO d.o.o (Rijeka)
- POMORSKI SERVIS – LUKA PLOČE d.o.o. (Ploče)
- RIJEKA TANK d.o.o. (Rijeka)

5.1.1 Capacity Calculation

Taking into consideration all facilities operated by private companies a capacity of 6000 up to 8000 m³ can be assumed[11], which is 3-4 times the current recorded and reported capacity. Running these facilities in a two shift system would allow a capacity of up to 20000 m³ per year.

This capacity is far enough for Annex I wastes and would allow also the treatment of liquid hazardous wastes from workshops, petrol stations, household origin and industries (metal industry – emulsion).

5.2 Logistics of collection

The current "in time" collection and the long distances between reception/treatment facilities and the ports result in an extreme high tariff situation (170-200 Euro/m³). Further are common used tank sizes 5 and 8 m³, which allows the preliminary assumption that small tanks in every port shall be installed to receive the Annex-I wastes. It has to be taken into consideration that bilge waters and waste oils shall not be mixed and require different storage / transport units due to different treatment options.

The following chapter analyses, which transport fluctuation, tank sizes, on-site intermediate storages result in different critical (economical orientated and limited) distances.

5.2.1 Distance Matrix from various ports

Table 24_Logistic matrix to different ports and treatment facilities

Logistic matrix in Km to HabourMaster (Port)								
Ports	**Pula**	**Rijeka**	**Senj**	**Zadar**	**Sibenik**	**Split**	**Ploce**	**Dubrovnik**
Pula	0	99,8	166	369	448	513	611	740
Rijeka	99,8	0	67,4	243	352	413	514	639
Senj	166	67,4	0	175	233	297	400	525
Zadar	389	243	175	0	91,1	158	260	378
Sibenik	448	352	233	91,1	0	92,1	194	314
Split	513	413	297	158	92,1	0	141	266
Ploce	611	514	400	260	194	141	0	125
Dubrovnik	740	639	525	378	314	266	125	0

These distances containing also the distances from the main road to the port facilities and called brut (gross) distances. The net distances are the distances between ports.

Distances from main roads to the port facility are calculated by dividing the difference of two-port distances by two. Some of the ports are directly accessible and the distance is therefore 0.

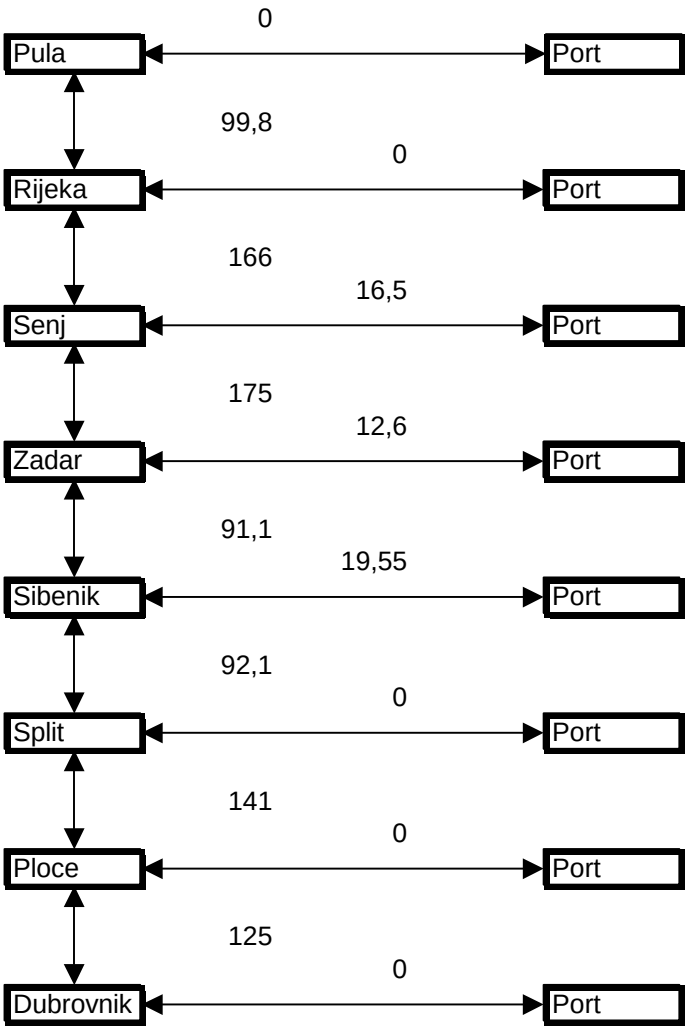
[11] not all companies provided data regarding collection and treatment capacities

Table 25_Distances to the ports from the main road

Ports	Pula	Rijeka	Senj	Zadar	Sibenik	Split	Ploce	Dubrovnik
Pula	0,6							
Rijeka		0,3						
Senj			16,55					
Zadar				12,6				
Sibenik					19,55			
Split						0		
Ploce							0	
Dubrovnik								0

The distance between two ports, reduced by the distance from the main road to the single port is called net distance.

Figure 18_Net distances and distances to the ports



5.2.2 Preliminary treatment cost calculation

In order to identify a reasonable transport fee, the operational costs have to be calculated. Operation costs plus the transportation costs shall not exceed 50 till 60 Euro/m³ which is an average fee in the international ports. The transportation fee and the

distances will be the factor to identify the critical distance, which is defined as those distance not to be exceeded for economical purposes. An increase of the distance results in a higher transportation cost situation. The high charge rates are also a significant reason for the delivery of rather low amounts and an insufficient efficiency of all the current licensed treatment plants, which would be able to operate 2 to 3 times of the current collected Annex I – wastes.

5.2.2.1 Basic data to be used

Table 26_Basic data for the calculation of operational costs for the treatment of waste oils and bilge waters[12]

Basic Data to for operational cost calculation			
Item	**Units**	**Amount**	**Option**
Singular Capacity	m³	8	
Density	kg/m³	1	
Yearly Treatment Capacity	m³/y	1.760	
Yearly Treatment Capacity	m³/y	2.112	
Working Capacity			
Shifts	sh/d	1	
Staff	pers	1	
Working hours	h/d	8	
Working days	d/y	220	
Efficiency	%	80%	
Nominative Working hours	h/y	1.760	
Real Working hours	h/y	1.408	
Treatment Capacity			
Real Working hours	h/y	1.408	
Total capacity	m³/y	1.760	
Specific treatment capacity	m³/h	1,25	
Investment	Units	Amount	
Input Storage Tank	Euro	15.000	
Process Tank	Euro	20.000	
Output Storage Tank	Euro	15.000	
Storage Tank - PORT	Euro	12.000	
Process Pump	Euro	2.300	
Excenter Pump	Euro	2.200	
Piping	Euro	20.000	
Building	Euro	176.000	
Separator	Euro	120.000	
Item Separator	**Unit**	**Menge**	
Depreciation Period	y	5	
Depreciation Period	y	25	
Capital Interest	%	0,53%	
Insurance rate	%	3%	
O&M percentage	%	5,5%	
Space requirement	m²	117,3	
Space costs	Euro/m²	1500,0	

[12] bilge waters = emulsion

Energy consumption	kW	4,7	
Energy tariff	€/kWh	0,14	
Water Tariff	€/litre	0,80	
Fuel tariff	€/litre	8,90	
Overhead rate	%	15%	
Profit marge	%	15%	
Risk marge	%	12%	
Spec. Transport costs	€/km	1,4	
Batches	m³/tour	5	I
Batches	m³/tour	10	II
Batches	m³/tour	20	III
Batches	m³/tour	30	IV
staff wages	Euro/months	750	
staff factor (insurance, etc)	f	1,5	
Montage of Investment	%	15	
Energy consumption Sep.	kW	23	

The operation costs are including capitalized investment according the depreciation period, insurance, maintenance, fuel-, water-, electricity costs, profit and risk marges, staff- and overhead costs.

The plant capacity has been chosen with an 8-m³ unit, allowing a yearly capacity of 1760 m³ for waste oils and 2.112 m³ for emulsions.

Table 27_Calculation of specific waste oil treatment costs

Basic Data or operational cost calculation			
Item	**Units**	**Amount**	**Option**
Investment Mech.	Euro	86.500	
Depreciation Period	Years	5	
Capital Interest	%	0,53%	
Capitalised investment	Euro	88795	
Depreciation	Euro/year	17759	
Investment Civil	Euro	176000	
Depreciation Period	Years	25	
Capital Interest	%	0,53%	
Capitalised investment	Euro	200616	
Depreciation	Euro/year	8025	
Investment costs	Euro/year	25784	
Staff costs	Euro/year	13500	
Energy Consumption	kWh	8272	
Energy Costs	Euro/year	1158	
Water Consumption	litre/year	5000	
Water Costs	Euro/year	4000	
Insurance	Euro/year	774	
Maintenance	Euro/year	1418	
Overhead Costs	Euro/year	2025	
Profit	Euro/year	7299	
Risk	Euro/year	5839	
SUM of Operation	Euro/year	61796	
Specific Costs	**Euro/m³**	**35,11**	

The calculation results in a specific costs situation of 35.11 Euro per m³ waste oil treated, which allows transportation costs of 10 Euro and would result in a collection and treatment tariff of 45 – 50 Euro per m³ waste oil.

