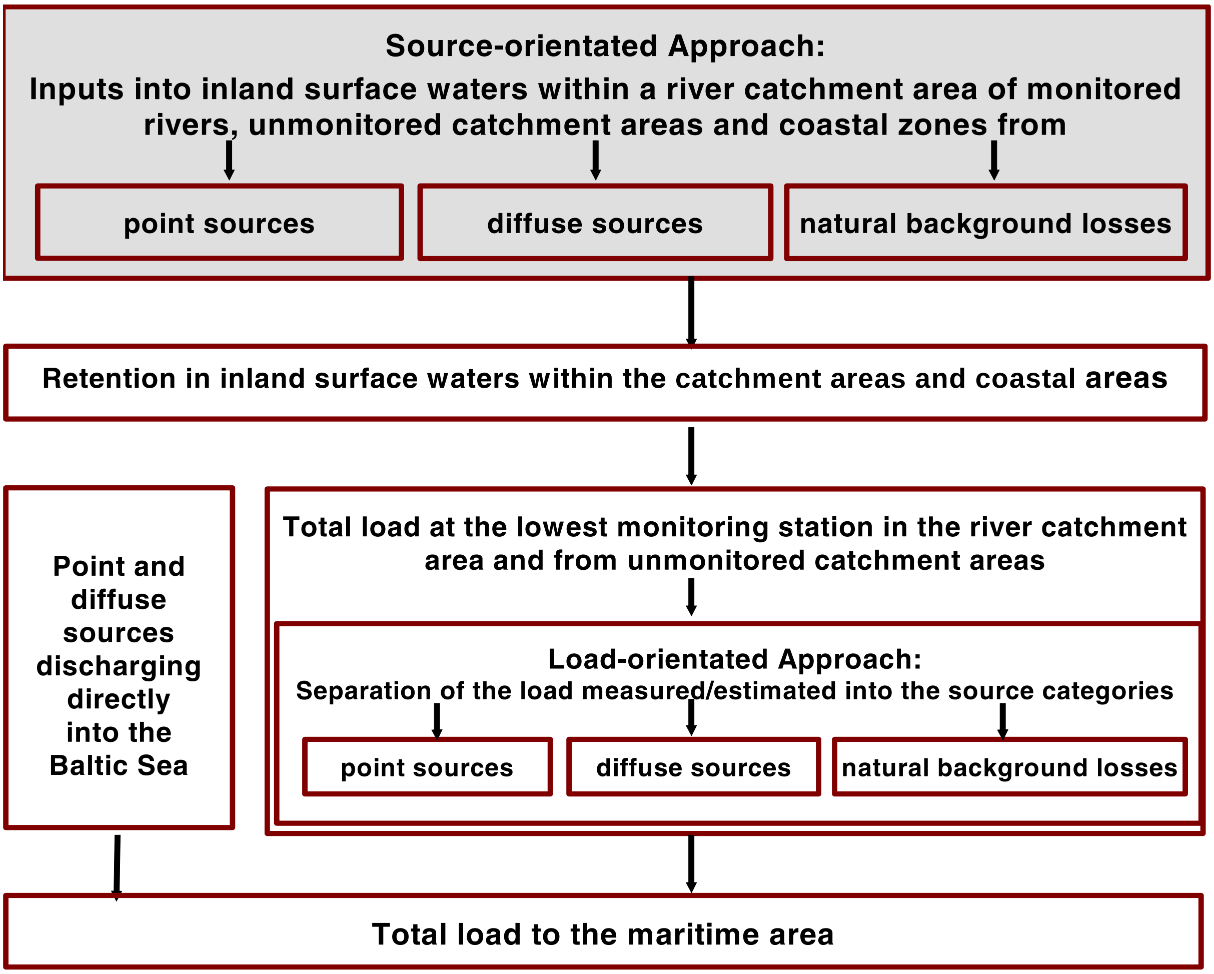
3. Source-orientated approach: Methodology for assessing point and diffuse sources and natural background losses

This part of the Guidelines – the so-called source-orientated approach (see shaded boxes below in the figure) – is dealing with the quantification of the discharges/losses into inland surface waters within the Baltic Sea catchment area from:

1. Point sources
2. Diffuse sources; and
3. Natural background losses.

All parts of the source-oriented approach are only done every sixth year starting in 2006. All information and data which have to be reported electronically are summarised in Annex 4.2.



3.1. Quantification of discharges from point sources

Methods for discharges from point sources include municipal and industrial effluents as well as discharges from fish farming plants directly into the Baltic Sea (annually) and into inland surface waters in the Baltic Sea catchment area located within the borders of the Contracting Parties (periodically every sixth year). The quantification methods are the same in both approaches.

3.1.1. Flow measurement

The accuracy of the wastewater flow measurement in municipal sewage systems and industrial plants is in many cases of a considerable lower quality than expected. Measurement errors more than 20% are not unusual. However, the accuracy can be improved by increasing the awareness of the types of errors, by elimination of these errors and by continuous maintenance of the measurement system and its accuracy. A relative error less than 5%, which can be achieved by most of the methods used in open and closed systems, should be a target in each case.

An open flow measurement system includes channels, flumes and weirs, e.g. Venturi- and Parshall channels/flumes and Thompson (V-notch) weirs. In closed systems the measurement takes place in pipes using different kind of flow meters, e.g. ultrasonic and electromagnetic meters. Most of these methods available are reliable in a proper use and can be recommended for the wastewater flow measurement. In this chapter only some general instructions related to the flow measurement and improvement of it's accuracy are presented. More detailed information can be obtained from numerous standards (e.g. ISO-/DIN-standards), guidelines and handbooks which deal with flow measurement methods, the theory and prerequisites of them as well as possible sources of error, calibration methods etc. These standards, guidelines and handbooks are rather easily available in every Baltic country.

