BALTIC SEA ENVIRONMENT PROCEEDINGS

No. 99

THEMATIC REPORT

STATUS OF THE HOT SPOTS IN DENMARK, FINLAND, GERMANY AND SWEDEN

Based on
the Seventh HELCOM PITF Regional Workshop
Germany, January 2002 and
the Eighth HELCOM PITF Regional Workshop
Sweden, May 2002

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INTRODUCTION

At the Ronneby Conference in 1990 prime ministers and other high-ranking political representatives of the countries surrounding the Baltic Sea initiated the Baltic Sea Joint Comprehensive Environmental Action Programme (JCP). The programme was devised to restore the Baltic Sea to a sound ecological balance and to support the implementation of the Helsinki Convention, and its strategic approach to setting priorities was approved at the Diplomatic Conference in Helsinki in 1992.

Since then, the progress made by the JCP has been remarkable. Evidence of this has been the various investments initiated by the JCP and the de-listing of more than one third of all Hot Spots from the List of Hot Spots by May 2002.

The updating and strengthening of the JCP in 1998 reinforced its stability, but concluded that limited adjustments were required. Additional focus on investment activities was among the modifications recommended, and this was further highlighted and confirmed as a priority of the Programme Implementation Task Force (PITF) in the course of the review process.

To obtain a clearer perspective of the current problems of the PITF and other HELCOM organs and the options available to overcome obstacles to implementation, a series of regional workshops was proposed for representatives from local, regional and national levels. The workshops were organised by the PITF Preparatory Group in collaboration with the hosting countries and the HELCOM Secretariat.

The aim of this report is to present the outcome of two joint workshops which took place in Germany and Sweden during 2002.

The Seventh Regional Workshop was convened in Lübeck on 29-30 January 2002 at the invitation of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety of Germany. In accordance with the discussions of the HELCOM PITF the workshop was a joint initiative, in which German and Danish Hot Spots were considered.

The Workshop was opened by Ms. Beate Hoffmann, Senator, on behalf of the City of Lübeck. Ms. Hoffmann welcomed the participants and related the reasons for identifying Lübeck as one of the JCP Hot Spots.

The Eighth Regional Workshop was arranged by the Swedish Environmental Protection Agency in Stockholm on 27-28 May 2002 with the aim of reviewing and discussing the status of the remaining Hot Spots in Finland and Sweden. A number of presentations also reviewed the status of previously de-listed Hot Spots in these countries.

In his opening address, Mr. Lars Ekecrantz of the Swedish Ministry of the Environment highlighted the main pollution problems of the Baltic Sea, the importance of the Baltic Sea Joint Comprehensive Environmental Action Programme (JCP) and the remedial activities related to the JCP Hot Spots.

Participants in the workshops represented local, regional and national authorities and Hot Spot “owners” from the countries where the Hot Spots are located, as well as members of HELCOM PITF and the Preparatory Group. Mr. Göte Svenson, Chairman of HELCOM PITF, was elected as Chairman of both Regional Workshops and Mr. Claus Hagebro from the HELCOM Secretariat acted as Rapporteur.

Assessment of the Hot Spots was conducted by the Workshops according to the "Criteria for Inclusion and Deletion of Hot Spots", which were adopted by HELCOM PITF in 1999.

Part A: Sweden

Municipal Hot Spots in Sweden

There are two municipal Hot Spots in Sweden, Gothenburg and Stockholm cities, which were included in the list of Hot Spots mainly because of nitrogen discharges into the Kattegat and the Stockholm archipelago.

Stockholm (Hot Spot No. 130)

Hot Spot No. 130 comprises five municipal wastewater treatment plants operated by three companies: Stockholm Water (operating three plants with one common outlet), Käppala Association and SYVAB, each operating one plant.

Stockholm Water plants

The three plants operated by Stockholm Water have their outlets in the same location close to the Henriksdal plant. However, the environmental impact of these plants is more correctly considered the effect of one installation. Thus, although the Bromma plant is located near Lake Mälaren, its discharges flow directly into the Baltic Sea via the Henriksdal plant. In its environmental decision of 30 June 2000 The Swedish Environmental Court designated the three plants as one unit with one set of conditions for permitted outlets into the Baltic Sea.

The three plants operated by Stockholm Water have very similar designs in terms of mechanical, biological and chemical treatment units. The two larger plants, Henriksdal and Bromma, also have a filtration unit, which is nonexistent at the considerably smaller Loudden plant. The biological treatment step is based on the activated sludge principle with nitrification and denitrification zones for the removal of nitrogen in addition to the reduction of BOD. Iron sulphate is used as the precipitator agent for chemical treatment.

The total investment for the reduction of nitrogen and phosphorus discharges to meet current Swedish requirements was SEK 1 billion.