Table 28_Calculation of specific bilge water treatment costs

Basic Data for operational cost calculation			
Item	**Units**	**Amount**	**Option**
Investment Mech.	Euro	194.600	
Depreciation Period	Years	5	
Capital Interest	%	0,53%	
Capitalised investment	Euro	199762	
Depreciation	Euro/year	39952	
Investment Civil	Euro	176.000	
Depreciation Period	Years	25	
Capital Interest	%	0,53%	
Capitalised investment	Euro	200616	
Depreciation	Euro/year	8025	
Investment costs	Euro/year	47977	
Staffcosts	Euro/year	13500	
Enery Consumption	kWh	40480	
Energy Costs	Euro/year	5667	
Water Consumption	litre/year	5000	
Water Costs	Euro/year	4000	
Insurance	Euro/year	1439	
Maintanance	Euro/year	2639	
Overhead Costs	Euro/year	2025	
Profit	Euro/year	11587	
Risk	Euro/year	9270	
SUM of Operation	Euro/year	98104	
Specific Costs	Euro/m³	46,45	

The calculation results in a specific costs situation of 46.45 Euro per m³ waste bilge water, which allows transportation costs of 10 Euro and would result in a collection and treatment tariff of 55 – 60 Euro per m³ bilge water.

5.3 Critical distance calculation

5.3.1 Optioneering and critical distance calculation for waste oil transportation

The amounts are sums from main port collected waste oils and those collected from Jadrolinija. The distances are either net distances or those from the treatment station to the port (internal distances).

The “in time” fluctuation reflects a once per week discharging frequency. In the case the chosen capacity requires a higher fluctuation the table shows the required amount above 52 times.

Different options have been calculated with different intervals. All collection frequencies, apart from “in time” require a reception facility of minimum the transport capacity (5m³, 10m³, etc.)

Every option has been set with different logistic (discharging) capacities – 5 m³ tanks, 10 m³.

In respect of an international harmonised discharge fee of (50 till 60 Euro), the critical transport distance have once been calculated with 10 and once with 5 Euro specific transportation costs per m³ as critical parameter.

The distances to various ports are related to the transport distance and illustrate the shortest distance to the next treatment facilities, which are located in Split and Rijeka.

Table 29_Optioneering – Waste oil collection

Option 0										
Optioneering	Unit	Pula	Rijeka	Senj	Zadar	Sibenik	Split	Ploce	Dubrovnik	Total
Amount	(m³/year)	18,96	1035,17	9,99	6,45	2,33	183,1	73,17	4,57	1333,74
Closest treatment facility	--	Rijeka	Rijeka	Rijeka	Split	Split	Split	Split	Split	
Distance to treatment facility	km	99,8	0,5	166	158	92,1	3	141	266	115,8
Current Storage Amount	(m³)	0,5	in time	in time	in time	in time	in time	in time	in time	
Discharge fluctuation	times	38	52	52	52	52	52	52	52	50,25
Total Distance per Year	km/year	3792,4	26	8632	8216	4789,2	156	7332	13832	46775,6
Transport Capacity	m³	5	5	5	5	5	5	5	5	5
Required fluctuation (limited by Vessel)	times	38	208	52	52	52	52	52	52	70
Required Distance per year	km/year	3792,4	104	8632	8216	4789,2	156	7332	13832	46853,6
Required Transport Distance per year	km/year	7584,8	208	17264	16432	9578,4	312	14664	27664	93707,2
Costs for Transportation	Euro/year	10618,72	291,2	24169,6	23004,8	13409,76	436,8	20529,6	38729,6	131190,1
Cost per m³ discharged	Euro/m³	560,06	0,28	2419,38	3566,64	5755,26	2,39	280,57	8474,75	98,36
Costs for Discharging	Euro/m³	189,60	10351,70	99,90	64,50	23,30	1831,00	731,70	45,70	13337,40
Maximum Transportation Distance	km/year	67,71	3697,04	35,68	23,04	8,32	653,93	261,32	16,32	4763,36
within Critical Distance		no	yes	no	no	no	yes	no	no	**68,05**

This option reflects the current situation. The average transport capacity is 5 m³. This calculation results in average transportation costs[13] of 98,36 Euro. Taking into consideration the critical parameter of maximum 10 Euro, the critical distance is 68 km, while only the main ports of Rijeka and Split could be economical reasonable served.

Option I										
Optioneering	Unit	Pula	Rijeka	Senj	Zadar	Sibenik	Split	Ploce	Dubrovnik	Total
Amount	(m³/year)	18,96	1035,17	9,99	6,45	2,33	183,1	73,17	4,57	1333,74
Closest treatment facility	--	Rijeka	Rijeka	Rijeka	Split	Split	Split	Split	Split	
Distance to treatment facility	km	99,8	0,5	166	158	92,1	3	141	266	115,8
Current Storage Amount	(m³)	1	in time	1	1	1	in time	1	1	
Discharge fluctuation	times	19	52	10	7	3	52	74	5	28
Total Distance per Year	km/year	1896,2	26	1660	1106	276,3	156	10434	1330	16884,5
Transport Capacity	m³	5	5	5	5	5	5	5	5	5
Required fluctuation (limited by Vessel)	times	19	208	10	7	3	52	74	5	47,25
Required Distance per year	km/year	1896,2	104	1660	1106	276,3	156	10434	1330	16962,5
Required Transport Distance per year	km/year	3792,4	208	3320	2212	552,6	312	20868	2660	33925
Costs for Transportation	Euro/year	5309,36	291,2	4648	3096,8	773,64	436,8	29215,2	3724	47495

[13] specific transportation cost = discharging cost/m³ = discharging fee/m³

Cost per m³ discharged	Euro/m³	280,03	0,28	465,27	480,12	332,03	2,39	399,28	814,88	35,61
Costs for Discharging	Euro/m³	189,60	10351,70	99,90	64,50	23,30	1831,00	731,70	45,70	13337,40
Maximum Transportation Distance	km/year	67,71	3697,04	35,68	23,04	8,32	653,93	261,32	16,32	4763,36
Within Critical Distance		yes	yes	no	no	yes	yes	no	no	**100,81**

The results of option I can be interpreted as follows. The average transport capacity is 5 m³ (critical parameter). In the ports of Pula, Senj, Zadar, Sibenik, Ploce and Dubrovnik reception facilities of minimum 1 m³ shall be installed. This calculation results in average transportation costs of 35.61 Euro. Taking the critical parameter of maximum 10 Euro into consideration, the critical distance is 100 km, while only the main ports of Rijeka, Pula, Sibenik and Split could be economically reasonable served.

Option II										
Optioneering	Unit	Pula	Rijeka	Senj	Zadar	Sibenik	Split	Ploce	Dubrovnik	Total
Amount	(m³/year)	18,96	1035,17	9,99	6,45	2,33	183,1	73,17	4,57	1333,74
Closest treatment facility	--	Rijeka	Rijeka	Rijeka	Split	Split	Split	Split	Split	
Distance to treatment facility	km	99,8	0,5	166	158	92,1	3	141	266	115,8
Current Storage Amount	(m³)	5	in time	5	5	5	in time	5	5	
Discharge fluctuation	times	4	52	2	2	1	52	15	1	17
Total Distance per Year	km/year	399,2	26	332	316	92,1	156	2115	266	3702,3
Transport Capacity	m³	5	5	5	5	5	5	5	5	5
Required fluctuation (limited by Vessel)	times	4	208	2	2	1	52	15	1	35,625
Required Distance per year	km/year	399,2	104	332	316	92,1	156	2115	266	3780,3
Required Transport Distance per year	km/year	798,4	208	664	632	184,2	312	4230	532	7560,6
Costs for Transportation	Euro/year	1117,76	291,2	929,6	884,8	257,88	436,8	5922	744,8	10584,84
Cost per m³ discharged	Euro/m³	58,95	0,28	93,05	137,18	110,68	2,39	80,93	162,98	7,94
Costs for Discharging	Euro/m³	189,60	10351,70	99,90	64,50	23,30	1831,00	731,70	45,70	13337,40
Maximum Transportation Distance	km/year	67,71	3697,04	35,68	23,04	8,32	653,93	261,32	16,32	4763,36
Within Critical Distance		yes	yes	no	no	yes	yes	no	no	**133,71**

The results of option II can be interpreted as follows. The average transport capacity is 5 m³ (critical parameter). In the ports of Pula, Senj, Zadar, Sibenik, Ploce and Dubrovnik reception facilities of minimum 5 m³ shall be installed (This intermediate storage could also be provided in the new Regional Waste Management Centres until a transport relevant amount can be reached). This calculation results in average transportation costs of 7,94 Euro for those ports within the critical distance.