The flow measurement system should be chosen so that continuous measurement and registration of wastewater flow can be carried out. In addition to the instant flow recorder the system should have totalizer to give the cumulative flow. Otherwise the system should be chosen on the basis of good accuracy and reliability.

The whole flow measurement system (waterways plus measurement devices) should be planned carefully as well as built and installed exactly according to dimensions, prerequisites and guidelines of the chosen system/method. Old systems should be checked thoroughly from time to time. Observed errors should be corrected; if this is not possible, a new accurate system should be applied.

The measurement system/equipment should be calibrated on-site (in the real measurement conditions). The calibration should be carried out by using an independent method/system which is accurate (relative error preferably less than + 2%). The accuracy of the calibration should be possible to estimate in each calibration. The calibration should be repeated from time to time e.g. once per 1-2 years. If the system is stable the calibration frequency can be reduced and vice versa.

In order to maintain continuously a good accuracy and reliability of the measurement system, waterways and devices have to be cleaned and the function of them checked regularly. For example, in the case of venturi-channels and overflow weirs the correctness of the water level measurement should be checked daily.

The above mentioned principles for selection of flow measurement systems and for calibration and control of systems are valid for treated and untreated wastewater. However, the untreated wastewater outflow is often not measured with stationary measurement systems. In these cases the flow have to be estimated, e.g. on the basis of the water consumption.

3.1.2. Sampling strategy: site selection and sampling frequency

There are several ISO-standards dealing in detail with the sampling of wastewater already applied by Contracting Parties. Therefore, in this chapter only the main principles of sampling are presented.

In order to get representative samples they should be taken at points where the effluent has a high turbulent flow to ensure good mixing. If the water is not mixed properly the suspended solids and other substances may be unequally distributed in the water column, which may cause a remarkable error. The chosen sampling location should be regularly cleaned to avoid excess contamination by sludge, bacterial film etc. from the walls. Sampling frequency should be optimised taking into account the variation of flow and concentration.

3.1.2.1. Municipal wastewater treatment plants

The EC Urban Wastewater Treatment Directive (UWWTD) calls for measurements at the outlet of municipal wastewater treatment plants, with a minimum frequency of sampling according to the number of PE (Population Equivalent) connected; the monitoring of pollutants is required for municipal wastewater treatment plants with more than 10000 PE connected. However, water samples are also required for municipal wastewater treatment plants between 2000 and 10000 PE connected (Table 3.1).

Table 3.1: Number of PE connected and number of samples required.

Number of PE connected	Number of samples
< 2000 PE	4 samples or theoretical quantification when no sampling
2000 - 9999 PE	4 samples[1]
10000 - 49999 PE	12 samples
≥ 50000 PE	24 samples

[1] If one sample of the four fails to comply with the requirements of the Urban Wastewater Treatment Directive, 12 samples should be taken in the year that follows.

3.1.2.2. Industrial plants

In self-controlled large polluters (pulp, paper and metal processing mills and larger plants producing chemicals) sampling and analyses should be made 2-7 times per week. At smaller polluters a sampling frequency 1-4 per month, or even only a few times per year at very small polluters, can be considered acceptable. Samples from treated and untreated wastewater should always be taken as composite samples, which are prepared either automatically or manually. In both cases 24-hours-flow-weighted composite samples[2] should be the target at a well-defined point in the outlet of the industrial plant. At plants with very small wastewater

[2] According to the Urban Wastewater Treatment Directive (UWWTD, Council Directive 91/271 EEC, Annex 1) alternative methods may be used provided that it can be demonstrated that equivalent results are obtained.

discharges the sampling period of the composite samples can be less than 24 hours (e.g. 8-12 hours).

For measurements at the outlet of industrial plant, which is consumption of water more than 500 m^3 per day, number of samples is 12 times per year, from 50-500 m^3 per day, number of samples is 4 times per year and from 5-50 m^3 per day, number of samples is 2 times per year. For the storm water treatments plants, number of samples is 4-12 times per year.

3.1.3. Compilation of annual load

3.1.3.1. Municipal effluents

3.1.3.1.1. Division of the municipal effluents

The following division has to be applied to municipal wastewater treatment plants (MWWTP) discharging directly into the Baltic Sea (see 2.1.4.) and discharging into inland surface waters within the Baltic Sea catchment area. According to the Urban Wastewater Treatment Directive (UWWTD) the monitoring of pollutants is required for MWWTP with more than 2000 PE connected (table 3.1).

During storm events, the sewers may not be able to discharge all wastewater into the wastewater treatment plants. A portion may be discharged directly via a combined sewer overflows[3] and by-passes[4] or indirectly via rainwater constructions into inland surface waters. These portions need to be quantified and the related nutrient loads estimated. However, these discharges from overflows and by-passes belong to the diffuse pathway rainwater construction and overflows (see Figure 3.1.) and must be included into losses from diffuse sources (see 2.1.4. and 3.2.1.).

3.1.3.1.2. Calculation and estimation methods

The wastewater outflow should be measured continuously in order to calculate the total volume in a certain time period (day, month, year). Furthermore, the wastewater samples should be taken frequently as flow-weighted composite samples. If that is not possible, the monitoring programme has to be optimised (see 3.1.1 and 3.1.2). Whenever possible, annual discharges should be calculated as the product of annual total quantity of wastewater and flow-weighted concentrations; the three ISO standard methods below are examples of such quantification procedures.

a) *Continuous flow measurement and sampling (e.g. 24 hours flow-weighted composite samples 7 times/week)*

The annual load is then the cumulative load of continuously monitored time periods and can be calculated as follows:

$$L = \sum_{i=1}^{n} Q_i * C_t$$

L = annual load
Q_i = wastewater volume of period i
C_i = flow weighted concentration of period i
n = number of sampling periods.

b) *Continuous flow measurement and non-continuous sampling every second day, once a week or twice a month (preferably as 24 hour composites)*

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[3] Overflows are discharges from combined sewerage system to the water body during rainfall when the flow (mixture of sewage and rainfall run-off) in the system is over-loading the designed volume of the system. Control of overflows is regulated with HELCOM Recommendation 23/5.

[4] By-passes are discharges from sewerage system to the water body for prevention of pumping station or treatment plant damages during the breaks in electricity supply or emergency repairing works. Use of by-passes is regulated with HELCOM Recommendation 16/9.

The annual load can then be calculated as follows:

$$L = \frac{\sum_{i=1}^{n} Q_i * C_i}{\sum_{i=1}^{n} Q_i} * Q_t$$

L = annual load
Q_i = wastewater volume of the period i
C_i = concentration of sample i
Q_t = total wastewater volume of the year
n = number of sampling periods

c) *Flow measurement only on sampling days and sampling rather seldom i.e. 1–12 times/ year*

In this case the annual load can be calculated by multiplying the average load of sampling days by 365.

$$L = \frac{\sum_{i=1}^{n} Q_i * C_i}{n} * 365$$

L = annual load
Q_i = wastewater volume on sampling day i
C_i = concentration of the period i
n = number of sampling days

d) *Load estimate of small MWWTPs (<2000PE) and for untreated sewage discharges without reliable monitoring*

If for small MWWTP (< 2000 PE) or for untreated sewage discharges no reliable monitoring has been done and only population data (PE) are available, the load may be derived on the basis of the below per capita load figures:

- BOD_7 1 PE = 70 g O_2/day (60 g O_2/day for BOD_5)
- N_{total} 1 PE = 12 g N/day
- P_{total} 1 PE = 2.7 g P/day

Countries should use their own estimates if more specific data about the local conditions are available. These estimates including the calculation methods used must be reported. The same methodology should be used for both annual reporting and point-source inventory in 2006.

3.1.3.1.3. Reporting

The discharges from individual MWWTPs into inland surface waters within the Baltic Sea catchment area should be reported every six years starting in 2006 and from MWWTP discharging directly into the Baltic Sea every year. Annual reporting of MWWTPs discharging directly into the Baltic Sea have been described in chapter 2.1.4.

The discharges from MWWTPs into inland surface waters should be reported in accordance with the requirements of the load-orientated approach, which means for every monitored river individually or aggregated for some of the monitored rivers. For unmonitored areas (partly monitored rivers, unmonitored parts of monitored rivers, unmonitored rivers and coastal areas including unmonitored islands) the discharges from MWWTP should be reported per Contracting Parties' contribution for each Baltic Sea sub-region. For all categories mentioned in the table 3.2 the number of MWWTPs and number of connected Population Equivalent (PE) have also to be reported as well as all calculation and/or estimation methods. Flow data, flow measurement methods and estimation of their accuracy should be reported by each Contracting Party participating in PLC-water. The calculation methodology should be reported. If the annual discharge loads differ from the periodic loads taken every six years (due to estimate), both values should be reported in the year of periodic reporting.

For PLC-Water assessments discharges from MWWTP must be reported separately for treated and untreated wastewater of the two size categories:

- Sewage effluents from MWWTP >10000 PE; and
- Sewage effluents from MWWTP ≤ 10000 PE

All information and data which have to be reported electronically are summarised in Annex 4.2.

Table 3.2: Data reporting on MWWTPs discharging into inland surface water and directly to the Baltic Sea.

MWWTPs DISCHARGING INTO THE INLAND SURFACE WATERS AND DIRECTLY TO THE BALTIC SEA							
REPORTING CATCHMENT	**SIZE OF MWWTP (PE)**	**TREATMENT STATUS**	**EVERY SIX YEAR REPORTING**			**ANNUAL REPORTING**	
			FLOW*	**LOAD***	**NUMBER OF PLANTS AND PE**	**FLOW**	**LOAD**
Monitored rivers reported individually	>10000	treated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported	No reporting	
		untreated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
	≤10000	treated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
		untreated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
Monitored rivers reported aggregated	>10000	treated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported	No reporting	
		untreated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
	≤10000	treated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
		untreated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
Unmonitored areas aggregated by sub-region	>10000	treated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported	No reporting	
		untreated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
	≤10000	treated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
		untreated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
Direct discharges into the Baltic Sea (aggregated by sub-region annually)			The same as for annual reporting			Details on reporting obligation are in chapter 2.1.4. and specified in table 2.3	

* The flow and loads should be reported divided on big (>10000 PE) and small (≤10000 PE), treated and untreated waste water

3.1.3.2. *Industrial effluents*

3.1.3.2.1. Division of the industrial effluents

The following division has to be applied to industrial plants discharging directly into the Baltic Sea and discharging into inland surface waters within the Baltic Sea catchment area. The distinguished industrial sectors for reporting have been based on the source categories of the EC Directive on Integrated Pollution Prevention and Control (Directive 96/61/EC; IPPC Directive), in order to allow to make use of the data reported under the IPPC Directive and the related Commission Decision of 17 July 2000 (2000/479/EC) on the Implementation of an European Pollutant Emission Register (EPER) according to Article 15 of the IPPC Directive. The main industrial sectors specified in Annex 1 of the IPPC Directive are as follows:

1. *Energy industries*
2. *Production and processing of metals*
3. *Mineral industry*
4. *Chemical industry*
5. *Waste management*
6. *Other activities*

The categories within each sector describing the threshold for the production capacity which should be used when dividing the industrial activities into size categories are contained in Annex 5.