Taken the critical parameter of maximum 10 Euro into consideration, the critical distance is 133 km, while only the main ports of Rijeka, Pula, Sibenik and Split could be economically reasonable served. Despite the reduced specific costs there is no significant difference to Option I and the investment of 5m³ intermediate storage tanks is economically not feasible.

Option III										
Optioneering	Unit	Pula	Rijeka	Senj	Zadar	Sibenik	Split	Ploce	Dubrovnik	Total
Amount	(m³/year)	18,96	1035,17	9,99	6,45	2,33	183,1	73,17	4,57	1333,74
Closest treatment facility	--	Rijeka	Rijeka	Rijeka	Split	Split	Split	Split	Split	
Distance to treatment facility	km	99,8	0,5	166	158	92,1	3	141	266	115,8
Current Storage Amount	(m³)	10	in time	10	5	5	10	10	5	
Discharge fluctuation	times	2	52	1	2	1	19	8	1	11

Total Distance per Year	km/year	199,6	26	166	316	92,1	57	1128	266	2250,7
Transport Capacity	m³	10	10	10	10	10	10	10	10	10
Required fluctuation (limited by Vessel)	times	2	104	1	2	1	19	8	1	17,25
Required Distance per year	km/year	199,6	52	166	316	92,1	57	1128	266	2276,7
Required Transport Distance per year	km/year	399,2	104	332	632	184,2	114	2256	532	4553,4
Costs for Transportation	Euro/year	558,88	145,6	464,8	884,8	257,88	159,6	3158,4	744,8	6374,76
Cost per m³ discharged	Euro/m³	29,48	0,14	46,53	137,18	110,68	0,87	43,17	162,98	4,78
Costs for Discharging	Euro/m³	189,60	10351,70	99,90	64,50	23,30	1831,00	731,70	45,70	13337,40
Maximum Transportation Distance	km/year	67,71	3697,04	35,68	23,04	8,32	653,93	261,32	16,32	4763,36
Within Critical Distance		yes	yes	yes	yes	yes	yes	yes	yes	**276,14**

The results of option III can be interpreted as follows. The average transport capacity is 10 m³ (critical parameter). In the ports of Pula, Senj, Split and Ploce 10 m³ reception (intermediate storage) tanks are installed, while in Zadar, Sibenik and Dubrovnik reception facilities of minimum 5 m³. (These intermediate storages could also be provided in the new Regional Waste Management Centres until a transport relevant amount can be reached). This calculation results in average transportation costs of 4,78 Euro for those ports within the critical distance.

All ports are within the critical distance. The investment of 10 m³ and 5m³ intermediate storage tanks and an arrangement with the regional facilities is economically feasible. The collection and disposal costs of < 50 Euro can be achieved.

5.3.2 Optioneering and critical distance calculation for bilge water transportation

The optioneering for bilge oil has used the same primary parameters, distances and critical parameters (discharging capacity, discharging frequency and discharging maximum costs of 10 Euro/m³)

Table 30_Optioneering - Bilge waters

Option 0										
Optioneering	Unit	Pula	Rijeka	Senj	Zadar	Sibenik	Split	Ploce	Dubrovnik	Total
Amount	(m³/year)	4,14	358,26	27,01	557,45	322,57	1651,65	197,83	169,35	3288,26
Closest treatment facility	--	Rijeka	Rijeka	Rijeka	Split	Split	Split	Split	Split	
Distance to treatment facility	km	99,8	0,5	166	158	92,1	3	141	266	115,8
Current Storage Amount	(m³)	in time	in time	in time	in time	in time	in time	in time	in time	
Discharge fluctuation	times	52	52	52	52	52	52	52	52	52
Total Distance per Year	km/year	5189,6	26	8632	8216	4789,2	156	7332	13832	48172,8
Transport Capacity	m³	5	5	5	5	5	5	5	5	5
Required fluctuation (limited by Vessel)	times	52	72	52	112	65	331	52	52	99
Required Distance per year	km/year	5189,6	36	8632	17696	5986,5	993	7332	13832	59697,1
Required Transport Distance per year	km/year	10379,2	72	17264	35392	11973	1986	14664	27664	119394
Costs for Transportation	Euro/year	14530,88	100,8	24169,6	49548,8	16762,2	2780,4	20529,6	38729,6	167152
Cost per m³ discharged	Euro/m³	3509,87	0,28	894,84	88,88	51,96	1,68	103,77	228,70	50,83
Costs for Discharging	Euro/m³	41,40	3582,60	270,10	5574,50	3225,70	16516,50	1978,30	1693,50	32882,60
Maximum Transportation Distance	km/year	14,79	1279,50	96,46	1990,89	1152,04	5898,75	706,54	604,82	11743,79
Within Critical Distance		yes	yes	no	no	yes	yes	no	no	**118,62**

This option reflects the current situation. There is no reception facility (apart from Rijeka) installed. The average transport capacity is 5 m³. This calculation results in average transportation costs of 50.83 Euro. Taken the critical parameter of maximum 10 Euro into consideration the critical distance is 118.62 km, while the main ports of Pula, Rijeka, Sibenik and Split could be economically reasonable served.

The difference to waste oil discharge fee results is based on reduced specific fixed costs due to a higher amount of bilge waters (fixed costs digression).

Option I										
Optioneering	Unit	Pula	Rijeka	Senj	Zadar	Sibenik	Split	Ploce	Dubrovnik	Total
Amount	(m³/year)	4,14	358,26	27,01	557,45	322,57	1651,65	197,83	169,35	3288,26
Closest treatment facility	--	Rijeka	Rijeka	Rijeka	Split	Split	Split	Split	Split	
Distance to treatment facility	km	99,8	0,5	166	158	92,1	3	141	266	115,8
Current Storage Amount	(m³)	5	5	5	in time	5	in time	5	5	
Discharge fluctuation	times	1	72	6	52	65	52	40	34	41
Total Distance per Year	km/year	99,8	36	996	8216	5986,5	156	5640	9044	30174,3
Transport Capacity	m³	5	5	5	5	5	5	5	5	5
Required fluctuation (limited by Vessel)	times	1	72	6	112	65	331	40	34	83
Required Distance per year	km/year	99,8	36	996	17696	5986,5	993	5640	9044	40491,3
Required Transport Distance per year	km/year	199,6	72	1992	35392	11973	1986	11280	18088	80982,6
Costs for Transportation	Euro/year	279,44	100,8	2788,8	49548,8	16762,2	2780,4	15792	25323,2	113376
Cost per m³ discharged	Euro/m³	67,50	0,28	103,25	88,88	51,96	1,68	79,83	149,53	34,48
Costs for Discharging	Euro/m³	41,40	3582,60	270,10	5574,50	3225,70	16516,50	1978,30	1693,50	32882,60
Maximum Transportation Distance	km/year	14,79	1279,50	96,46	1990,89	1152,04	5898,75	706,54	604,82	11743,79
Within Critical Distance		yes	yes	no	no	yes	yes	yes	no	**141,49**

The results of Option I can be interpreted as follows. The average transport capacity is 5 m³ (critical parameter). In the ports of Pula, Senj, Zadar, Sibenik, Ploce and Dubrovnik reception facilities of minimum 5 m³ shall be installed (This intermediate storage could also be provided in the new Regional Waste Management Centres until a transport relevant amount can be reached). This calculation results in average transportation costs of 34,48 Euro. Taken the critical parameter of maximum 10 Euro into consideration, the critical distance is 141.49 km, while only the main ports of Rijeka, Pula, Sibenik, Ploce and Split could be economically reasonably served.

Option II										
Optioneering	Unit	Pula	Rijeka	Senj	Zadar	Sibenik	Split	Ploce	Dubrovnik	Total
Amount	(m³/year)	4,14	358,26	27,01	557,45	322,57	1651,65	197,83	169,35	3288,26
Closest treatment facility	--	Rijeka	Rijeka	Rijeka	Split	Split	Split	Split	Split	
Distance to treatment facility	km	99,8	0,5	166	158	92,1	3	141	266	115,8
Current Storage Amount	(m³)	5	10	10	10	10	in time	10	10	
Discharge fluctuation	times	1	36	3	56	33	52	20	17	28
Total Distance per Year	km/year	99,8	18	498	8848	3039,3	156	2820	4522	20001,1
Transport Capacity	m³	10	10	10	10	10	10	10	10	10
Required fluctuation (limited by Vessel)	times	1	36	3	56	33	166	20	17	42
Required Distance per year	km/year	99,8	18	498	8848	3039,3	498	2820	4522	20343,1
Required Transport Distance per year	km/year	199,6	36	996	17696	6078,6	996	5640	9044	40686,2

Costs for Transportation	Euro/year	279,44	50,4	1394,4	24774,4	8510,04	1394,4	7896	12661,6	56960,7
Cost per m³ discharged	Euro/m³	67,50	0,14	51,63	44,44	26,38	0,84	39,91	74,77	17,32
Costs for Discharging	Euro/m³	41,40	3582,60	270,10	5574,50	3225,70	16516,50	1978,30	1693,50	32882,60
Maximum Transportation Distance	km/year	14,79	1279,50	96,46	1990,89	1152,04	5898,75	706,54	604,82	11743,79
Within Critical Distance		yes	yes	yes	yes	yes	yes	yes	yes	**279,61**

The results of option II can be interpreted as follows. The average transport capacity is 10 m³ (critical parameter). In the ports of Senj, Rijeka, Sibenik, Ploce and Dubrovnik are 10 m³ reception (intermediate storage) tanks installed, while in Pula a reception facility of minimum 5 m³. (These intermediate storages could also be provided in the new Regional Waste Management Centres until a transport relevant amount can be reached). All ports are within the critical distance. The investment of 10 m³ and 5m³ intermediate storage tanks and an arrangement with the regional facilities is economically feasible. The collection and disposal costs of < 60 Euro can just be achieved.

Option III										
Optioneering	Unit	Pula	Rijeka	Senj	Zadar	Sibenik	Split	Ploce	Dubrovnik	Total
Amount	(m³/year)	4,14	358,26	27,01	55,745	32,257	1651,65	19,783	16,935	2165,78
Closest treatment facility	--	Rijeka	Rijeka	Rijeka	Split	Split	Split	Split	Split	
Distance to treatment facility	km	99,8	0,5	166	158	92,1	3	141	266	115,8
Current Storage Amount	(m³)	5	10	10	10	10	in time	10	10	
Discharge fluctuation	times	1	36	3	6	4	52	2	2	14
Total Distance per Year	km/year	99,8	18	498	948	368,4	156	282	532	2902,2
Transport Capacity	m³	10	10	10	10	10	10	10	10	10
Required fluctuation (limited by Vessel)	times	1	36	3	6	4	166	2	2	27,5
Required Distance per year	km/year	99,8	18	498	948	368,4	498	282	532	3244,2
Required Transport Distance per year	km/year	199,6	36	996	1896	736,8	996	564	1064	6488,4
Costs for Transportation	Euro/year	279,44	50,4	1394,4	2654,4	1031,52	1394,4	789,6	1489,6	9083,76
Cost per m³ discharged	Euro/m³	67,50	0,14	51,63	47,62	31,98	0,84	39,91	87,96	4,19
Costs for Discharging	Euro/m³	41,40	3582,60	270,10	557,45	322,57	16516,50	197,83	169,35	21657,80
Maximum Transportation Distance	km/year	14,79	1279,50	96,46	199,09	115,20	5898,75	70,65	60,48	7734,93
Within Critical Distance		yes	yes	yes	yes	yes	yes	yes	yes	**281,27**

The results of option III can be interpreted as follows. The average transport capacity is 10 m³ (critical parameter). In the ports of Senj, Rijeka, Sibenik, Ploce and Dubrovnik 10 m³ reception (intermediate storage) tanks are installed, while in Pula a reception facility of minimum 5 m³. In Zadar, Sibenik, Ploce and Dubrovnik a pre-treatment takes place in order to reduce the amount of transportation from those ports with long distances. A critical distance of 281 km can be achieved and all ports are within this distance. The specific costs have dropped below 10 Euro and are calculated with 4.19. The pre-treatment and intermediate storages could also be provided in the new Regional Waste Management Centres until a transport relevant amount can be reached. The investment of 10 m³ and 5m³ intermediate storage tanks and an arrangement with the regional facilities is economically feasible. The collection and disposal costs of < 60 Euro can be achieved.

5.3.3 Optioneering and critical distance calculation for bilge water transportation – future scenario

While the part of tourism increases with approximate rate of 2.8 to 3.5% per year, due to an increased affordability, the transportation increases with approximate rate of 1 to 1.5% per year. This would result in a doubling of the amount within a 5 years prognosis. The following optioneering has been carried out with the double amount of bilge waters and has used the same primary parameters, distances and critical parameters (discharging capacity, discharging frequency and discharging maximum costs of 10 Euro/m³).

Table 31_Optioneering – Bilge waters – 5 years prognosis

Option 0										
Optioneering	Unit	Pula	Rijeka	Senj	Zadar	Sibenik	Split	Ploce	Dubrovnik	Total
Amount	(m³/year)	8,28	716,52	54,02	1114,9	645,14	3303,3	395,66	338,7	6576,52
Closest treatment facility	--	Rijeka	Rijeka	Rijeka	Split	Split	Split	Split	Split	
Distance to treatment facility	km	99,8	0,5	166	158	92,1	3	141	266	115,8
Current Storage Amount	(m³)	in time	in time	in time	in time	in time	in time	in time	in time	
Discharge fluctuation	times	52	52	52	52	52	52	52	52	52
Total Distance per Year	km/year	5189,6	26	8632	8216	4789,2	156	7332	13832	48172,8
Transport Capacity	m³	5	5	5	5	5	5	5	5	5
Required fluctuation (limited by Vessel)	times	52	144	52	223	130	661	80	68	176,25
Required Distance per year	km/year	5189,6	72	8632	35234	11973	1983	11280	18088	92451,6
Required Transport Distance per year	km/year	10379,2	144	17264	70468	23946	3966	22560	36176	184903
Costs for Transportation	Euro/year	14530,88	201,6	24169,6	98655,2	33524,4	5552,4	31584	50646,4	258864
Cost per m³ discharged	Euro/m³	1754,94	0,28	447,42	88,49	51,96	1,68	79,83	149,53	39,36
Costs for Discharging	15Euro/m³	82,80	7165,20	540,20	11149,00	6451,40	33033,00	3956,60	3387,00	65765,20
Maximum Transportation Distance	km/year	29,57	2559,00	192,93	3981,79	2304,07	11797,50	1413,07	1209,64	23487,57
Within Critical Distance		yes	yes	no	no	yes	yes	no	no	**133,26**

This option reflects a doubling of the amount under current logistic situation. There is no reception facility (apart from Rijeka) installed. The average transport capacity is 5 m³. This calculation results in average transportation costs of 39.36 Euro. Taken the critical parameter of maximum 10 Euro into consideration the critical distance is 133.26 km, while the main ports of Pula, Rijeka, Sibenik and Split could be economically reasonably served. The difference to the optioneering under current bilge water amount in a reduced discharging fee is based on reduced specific fixed costs due to a higher amount of bilge waters (fixed costs digression)

Option I										
Optioneering	Unit	Pula	Rijeka	Senj	Zadar	Sibenik	Split	Ploce	Dubrovnik	Total
Amount	(m³/year)	8,28	716,52	54,02	1114,9	645,14	3303,3	395,66	338,7	6576,52
Closest treatment facility	--	Rijeka	Rijeka	Rijeka	Split	Split	Split	Split	Split	
Distance to treatment facility	km	99,8	0,5	166	158	92,1	3	141	266	115,8
Current Storage Amount	(m³)	5	5	5	5	5	5	5	5	
Discharge fluctuation	times	2	144	11	223	130	661	80	68	165
Total Distance per Year	km/year	199,6	72	1826	35234	11973	1983	11280	18088	80655,6
Transport Capacity	m³	5	5	5	5	5	5	5	5	5
Required fluctuation (limited by Vessel)	times	2	144	11	223	130	661	80	68	164,875
Required Distance per year	km/year	199,6	72	1826	35234	11973	1983	11280	18088	80655,6
Required Transport Distance per year	km/year	399,2	144	3652	70468	23946	3966	22560	36176	161311
Costs for Transportation	Euro/year	558,88	201,6	5112,8	98655,2	33524,4	5552,4	31584	50646,4	225836
Cost per m³ discharged	Euro/m³	67,50	0,28	94,65	88,49	51,96	1,68	79,83	149,53	34,34
Costs for Discharging	15Euro/m³	82,80	7165,20	540,20	11149,00	6451,40	33033,00	3956,60	3387,00	65765,20
Maximum Transportation Distance	km/year	29,57	2559,00	192,93	3981,79	2304,07	11797,50	1413,07	1209,64	23487,57
Within Critical Distance		yes	yes	no	no	yes	yes	yes	no	**142,46**

The results of Option I can be interpreted as follows. The average transport capacity is 5 m³ (critical parameter). In the ports of Pula, Senj, Zadar, Sibenik, Ploce and Dubrovnik reception facilities of minimum 5 m³ shall be installed (This intermediate storage could also be provided in the new Regional Waste Management Centres until a transport relevant amount can be reached). This calculation results in average transportation costs of 34.34 Euro. Taken the critical parameter of maximum 10 Euro into consideration, the critical distance is 142.46 km, while only the main ports of Rijeka, Pula, Sibenik, Ploce and Split could be economically reasonably served.