In cases where an industrial plant belongs to more than one distinguished industrial sector and that it is impossible to divide the discharges of that plant on the various sectors, the discharges of the plant should be addressed to the main industrial sector to which the plant belongs.

3.1.3.2.2. Calculation and estimation methods

Ideally, all industrial plants should have a monitoring programme; practically it is necessary to ensure that at least the industrial plants exceeding the EPER threshold values (EPER threshold values are presented in Annex A1 to the Commission Decision 2000/479/EC on the implementation of EPER) have an adequate monitoring programme. The ultimate aim is that the figures should provide comparable and transparent figures, and that the reported figures are as complete as possible.

Wherever possible, the annual discharges from industrial plants should be calculated as the product of the total quantity of wastewater in a period multiplied with the corresponding flow-weighted concentrations and summed up annually. The three ISO standard methods in chapter 3.1.3.1.2 are examples of such quantification procedures. For industrial plants discharging less than the EPER threshold value into waters, relevant standard discharge coefficients should be used in cases where no monitoring data is available. The determination of such coefficients should be based on experience with discharges from larger plants that have monitoring programmes, taking into account of differences in the degree of internal treatment at the plants.

3.1.3.2.3. Reporting

The quantification of discharges from industrial plants into inland surface waters within the Baltic Sea catchment area should be carried out every six year starting in 2006 and from industrial plants discharging directly into the Baltic Sea every year (see 2.1.4 for annual reporting). For PLC-Water assessments discharges from industrial plants must be reported separately for treated and untreated wastewater for each of the industrial sectors described in chapter 3.1.3.2.1 of:

- industrial activities exceeding the IPPC production capacity (IPPC plants); and
- industrial activities below IPPC production capacity

The discharges from industrial plants into inland surface waters should be reported in accordance with the requirements of the load-orientated approach, which means for every monitored river individually or aggregated for some of the monitored rivers. For unmonitored areas (partly monitored rivers, unmonitored parts of monitored rivers, unmonitored rivers and coastal areas including unmonitored islands) the discharges from industrial plants should be reported per Contracting Parties' contribution for each Baltic Sea sub-region. Flow data, flow measurement methods and estimation of their accuracy should be reported by each Contracting Party participating in PLC-water. The calculation methodology should be reported. If the annual discharge loads differ from the periodic loads taken every six years (due to estimate), both values should be reported in the year of periodic reporting.

According to the Commission Decision 2000/479/EC on the Implementation of EPER, pollutants should only be reported if the thresholds presented in Annex A1 to the EPER Decision are exceeded. Discharges above these thresholds for relevant pollutants should also be reported to PLC-5 as a minimum. The Contracting Parties should also report discharges below the threshold as well as for non-IPPC industrial plants if data is available.

All information and data which have to be reported electronically are summarised in Annex 4.2.

Table 3.3: Data reporting on industrial plants discharging into inland surface water and directly to the Baltic Sea.

INDUSTRIAL PLANTS DISCHARGING INTO THE INLAND SURFACE WATERS AND DIRECTLY TO THE BALTIC SEA							
REPORTING CATCHMENT	**SIZE OF THE INDUSTRIAL PLANT**	**TREAT-MENT STATUS**	**EVERY SIX YEAR REPORTING**			**ANNUAL REPORTING**	
			FLOW*	**LOAD***	**NUMBER OF PLANTS**	**FLOW**	**LOAD**
Monitored rivers reported individually	>IPPC production capacity	treated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported	No reporting	
		untreated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
	≤IPPC production capacity	treated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
		untreated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
Monitored rivers reported aggregated	>IPPC production capacity	treated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported	No reporting	
		untreated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
	≤IPPC production capacity	treated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
		untreated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
Unmonitored areas aggregated by sub-region	>IPPC production capacity	treated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported	No reporting	
		untreated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
	≤IPPC production capacity	treated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
		untreated	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
Direct discharges into the Baltic Sea (aggregated by sub-region annually)			The same as for annual reporting			Details on reporting obligation are in chapter 2.1.4. and specified in table 2.3	

* The flow and loads should be reported divided on big and small industrial plants (according to the IPPC production capacity), treated and untreated waste water as well as for six industrial sectors

3.1.3.3. Fish farming plants

The main source for nitrogen, phosphorus and BOD discharges from fish farming plants is overall the feed supplied into the farming system. Discharges of nitrogen, phosphorus and BOD are derived from uneaten feed, undigested nitrogen, phosphorus and BOD (faeces), and excretion via the gills and the urine. Measures aimed at the reduction of discharges from fresh water and marine fish farming are regulated in HELCOM recommendation 25/4.