Option II										
Optioneering	Unit	Pula	Rijeka	Senj	Zadar	Sibenik	Split	Ploce	Dubrovnik	Total
Amount	(m³/year)	8,28	716,52	54,02	1114,9	645,14	3303,3	395,66	338,7	6576,52
Closest treatment facility	--	Rijeka	Rijeka	Rijeka	Split	Split	Split	Split	Split	
Distance to treatment facility	km	99,8	0,5	166	158	92,1	3	141	266	115,8
Current Storage Amount	(m³)	10	10	10	10	10	10	10	10	
Discharge fluctuation	times	1	72	6	112	65	331	40	34	83
Total Distance per Year	km/year	99,8	36	996	17696	5986,5	993	5640	9044	40491,3
Transport Capacity	m³	10	10	10	10	10	10	10	10	10
Required fluctuation (limited by Vessel)	times	1	72	6	112	65	331	40	34	82,625
Required Distance per year	km/year	99,8	36	996	17696	5986,5	993	5640	9044	40491,3
Required Transport Distance per year	km/year	199,6	72	1992	35392	11973	1986	11280	18088	80982,6
Costs for Transportation	Euro/year	279,44	100,8	2788,8	49548,8	16762,2	2780,4	15792	25323,2	113376
Cost per m³ discharged	Euro/m³	33,75	0,14	51,63	44,44	25,98	0,84	39,91	74,77	17,24
Costs for Discharging	15Euro/m³	82,80	7165,20	540,20	11149,00	6451,40	33033,00	3956,60	3387,00	65765,20
Maximum Transportation Distance	km/year	29,57	2559,00	192,93	3981,79	2304,07	11797,50	1413,07	1209,64	23487,57
Within Critical Distance		yes	yes	yes	yes	yes	yes	yes	yes	**284,27**

The results of option II can be interpreted as follows. The average transport capacity is 10 m³ (critical parameter). In all ports 10 m³ reception (intermediate storage) tanks are installed (These intermediate storages could also be provided in the new Regional Waste Management Centres until a transport relevant amount can be reached). All ports are within the critical distance. The investment of 10 m³ and 5m³ intermediate storage tanks and an arrangement with the regional facilities is economically feasible. The collection and disposal costs of < 60 Euro can just be achieved.

Option III										
Optioneering	Unit	Pula	Rijeka	Senj	Zadar	Sibenik	Split	Ploce	Dubrovnik	Total
Amount	(m³/year)	8,28	716,52	54,02	1114,9	645,14	3303,3	395,66	338,7	6576,52
Closest treatment facility	--	Rijeka	Rijeka	Rijeka	Split	Split	Split	Split	Split	
Distance to treatment facility	km	99,8	0,5	166	158	92,1	3	141	266	115,8
Current Storage Amount	(m³)	10	20	20	20	20	20	20	20	
Discharge fluctuation	times	1	36	3	56	33	166	20	17	42
Total Distance per Year	km/year	99,8	18	498	8848	3039,3	498	2820	4522	20343,1
Transport Capacity	m³	20	20	20	20	20	20	20	20	20
Required fluctuation (limited by Vessel)	times	1	36	3	56	33	166	20	17	41,5
Required Distance per year	km/year	99,8	18	498	8848	3039,3	498	2820	4522	20343,1
Required Transport Distance per year	km/year	199,6	36	996	17696	6078,6	996	5640	9044	40686,2
Costs for Transportation	Euro/year	279,44	50,4	1394,4	24774,4	8510,04	1394,4	7896	12661,6	56960,7
Cost per m³ discharged	Euro/m³	33,75	0,07	25,81	22,22	13,19	0,42	19,96	37,38	8,66
Costs for Discharging	15Euro/m³	82,80	7165,20	540,20	11149,00	6451,40	33033,00	3956,60	3387,00	65765,20
Maximum Transportation Distance	km/year	29,57	2559,00	192,93	3981,79	2304,07	11797,50	1413,07	1209,64	23487,57
Within Critical Distance		yes	yes	yes	yes	yes	yes	yes	yes	**565,97**

The results of option III can be interpreted as follows. The average transport capacity is 20 m³ (critical parameter). 20 m³ reception (intermediate storage) tanks are installed in all

ports, except in Pula only 10 m³ (These intermediate storages could also be provided in the new Regional Waste Management Centres until a transport relevant amount can be reached). The average specific discharging costs are below the critical fee of 10 Euro and results in 8.66 Euro/m³. The critical distance is far above the required of 266 km. All ports are within the critical distance. The investment of 20 m³ and 10m³ intermediate storage tanks and an arrangement with the regional facilities is economically feasible. The collection and disposal costs of < 60 Euro can just be achieved.

Option IV										
Optioneering	Unit	Pula	Rijeka	Senj	Zadar	Sibenik	Split	Ploce	Dubrovnik	Total
Amount	(m³/year)	8,28	716,52	54,02	111,49	64,514	3303,3	39,566	33,87	4331,56
Closest treatment facility	--	Rijeka	Rijeka	Rijeka	Split	Split	Split	Split	Split	
Distance to treatment facility	km	99,8	0,5	166	158	92,1	3	141	266	115,8
Current Storage Amount	(m³)	10	20	20	20	20	20	20	20	
Discharge fluctuation	times	1	36	3	6	4	166	2	2	28
Total Distance per Year	km/year	99,8	18	498	948	368,4	498	282	532	3244,2
Transport Capacity	m³	20	20	20	20	20	20	20	20	20
Required fluctuation (limited by Vessel)	times	1	36	3	6	4	166	2	2	27,5
Required Distance per year	km/year	99,8	18	498	948	368,4	498	282	532	3244,2
Required Transport Distance per year	km/year	199,6	36	996	1896	736,8	996	564	1064	6488,4
Costs for Transportation	Euro/year	279,44	50,4	1394,4	2654,4	1031,52	1394,4	789,6	1489,6	9083,76
Cost per m³ discharged	Euro/m³	33,75	0,07	25,81	23,81	15,99	0,42	19,96	43,98	2,10
Costs for Discharging	15Euro/m³	82,80	7165,20	540,20	1114,90	645,14	33033,00	395,66	338,70	43315,60
Maximum Transportation Distance	km/year	29,57	2559,00	192,93	398,18	230,41	11797,50	141,31	120,96	15469,86
Within Critical Distance		yes	yes	yes	yes	yes	yes	yes	yes	**562,54**

The results of option IV can be interpreted as follows. The average transport capacity is 20 m³ (critical parameter). In the ports of Senj, Rijeka, Sibenik, Ploce and Dubrovnik 20 m³ reception (intermediate storage) tanks are installed, while in Pula a reception facility of minimum 10 m³. In Zadar, Sibenik, Ploce and Dubrovnik a pre-treatment takes place in order to reduce the amount of transportation from those ports with long distances. A critical distance of far above the minimum required one of 266 km can be achieved and all ports are within this distance. The specific costs have dropped below 5 Euro and are calculated with 2.10. The pre-treatment and intermediate storages could also be provided in the new Regional Waste Management Centres until a transport relevant amount can be reached. The investment of 20 m³ and 10m³ intermediate storage tanks and an arrangement with the regional facilities are economically feasible. The collection and disposal costs of **< 50 Euro** can be achieved.

5.3.4 Summary of Results of Optioneering

5.3.4.1 Optioneering waste oil

Table 32_Critical distances waste oil – summary

Medium		Waste Oil Transport - 10 Euro			
Options		Option 0	Option I	Option II	Option III
Optioneering	Unit	Total	Total	Total	Total
Amount	(m^3/year)	1333,7	1333,7	1333,7	1333,7
Closest treatment facility	--	0,0	0,0	0,0	0,0
Distance to treatment facility	km	115,8	115,8	115,8	115,8
Current Storage Amount	(m^3)	0,0	0,0	0,0	0,0
Discharge fluctuation	times	50,3	28,0	17,0	11,0
Total Distance per Year	km/year	46775,6	16884,5	3702,3	2250,7
Transport Capacity	m^3	5,0	5,0	5,0	10,0
Required fluctuation (limited by Vessel)	times	70,0	47,3	35,6	17,3
Required Distance per year	km/year	46853,6	16962,5	3780,3	2276,7
Required Transport Distance per year	km/year	93707,2	33925,0	7560,6	4553,4
Costs for Transportation	Euro/year	131190,1	47495,0	10584,8	6374,8
Cost per m^3 discharged	Euro/m^3	98,4	35,6	7,9	4,8
Costs for Discharging	Euro/m^3	13337,4	13337,4	13337,4	13337,4
Maximum Transportation Distance	km/year	4763,4	4763,4	4763,4	4763,4
Within Critical Distance	**km**	**68,0**	**100,8**	**133,7**	**276,1**

The summary of the results shows, that a sufficient distance can be achieved by following option III, while a total treatment and discharging fee of <50 Euro can be achieved. Required installations (reception facilities) close to every port are required. The regional waste management centres can play a crucial role within this strategy to provide storage facilities until a transport relevant amount can be reached.

5.3.4.2 Optioneering bilge water

Table 33_ Critical distances bilge water – summary

Medium		Bilge Water - 10 Euro				2 times Bilge Water - 10 Euro				
Options		Option 0	Option I	Option II	Option III	Option 0	Option I	Option II	Option III	Option IV
Optioneering	Unit	Total	Total	Total	Total	Total	Total	Total	Total	Total
Amount	(m³/year)	3288,3	3288,3	3288,3	2165,8	6576,5	6576,5	6576,5	6576,5	4331,6
Closest treatment facility	--	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Distance to treatment facility	km	115,8	115,8	115,8	115,8	115,8	115,8	115,8	115,8	115,8
Current Storage Amount	(m³)	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Discharge fluctuation	times	52,0	41,0	28,0	14,0	52,0	165,0	83,0	42,0	28,0
Total Distance per Year	km/year	48172,8	30174,3	20001,1	2902,2	48172,8	80655,6	40491,3	20343,1	3244,2
Transport Capacity	m³	5,0	5,0	10,0	10,0	5,0	5,0	10,0	20,0	20,0
Required fluctuation (limited by Vessel)	times	99,0	83,0	42,0	27,5	176,3	164,9	82,6	41,5	27,5
Required Distance per year	km/year	59697,1	40491,3	20343,1	3244,2	92451,6	80655,6	40491,3	20343,1	3244,2
Required Transport Distance per year	km/year	119394,2	80982,6	40686,2	6488,4	184903,2	161311,2	80982,6	40686,2	6488,4
Costs for Transportation	Euro/year	167151,9	#######	56960,7	9083,8	258864,5	225835,7	113375,6	56960,7	9083,8
Cost per m³ discharged	Euro/m³	50,8	34,5	17,3	4,2	39,4	34,3	17,2	8,7	2,1
Costs for Discharging	Euro/m³	32882,6	32882,6	32882,6	21657,8	65765,2	65765,2	65765,2	65765,2	43315,6
Maximum Transportation Distance	km/year	11743,8	11743,8	11743,8	7734,9	23487,6	23487,6	23487,6	23487,6	15469,9
Within Critical Distance	**km**	**118,6**	**141,5**	**279,6**	**281,3**	**133,3**	**142,5**	**284,3**	**566,0**	**562,5**

The summary of the results shows, that a sufficient distance can be achieved by following option III and improved following option IV while a total treatment and discharging fee of <60 Euro under current amount can be achieved. The option IV includes the pre-treatment of bilge water in the Regional Waste Management facilities and an intermediate storage to achieve a transport relevant amount. Under this circumstance a discharging fee below 55 Euro is possible.

The future scenario with a doubled amount allows a more optimistic expectation. Option three (intermediate storage) reaches a discharging fee of < 60 Euro. Pre-treatment on Regional Waste Management Centres allows a fee below 50 Euro. For options III and IV of both scenarios are installations (reception facilities) close to every port required. The regional waste management centres can play a crucial role within this strategy to carry out pre-treatment and to provide storage facilities until a transport relevant amount can be reached.

All results are illustrated in chapter Summary chart of critical distance calculation 7.4

6 Evaluation of technology for a pre-treatment on reception facilities

6.1 Treatment plant – equipment requirement

A pre-treatment facility for a waste oil separation consists of: 1 Inlet basin (20m³) – constructed by oil resistivity concrete – Option I 1 Inlet tank (5-8m³) – Option II	Inlet situation Option I Option II
1 Emulsion tank (5-8m³) 1 Oil storage tank (10-20m³) 1 Inlet pump (either by vessel pressure or membrane pump) 1 Sludge-discharging pump (eccentric pump) 1 Emulsion water pump (membrane pump) 1 Compressor (5-6 bar) 2 Skip containers (5-7m³) 1 unit piping and fitting 1 unit control system (level meter, flow meter)	Option A
A pre-treatment facility for a bilge water separation consists of: 1 Emulsion Tank (5-8m³) 1 Inlet pump (either by vessel pressure or membrane pump) 1 compressor (5- 6 bar)	Option B
1 Emulsion tank (5-8m³) 1 Plate centrifuge (3-phase centrifuge) 1 Compressor (5-6 bar) 1 unit piping and fitting 1 unit control system (level meter, flow meter, etc.)	Option E
A water treatment facility for residues water purification consists of: 1 Preparatory unit with three chambers 3 Agitators 1 Flocculation unit 1 Conditioner (coagulation unit) 1 Separation tank 3 m³ 1 Drain filter 1 Clear water pump (membrane pump) 1 Sludge pump (eccentric pump) 1 Skip container (5-7m³)	Option D
Outlet – discharge unit consists of: Discharge unit into landfill leachate pond – Option F Discharge unit into sewer system – Option G	Outlet situation Option F Option G

6.2 Optioneering

6.2.1 Waste oil treatment

OPTION A - The waste oil treatment can be provided with waste oil either by a collection basin (**Option II**) of 20m³ (fed by a pump) or directly by a tank (**Option I**) with 5-10m³. The first storage tank is mainly for the physical separation of oil sludge, emulsion and oil. The oil sludge on the bottom is pumped into a skip container, where the sludge can dry, while leachate will be pumped back into the oil storage tank. The emulsion, mainly in the middle of the tank body is lead into the emulsion tank, while the oil, on the top of the tank is pumped into a final oil storage tank for further transportation to a reuse station.

OPTION F -The Emulsion with a content of 1-5% oil can either be discharged into the leachate ponds of the Regional Sanitary Landfill (the COD is approximate 400-600 mgO_2/litre) or has to be treated further to achieve public sewer discharge quality.

OPTION G – in order to achieve public sewer discharge quality the emulsion have to be treated further

Either

OPTION D – by a water treatment and purification station. The emulsion is coagulated and flocculated with additives in retention chambers of 0,5 m³ , mixed by agitators. The overflow reaches a reactor to increase the reaction and sedimentation time. The sedimented components (oily sludge) is pumped by an eccentric pump into a drain bed filter and dewatered until a DS of 22% by vibration onto the filter. Sludge is disposed into a skip container for further drying. The leachate water from the container is pumped back into the emulsion tank, while the clear water from the drain bed is discharged into the public sewer system. The water has a maximum content of 20 ppm oil.

Or

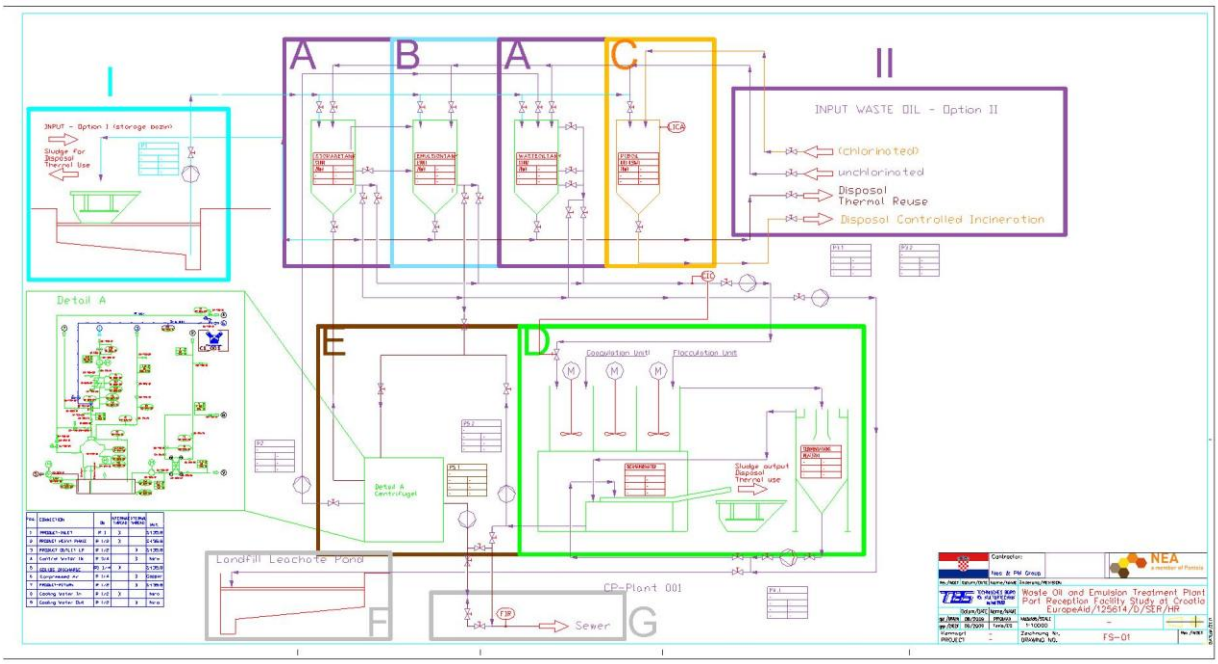
OPTION E – by a centrifuge, which allows the separation of three phases – oil to be pumped back into the oil storage tank, water which is discharged into the public sewer and sludge which is pumped into the skip container for further drying to increase the DS (dry substance). The sewer-discharged water has a maximum content of 15 ppm oil.