Discharges from fish farming plants can be determined by monitoring of discharges or by calculations based either on records of fish production and feed used or by using feed conversion rates (FCR) combined with chemical analyses of feed and fish and taking into account removal of nutrients (and organic matter) by natural processes and sludge removal. Quantification of discharges from fish farming plants should be based on aggregated information extracted from national registers of annual figures for relevant parameters from each individual plant. Such statistics are usually collected as part of the requirements in the discharge permits. For the quantification of discharges, the distinction is made between two main production types:

a) *Plants without treatment (e.g. plants where the sludge is not collected or where the sludge is collected, but discharged to the aquatic environment without treatment); and*

b) *Plants with treatment (e.g. plants with permanent removal of sludge), where the N and P contents (and organic matter) in the sludge removed are quantified.*

Two quantification approaches of discharges from fish farming plants are described in the following:

1. *Approach 1 is based on calculations from production parameters. The starting point is that information is available on both production and feed consumption at catchment level. The quantification method is based on mass balance equations.*

2. *Approach 2 is based on monitoring the discharge. It is practicable for ponds or other land based production systems where the discharges are distinct point discharges (such as end of pipe/channel). The quantification of losses is also based on mass balance equation but on monitoring results.*

3.1.3.3.1. Approach 1

This approach forms a basis for the estimation of nitrogen, phosphorus and BOD discharges from fish farming plants (Cho *et al.* 1991).

a. <u>For farms without treatment (sludge removal):</u>

$$\mathbf{L=0.01*(IC_i-GC_f)-M-T} \qquad (1)$$

L = phosphorus (P) or nitrogen (N) discharge to water body in kg/a;
I = amount of feed used for feeding of fish in kg/a;
C_i = P or N content in feed in %;
G = net growth of fish including dead fish in kg/a;
C_f = P or N content in fish in %;
M = nutrient losses due to metabolism in fish
T = nutrient removal processes on the fish farm not related to sludge removal (e.g. nutrient turnover, denitrification etc.)

$L=(P_L-D)$ (2)

L = BOD discharge to water body in kg/a;
P_L = Internal fish farm loss from fish production:
$=(686-1671*F_k+1544*F_k^2-354*F_k^3)*G$ (3)
F_k = I/G feed quotient, i.e. feed used for producing fish during a year
I = amount of feed used for feeding of fish in t/a
G = net growth of fish including dead fish in t/a
D = area-decomposition/turnover of BOD:
$= E_d * A$ (4)
E_d = specific decomposition/turnover in $kg/m^2/a$:
$= (6.4 * F_k - 4,2) * 0,365$ (5)
A = water covered surface area in the fish farm (expect the surface area of a sedimentation basin) in m^2

b. <u>For farms with treatment (sludge removal):</u>

$L=0.01*(IC_i-GC_f)-M-T-S$ (6)

L = phosphorus (P) or nitrogen (N) load to water body in kg/a;
I = amount of feed used for feeding of fish in kg/a;
C_i = P or N content in feed in %;
G = growth of fish in kg/a
C_f = P or N content in fish in %
M = nutrient losses due to metabolism in fish
T = nutrient removal processes on the fish farm not related to sludge removal (e.g. nutrient turnover, denitrification etc.)
S = amount of P or N removed with the sludge in kg/a

$L = (P_L - D) * (1 - S)$ (7)

L = BOD discharge to water body in kg/a;
P_L = Internal fish farm loss from fish production:
$=(686-1671*F_k+1544*F_k^2-354*F_k^3)*G$ (8)
F_k = I/G feed quotient, i.e. feed used for producing fish during a year
I = amount of feed used for feeding of fish in t/a
G = net growth of fish including dead fish in t/a
D = area-decomposition/turnover of BOD:
$= E_d * A$ (9)
E_d = specific decomposition/turnover in $kg/m^2/a$:
$= (6.4 * F_k - 4,2) * 0,365$ (10)
A = water covered surface area in the fish farm (expect the surface area of a sedimentation basin) in m^2
S = reduction factor for nutrient removal processes on the fish farm not related to sludge removal.

The net growth (G) of one year in equations 1, 2, 6, and 7 is calculated as the sum of i, ii, and iii below + the difference between the standing stock by the end of the year and the beginning of the year:

i) organisms taken out of the water for slaughter (alternatively the sum of slaughter weight and slaughter offal) or sold alive (t/a);

ii) dead organisms collected during the year (t/a); and

iii) escaped organisms (t/a).

The total nitrogen and phosphorus content in the feed may be obtained from the feed manufacturers. In order to facilitate national calculations, average figures based on the typical feed used in the catchment area may be used, but if the type(s) of feed in each individual fish farm is known ideally that information should be used. The indicative figures in Table 3.4 may be used if the above mentioned figures are not available. If “moist/semi-moist feed” (higher content of water than “dry feed”)[5] is used, the quantity of moist/semi-moist feed should be converted to the comparable quantity of dry feed, as an expression of the total quantity of feed used. The total phosphorus and nitrogen content in the produced organisms can be obtained as a standard figure for each catchment area. If such figures are not available, the figures in Table 3.4 may be used.

Table 3.4: Content of nitrogen and phosphorus in fish

	Total phosphorus content (%)	Total nitrogen content (%)
Fish	0.4	2.5
Dry feed [1]	1.0	7.5
Semi-moist feed [2]	0.5	5.0
Moist(fresh) feed [3]	0.45	2.5

[1] Dry matter >80 % [2] Dry matter 35-80 % [3] Dry matter <35 %

The calculation of treatment yield requires that the nitrogen and phosphorus content in the sludge is calculated/measured regularly (e.g. based on requirements in the discharge permits) as basis for quantification of the fraction that is removed by the sludge. If such figures are unavailable and, in the case of regular removal of sludge, an average removal of 10% N and 40% P due to decantation may be considered.