6.2.2 Options

Table 34_Alternatives

Options	I	II	A	B	C	D	E	F	G	Sludge	Water	Oil
Option 1	x		x	x				x		Skip, 5%DS	Leachate 5% oil, COD 400 mg/l	Tank
Option 2		x	x	x				x		Skip, 5%DS	Leachate 5% oil, COD 400 mg/l	Tank
Option 3	x		x	x		x			x	Skip, 22%DS	Sewer 20ppm oil	Tank
Option 4		x	x	x		x			x	Skip, 22%DS	Sewer 20ppm oil	Tank
Option 5	x		x	x			x		x	Skip 10% DS	Sewer 15 ppm oil	Tank
Option 5		x	x	x			x		x	Skip 10% DS	Sewer 15 ppm oil	Tank
Option 6	x			x				x		Skip, 2%DS	Leachate 5% oil, COD 400 mg/l	Tank
Option 7		**x**		**x**				**x**		**Skip, 2%DS**	**Leachate 5% oil, COD 400 mg/l**	**Tank**
Option 8	x			x		x			x	Skip, 22%DS	Sewer 20ppm oil	Tank
Option 9		x		x		x			x	Skip, 22%DS	Sewer 20ppm oil	Tank
Option 10	x			x			x		x	Skip 10% DS	Sewer 15 ppm oil	Tank
Option 11		x		x			x		x	Skip 10% DS	Sewer 15 ppm oil	Tank

Figure 19_Process chart and treatment options



6.2.3 Description of preferred option

The options logistic analysed in previous chapter have shown that a waste oil treatment in the regional centres is economically not feasible and would increase a not required capacity. The current treatment of licensed companies is sufficient to treat 2 to three times the amount of current generated Annex I wastes.

From logistic point of view a pre-treatment of emulsion (bilge water) analysed economically feasible in order to achieve a costs structure below 60 Euro per m³. The most simple form of emulsion (bilge water) treatment is the combination II – B – F due to the fact that storage basins require construction costs and additional permits. The

physically separated water (still contains 3% of oil) is discharged into the leachate ponds of the sanitary landfill with a COD content of 400 mg/litre O_2, which is far below of leachate water from landfills (above 6000 mg O_2/litre).

If there is no possibility of joint treatment within the leachate stream and water has to be discharged into the public sewer the combination – II – B – E – G shall be taken as the most efficient into consideration. A 3-phase centrifuge with a capacity of 2,5m³ per hour is more than sufficient, even for a future increased (double as forecasted within the next 5 years) amount.

The advantage of an integrated system with the Regional Waste Management Centres can be summarized as following:

Short distances to ports

- Operation costs sharing due to an ongoing waste treatment
- Integrated approach for port wastes and hazardous waste generated by households in a regional context
- Cost sharing situation and fix cost digression
- Regional coordination and waste stream management
- Capacity concentration
- Increased competencies due to special waste stream management
- Central recording and reporting
- Reduced process water treatment costs by using leachate ponds for discharging

7 Annexes

7.1 Calculation Models

7.1.1 The REMPEC model

7.1.1.1 Garbage

The volumes of domestic, maintenance and cargo – associated waste are calculated from the following formula:

$$G = G_D + G_M + G_C \text{ (kg/week)}$$

or

$$G = G_D + G_M + G_C / \rho \text{ (m3/week)}$$

(where ρ=250 kg/ m3 the average density of shipboard household and household related wastes)

G = the quantity of household and household related wastes received in peak seven day period (kg/week)

G_D = the quantity of domestic solid waste received in a peak seven day period (kg/week)

G_M = the quantity of maintenance solid wastes received in a peak seven day period (kg/week)

G_C = the quantity of cargo associated waste received in a peak seven day period (kg/week)

Quantity of domestic waste

$$G_D = G_B + G_P + G_H$$

$$G_B = N_B * T_B * Q_B * P_B$$

where

G_B = quantity of domestic household and household related wastes received in peak seven day period from sea-going cargo ships (kg/week)

N_B = number of cargo ships calling at the port in the same period

T_B = average duration of voyage and stay at the port of sea going cargo ships (days)

Q_B = average daily domestic household and household related wastes generation rate on sea-going cargo ships (2.0 kg/person and day)

P_B = average number of persons onboard a typical sea-going cargo ship (persons/vessel)

$$G_P = N_P * T_P * Q_P * P_P$$

where

N_P = number of passenger ships calling at the port in the same period

G_P = quantity of domestic household and household related wastes received in peak seven day period from passenger ships (kg/week)

T_P = average duration of voyage and stay at the port this kind of ships (days)

Q_P = average daily domestic household and household related wastes generation rate on passenger ships (3.0 kg / person and day)

P_P = average number of persons onboard a typical passenger ship (persons/vessel)

$$G_H = N_H * T_H * Q_H * P_H$$

where

N_H = number of harbour craft engaged in the port operation

G_H = quantity of domestic household and household related wastes received in peak seven day period from harbour craft (kg/week)

T_H = average duration of voyage and stay at the port of harbour craft (7 days)

Q_H = average daily domestic household and household related wastes generation rate on harbour chart (1.0 kg/person and day)

P_H = average number of persons onboard a typical harbour craft (persons/vessel)

Quantity of maintenance waste

$$G_M = N * T * M$$

N = number of vessels in port during a peak seven-day period (vessels/week);

T = average duration of ships' transit and stay at the port area (days);

M = average quantity of maintenance solid wastes generated daily from a typical vessel (11 kg/vessel-day)

Quantity of cargo – associated waste

$$G_C = C_B + C_D + C_C$$

where:

C_B = W_B * 1/123 = quantity of break bulk cargo solid wastes received in a peak seven-day period (kg/week);

W_B = quantity of break bulk cargo received in a peak seven-day period (kg/week);

1 / 123 = break bulk cargo waste generation factor;

C_D = W_D * 1/10,000 = quantity of dry bulk cargo solid wastes received in a peak seven-day period (kg/week);

W_D = quantity of dry bulk cargo received in a peak seven-day period (kg/week);

1/10,000 = dry bulk cargo waste generation factor;

C_C = W_C 1/25,000 = quantity of container cargo solid wastes received in a peak seven-day period (kg/week);

W_C = quantity of container cargo received in a peak seven-day period (kg/week);

1/25,000 = container cargo waste generation factor.

7.1.1.2 Oily bilge water and oil residues

$$Q_t = Q_{sl} + Q_m \quad (m^3/day)$$

$$Q_{sl} = \frac{N_1 * P_{sl} * T}{365}$$

$$Q_m = \frac{N_2 * P_m * T}{365}$$

where:

Q_t = Volume of oily wastes from the machinery spaces of ships to be received (m3/day)

Q_{sl} = Volume of oil residues (sludge) to be received (m3/day)

Q_m = Volume of oily bilge water to be received (m3/day)

N_1 = Number of ships calling at the port annually

N_2 = Number of ships without oily bilge water separating and filtering equipment (with only bilge holding tanks) calling at the port on an annual basis

P_{sl} = Oil residues daily production (0.02 x fuel oil daily consumption per day (gr/HP * hr) of voyage (m3/day)

P_m = Oily bilge water production per sailing day from N2 ships calling at the port (m3/day)

T = Average duration of voyage before calling at the port and stay at the port area (days)

7.1.2 The FSI formulas

$V_{\text{Kind of waste}}$ = Factor x d x P = V dm3 [(dm3 / d x P) x d x P = dm3]

where

V is the volume of the relevant kind of waste in dm3;

d is the duration of journey in days (**at least 30 days**);

P is the number of persons on board.

Glass

$V_{\text{Glass}} = 1{,}84 \times d \times P$

Density in t/m³, e.g., ≈ 1,2 for waste glass[14]

Paper, cardboard, cartons

$V_{\text{Paper}} = 1{,}05 \times d \times P$

Density in t/m³, e.g., ≈ 0,5 for waste paper

Packaging, plastics

$V_{\text{Plastics}} = 1{,}0 \times d \times P$

Density in t/m³, e.g., ≈ 0,2 for plastic containers

Wood

As waste wood normally is a result of cargo residues, no general quantity calculation can be made.

Density in t/m³, e.g., ≈ 0,48 m³ for dunnage, waste wood

Metal, scrap

$V_{\text{Metal}} = 0{,}55 \times d \times P$

Density in t/m³, e.g., ≈ 2,0 for iron scrap

$V_{\text{Special waste}} = 1{,}84 * d \times P$

Organic waste

$V_{\text{Plastics}} = 1{,}02 \times d \times P$

[14] Data according to Landesumweltamt NRW (Germany), density table of LAGA kinds of waste.

7.2 References

[1]... (JS 06_30) Dsitribution of sizes of ships; NEA

[2]... 5th MR Annex 1 (Jan)

[3]… 5th MR Annex 2 (Jan)

[4]… 5th MR Annex 3 - Liquid oily wastes (final 22.07.09)

[5]… 5th MR Annex 4 (Jan)

[6]… 5th MR Annex 5 (Rob)

[7]… Interim report PRFS Phase 1 (R20090104)

[8]… Result of activity 14

[9]… Activity 3 - Final Report Consolidated; OPTIMUM SOLUTIONS FOR COLLECTING, TREATMENT AND DISPOSAL OF RELEVANT SHIP-GENERATED SOLID AND LIQUID WASTES IN ALBANIA, CROATIA AND SLOVENIA; FINAL REPORT; May 2004; REMPEC

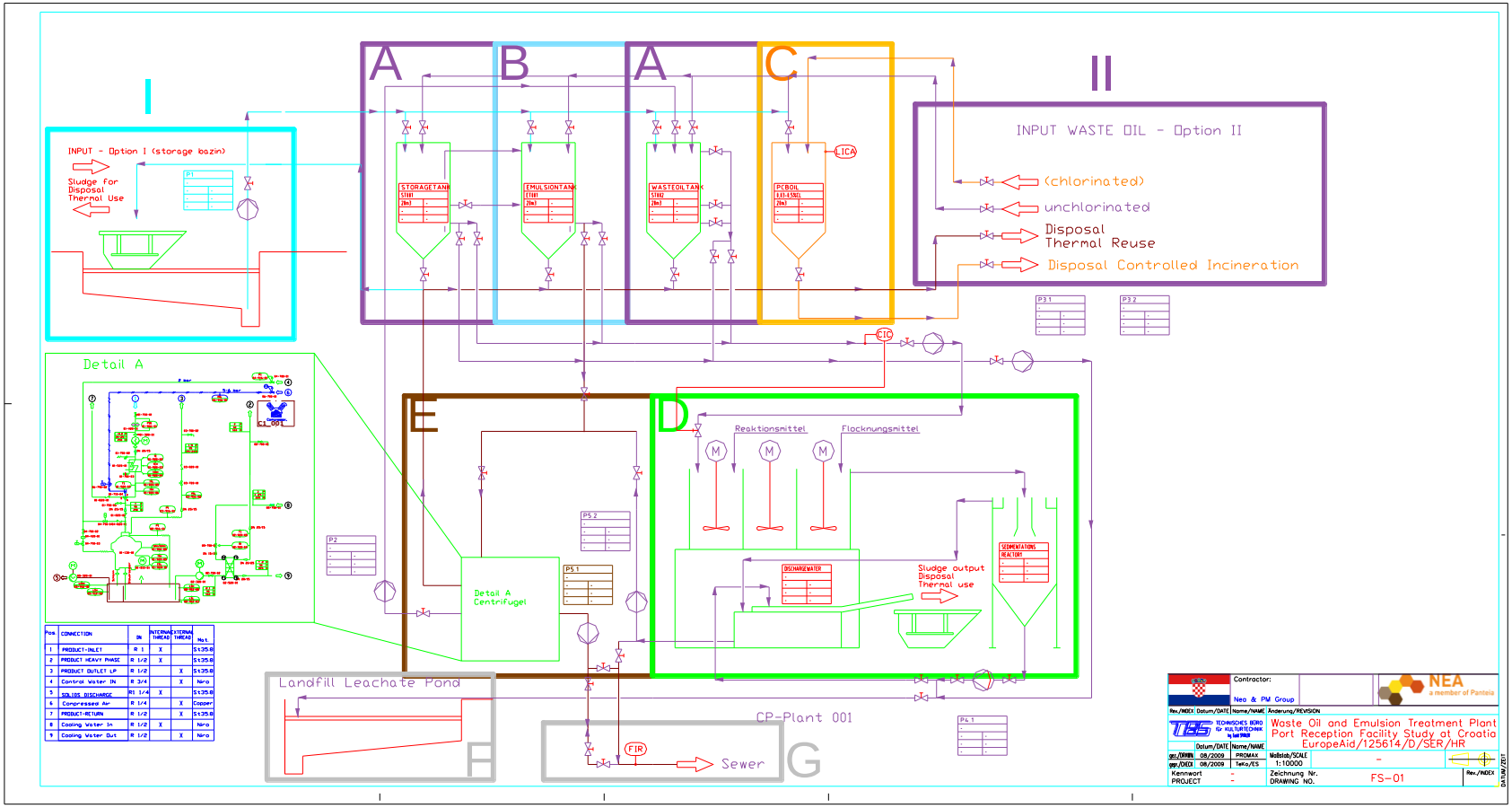
[10]… Activity D Final Report (E); PROJECT MED.B4.4100.97.0415.8; PORT RECEPTION FACILITIES FOR COLLECTING SHIP-GENERATED household and household related wastes, BILGE WATERS AND OILY WASTES; ACTIVITY D; STANDARD DESIGNS FOR (A) OILY WASTES RECEPTION, TREATMENT, STORAGE AND DEWATERING FACILITIES AND (B) household and household related wastes COLLECTION, TREATMENT AND DISPOSAL FACILITIES; FINAL REPORT; October 2004; REMPEC

[11]… Garbage management plans MEPC/Circ.317; ANNEX; GUIDELINES FOR THE DEVELOPMENT OF household and household related wastes MANAGEMENT PLANS; MEPC/Circ.317; 10 July 1996; T5/1.01

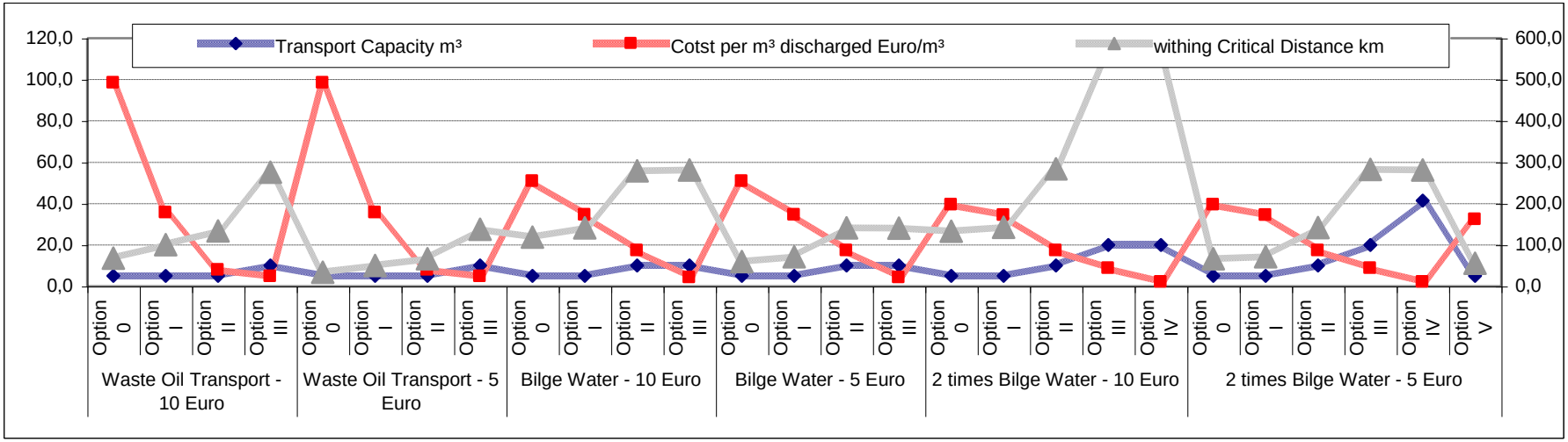
[12]… MARPOL; Annex I; International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL)

[13]… MARPOL, Annex V; Prevention of pollution by household and household related wastes from ships; Entry into force: 31 December 1988

7.3 Designs


I
A
B
A
C
II
INPUT - Option I (storage bazin)
Sludge for Disposal Thermal Use
INPUT WASTE OIL - Option II
(chlorinated)
unchlorinated
Disposal Thermal Reuse
Disposal Controlled Incineration
Detail A
E
D
Reaktionsmittel
Flocknungsmittel
Detail A Centrifugel
Sludge output Disposal Thermal use
Landfill Leachate Pond
F
G
CP-Plant 001
Sewer
Contractor:
Nea & PM Group
NEA
a member of Pantela
Waste Oil and Emulsion Treatment Plant
Port Reception Facility Study at Croatia
EuropeAid/125614/D/SER/HR
FS-01

7.4 Summary chart of critical distance calculation



Comments / Notes