3.1.3.3.2. Approach 2

For land-based systems such as artificial ponds, basins, raceways, the nitrogen and phosphorus discharges may be quantified by monitoring the nitrogen and phosphorus concentrations and the water flow in the inlet(s) and outlet(s) of the production system, followed by a calculation of the increased discharge. The discharge of nitrogen and phosphorus (and organic matter) from a production system may vary considerably over both a short and long timescale and depend, *inter alia*, on operational factors such as time of feeding, time of cleaning operations, the presence of different purification tools and on the natural variations in the inlet(s). Effluent monitoring strategy must reflect this variation.

[5] The water content in these feed category varies, but a general guidance can be: semi-moist feed (35-80% is dry matter), moist feed (< 35% is dry matter), while a dry feed has > 80% dry matter.

All fish farming plants with an annual production of more than 200 tonnes should, ideally, take as a minimum 12 contemporary samples a year in the inlet(s) and the outlet(s) for measurements of nitrogen and phosphorus concentrations.

Sampling of water for analyses of nitrogen and phosphorus (and organic matter) should be flow-proportional over at least 24 hours and be carried out using automatic samplers in order to ensure a reliable quantification of the total nitrogen and phosphorus discharges. If the sampling is not automatic, the following additional information may need to be reported to relevant authorities:

- The number of samples included in the average annual concentration;
- The period the mean concentration is based on (daily, weekly, monthly, or yearly).

Good international laboratory practices, aiming at minimising the degradation of samples between collection and analysis should be applied. The water flow should be registered continuously. Flow measurements should preferably be performed according to international standards (e.g. ISO standards).

The annual load of inlet(s) and outlet(s) may be calculated as follows:

$$L = \frac{\sum_{i=l}^{n} Q_i * C_i}{\sum_{i=l}^{n} Q_i} * Q_t$$

L	= annual load;
Q_i	= wastewater volume of the period I;
C_i	= concentration of sample I;
Q_t	= total wastewater volume of the year;
n	= number of sampling periods.

The total added load of nitrogen or phosphorus (or organic matter) from the production system is calculated by deducting the total nitrogen or phosphorus load in the inlet(s) from the total nitrogen or phosphorus load in the outlet(s).

3.1.3.3.3. Reporting

The quantification of discharges from fish farming plants into inland surface waters within the Baltic Sea catchment area should be carried out every six year starting in 2006 and from fish farming plants discharging directly into the Baltic Sea every year. For PLC-Water assessments discharges from fish farming plants must be reported separately for the two size categories:

- Fish farming plants with the production > 200 t/a; and
- Fish farming plants with the production ≤ 200 t/a.

The discharges from fish farming plants into inland surface waters should be reported in accordance with the requirements of the load-orientated approach, which means for every monitored river individually or aggregated for some of the monitored rivers. For unmonitored areas (partly monitored rivers, unmonitored parts of monitored rivers, unmonitored rivers and coastal areas including unmonitored islands) the discharges from fish farming plants should be reported per Contracting Parties’ contribution for each Baltic Sea sub-region. Flow data, flow measurement methods and estimation of their accuracy should be reported by each

Contracting Party participating in PLC-water. The calculation methodology should be reported. If the annual discharge loads differ from the periodic loads taken every six years (due to estimate), both values should be reported in the year of periodic reporting. All information and data which have to be reported electronically are summarised in Annex 4.2.

Table 3.5. Overview of reporting obligations related to Fish farming plants should be included.

FISH FARMING PLANTS DISCHARGING INTO THE INLAND SURFACE WATERS AND DIRECTLY TO THE BALTIC SEA						
REPORTING CATCHMENT	**SIZE CATEGORY**	**EVERY SIX YEAR REPORTING**			**ANNUAL REPORTING**	
		FLOW*	**LOAD***	**NUMBER OF PLANTS AND FEED CONSUMPTION**	**FLOW**	**LOAD**
Monitored rivers reported individually	Production >200 t/a	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported	No reporting	
	Production ≤200 t/a	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
Monitored rivers reported aggregated by sub-region	Production >200 t/a	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported	No reporting	
	Production ≤200 t/a	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
Unmonitored areas aggregated by sub-region	Production >200 t/a	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported	No reporting	
	Production ≤200 t/a	Total, m^3/a	Parameters as in table 1.2, t/a	To be reported		
Direct discharges into the Baltic Sea (aggregated by sub-region annually)		The same as for annual reporting			Details on reporting obligation in chapter 2.1.4. and specified in table 2.3	

* The flow and loads should be reported divided on farming plants producing >200 or ≤200 t/a.

3.2. Quantification of nutrient losses from anthropogenic diffuse sources

3.2.1. Quantification

Within PLC-Water the quantification of anthropogenic diffuse sources of nutrients into inland surface waters is required. Diffuse sources of nutrients are defined as any source of nutrients, which is not accounted for as a point source. Nitrogen and phosphorus losses from the following sources should be considered:

- Agricultural land
- Managed forestry and other managed land
- Atmospheric deposition directly on inland surface waters
- Scattered dwellings
- Rainwater constructions and overflows

Whereas point sources (defined as waste water treatment plants, industrial plants and fish farming plants) are discharging directly into inland surface waters, losses from diffuse sources (agriculture, forestry, atmospheric deposition, scattered dwellings, rainwater constructions, and overflows) are delivered via a number of different pathways into inland surface waters. The pathways are characterised by different flow characteristics and includes very different processes (see Figure 3.1). Depending on the land use, losses of phosphorus and nitrogen can vary substantially. PLC -Water defines and considers 7 diffuse pathways:

- Surface run-off
- Erosion
- Groundwater
- Tile drainage
- Interflow
- Atmospheric deposition on inland surface waters
- Rainwater constructions and overflows and
- Scattered dwellings

Discharges directly via a combined sewer overflows[6] and by-passes[7] or indirectly via rainwater constructions into inland surface waters belong to diffuse sources. Moreover, small, dispersed point source discharges from point sources in agriculture (e.g. farmyards) should also be dealt with as diffuse sources. These portions needs to be quantified and the respective nutrient losses estimated.

A large number of removal, storage or transformation processes may influence the final quantities of nitrogen and phosphorus entering inland surface waters. Knowledge about these

[6] Overflows are discharges from combined sewerage system to the water body during rainfall when the flow (mixture of sewage and rainfall run-off) in the system is over-loading the designed volume of the system. Control of overflows is regulated with HELCOM Recommendation 23/5.

[7] By-passes are discharges from sewerage system to the water body for prevention of pumping station or treatment plant damages during the breaks in electricity supply or emergency repairing works. Use of by-passes is regulated with HELCOM Recommendation 16/9.

processes of transformation and retention is necessary to quantify and to predict nutrient losses into river systems in relation to their sources.

The different loss processes and pathways are very complex and variable, and the significance of their effects also varies between nitrogen and phosphorus. It is therefore difficult to quantify diffuse losses accurately. The PLC-Water guidelines are not including a methodology for quantifying diffuse sources or delivery pathways. There are many different methodologies, but e.g. OSPAR HARP-NUT Guideline 6 on diffuse sources is not finalised and no common methodology is agreed yet. In the absence of comprehensive measurements, it is necessary to apply calculation methodologies (e.g. computer-based modelling techniques). It is important that used methodology, including measurements, are described by the Contracting Parties.

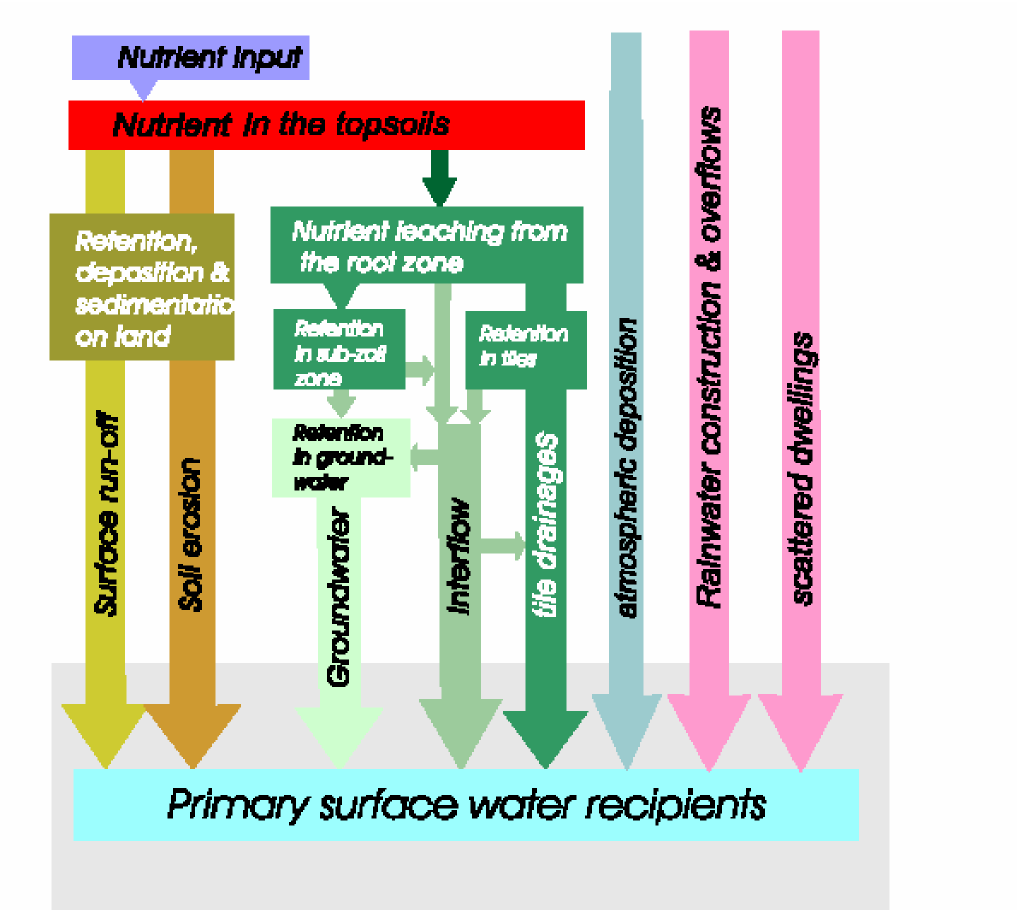

Figure 3.1: Pathways of nutrient losses from diffuse sources to inland surface water recipients.

3.2.2. Reporting

The quantification of losses from diffuse sources of nutrients into inland surface waters within the Baltic Sea catchment area should be carried out every six year starting in 2006. For PLC-Water assessments losses from diffuse sources of nutrients can be estimated either as the total for all delivery pathways without dividing on pathways or as losses by every individual pathway (see Figure 3.1). If information on one or more pathways is missing, then losses can be estimated as a sum of two or more pathways. Further it should be stressed that sum of all pathways must give the same figure as the sum of the corresponding source(s).

In the absence of harmonized quantification procedures, the Contracting Parties should apply the most appropriate method/model to quantify losses from diffuse sources taking into account the relevant geological, topographical, soil type, climatological, land use and agricultural practices condition in their region. Applied models must be calibrated with monitoring data and afterwards validated on another set of monitoring data. Documentation for model validation and calibration should be provided by the Contracting Parties. Whatever methodology is adopted by a Contracting Party, it is essential that certain minimum requirements are fulfilled. In particular, the methodology should be based on measurements or upon objectively determined loss coefficients which should be sensitive to variations in losses associated with different land use types (e.g. different agricultural crops, forestry practises and livestock densities).

The losses from diffuse sources of nutrients into inland surface waters should be reported in accordance with the requirements of the load-orientated approach, which means for every monitored river individually or aggregated for some of the monitored rivers. For unmonitored areas (partly monitored rivers, unmonitored parts of monitored rivers, unmonitored rivers and coastal areas including unmonitored islands) the losses from diffuse sources of nutrients into inland surface waters should be reported per Contracting Parties' contribution for each Baltic Sea sub-region. The applied method should be described in detail and reported. All information and data which have to be reported electronically are summarised in Annex 4.2.

Table 3.6: Overview of reporting obligations related to losses from diffuse sources of nutrients into inland surface waters

<table>
<tr><th colspan="3">LOSSES FROM DIFFUSE SOURCES INTO INLAND SURFACE WATERS</th></tr>
<tr><th>REPORTING CATCHMENT</th><th>ANNUAL REPORTING</th><th>EVERY SIX YEAR REPORTING</th></tr>
<tr><td>Monitored rivers reported individually</td><td>No reporting</td><td rowspan="3">Diffuse losses of total N and total P as t/yr either as a sum of all delivery pathways or as losses by every individual pathway for:
Agriculture as well as managed forestry as a sum or divided on:
• erosion
• surface runoff
• interflow
• tile drainage
• groundwater
- Atmospheric deposition
- Rainwater constructions and overflows
- Scattered dwellings</td></tr>
<tr><td>Monitored rivers reported aggregated by sub-region</td><td>No reporting</td></tr>
<tr><td>Unmonitored areas[1] aggregated by sub-region</td><td>No reporting</td></tr>
</table>

[1] To be reported if riverine load apportionment have been performed on unmonitored areas.

3.3. Quantification of the natural background nutrient losses

3.3.1. Quantification

Procedures for quantification of losses of nitrogen and phosphorous from natural background sources into inland surface waters are described below. Natural background losses cover:

- Losses from unmanaged land; and
- That part of the losses from managed land that would occur irrespective of anthropogenic e.g. agricultural activities.

That means that the natural background losses are a part of the total diffuse losses. The Contracting Parties can use two different approaches or a combination of the approaches to estimate natural background losses:

- Monitoring of small unmanaged catchment areas without any point sources, and
- Use of models.

When the background losses are estimated by models then it is assumed that the agricultural surplus is zero.

Natural background losses of nutrients are monitored in several countries. The figures given are related to the period 1990-2000. They are obtained from forested catchment areas and/or catchment areas with very low human impact (with the exception of the impact of atmospheric deposition).

Table 3.7: Annual natural background losses and flow-weighed concentrations of nutrients as reported by Contracting Parties.

Country	Total Nitrogen in kg/ha	Total Nitrogen in mg/l	Total Phosphorus in kg/ha	Total Phosphorus in mg/l	Discharge in $l/(s \cdot km^2)$
Denmark[1]	2.23± 0.55	1.43±0.11	0.072±0,01	0.049±0,004	5.67±0,43
Estonia	3.3	1.1	0.12	0.04	
Finland	0.7 – 2.0		0.03 – 0.7		
Germany	1.23	0.733	0.061	0.036	
Latvia			0.11		
Lithuania	0.6-1.2	0.32-0.8	0.02-0.08	0.05 – 0.09	6.6
Poland	1.5		0.1		
Sweden		0,33-2,8		0,013-0,065	

[1] The average of median monitored values for 15 years (1989-2003) ±2 times standard error (corresponding to the 95% confidence interval) in seven small catchment without or with very low human activities.

3.3.2. Reporting

The quantification of natural background losses of nutrients into inland surface waters within the Baltic Sea catchment area should be carried out every six year starting in 2006. The natural background losses into inland surface waters should be reported in accordance with the requirements of the load-orientated approach, which means for every monitored river individually or aggregated for some of the monitored rivers. For unmonitored areas (partly monitored rivers, unmonitored parts of monitored rivers, unmonitored rivers and coastal areas including unmonitored islands) the natural background losses of nutrients into inland surface waters should be reported per Contracting Parties' contribution for each Baltic Sea sub-region. The applied method should be described in detail and reported. All information and data which have to be reported electronically are summarised in Annex 4.2.

Table 3.8: Overview of reporting obligations related to natural background losses.

NATURAL BACKGROUND LOSSES INTO INLAND SURFACE WATERS		
REPORTING CACTCHMENT	**ANNUAL REPORTING**	**EVERY SIX YEAR REPORTING**
Monitored rivers reported individually	No reporting	Total N and total P, t/a
Monitored rivers reported aggregated by sub-region	No reporting	Total N and total P, t/a
Unmonitored areas[1] by sub-region	No reporting	Total N and total P, t/a

[1] To be reported if riverine load apportionment has been performed on unmonitored areas