Stockholm Water houses a special unit for improving the quality of water released into the wastewater system. Industrial effluents unsuitable for the system undergo essential pre-treatment before being fed into the municipal system. The resulting effluent is the subject of specific conditions outlined in the environmental permit issued for the actual industrial activity, and is monitored regularly by Stockholm Water. . These factors have resulted in the retention of a substantial portion of the environmentally harmful elements and compounds in the sludge, evidence of the success of measures implemented to control the release of effluents into the wastewater system.

Regular monitoring of the sludge quality has shown that it satisfies the Swedish requirements for heavy metals and harmful organic compounds (PAH, PCB and nonylphenol). (See data below.)

To reduce overflows, continuous work has been done over the last 20 years to improve the pipeline network, including the construction of 19 storage facilities. These measures have resulted in a 50% reduction in overflows from the network over the same period. A strategy for treating local storm water has been established, which involveslocal filtration and delaying arrival at the wastewater treatment plant. To encourage better storm water management, local water use rates offer a reduction if storm water is filtered or held on the property.

Since the three Stockholm Water plants have their outlets at the same location, and collectively satisfy HELCOM requirements for discharges into the environment they can, from an environmental point of view, be considered one source. The flow-weighted annual average values[1] for discharges of wastewater from Stockholm to the outlet point for the year 2001 were:

Load, pe	955 700
Water flow, m^3	136000 000
BOD_7 mg/l	2
BOD_7, tonnes	314
Tot N, mg/l	8.5
Tot N, tonnes	1155
Tot P, mg/l	0.12
Tot P, tonnes	17

The monitored quality of sludge from the three plants as average values for the year 2001 was as follows:

Parameter	Henriksdal	Bromma	Loudden	Swedish Limit value
TS %	28	30	28	-
Pb mg/kg TS	44	34	36	100
Cd -	1.4	1.0	1.2	2
Cu -	380	350	380	600
Cr -	29	25	17	100
Hg -	1.7	0.9	0.9	2.5
Ni -	25	24	11	50
Zn -	560	490	580	800

As can be seen, the Swedish requirements for sludge quality have been fulfilled.

Käppala plant

Käppalaförbundet (The Käppala Association) operates one plant in the municipality of Lidingö, the Käppala plant. Lidingö lies on the Northeast border of the city of Stockholm, and the plant's outlet flows into the Baltic Sea about 5 km north-east of the outlets from the Stockholm Water plants.

The plant has mechanical, biological and chemical treatment units. Chemical treatment takes place in two stages with iron sulphate as a precipitator. Apart from removal of BOD and nitrogen in the biological treatment unit there is also some biological reduction of phosphorus. The majority of phosphorus, however, is removed in the two chemical treatment processes.

The investment involved in the reduction of nitrogen and phosphorus discharges to meet current Swedish environmental standards was SEK 1.3 billion.

[1] The effluent is monitored using flow-proportional 24-hour sampling. The yearly average concentration, C_{year}, is calculated as: $C_{year} = \frac{\sum_{i=1}^{365}(C_i \times Q_i)}{Q_{year}}$, where C_i is the average concentration day i, and Q_i is the flow the same day.

The flow-weighted annual average values for discharges of wastewater from the Käppala treatment plant to the outlet point for the year 2001 are shown below:

Load, pe	510 000
Water flow, m^3	53 000 000
$BOD_{7,}$ mg/l	2
BOD_7, tonnes	130
Tot N, mg/l	9
Tot N, tonnes	475
Tot P, mg/l	0.2
Tot P, tonnes	10

For several years strenuous efforts were made to improve the sewerage network and to increase capacity where needed. As a result, no overflow at all was recorded during the year 2001, and leakages into the network were reported to be approximately 10 % of total wastewater flow for the year.

The average content of heavy metals in the sludge for the year 2001 was:

	Käppala	Swedish Limit value
TS %	20.2	-
Pb mg/kg TS	33	100
Cd -	1.1	2
Cr -	23	100
Cu -	390	600
Hg -	1.0	2.5
Ni -	18	50
Zn -	510	800

As can be seen the Swedish environmental requirements for sludge quality have been fulfilled.

Himmerfjärd plant

The SYVAB Company operates the Himmerfjärd plant, which is located about 45 km Southwest of the City of Stockholm, and discharges directly into the Baltic Sea. The plant has mechanical, biological and chemical processes for treatment of wastewater with sand filters for polishing in the final stages. Iron sulphate is used as a chemical precipitator, added at the primary sedimentation stage for initial removal of phosphorus.

Biological treatment involves activated sludge where nitrification takes place followed by a fluidised bed for denitrification. In the denitrification process methanol and ethanol are utilised as the carbon source.

The investment involved in the reduction of nitrogen discharges to satisfy current Swedish requirements was SEK 120 millions.

The flow-weighted annual average values for discharges of wastewater from the Himmerfjärd treatment plant to the outlet point for the year 2001 are shown below:

Load, pe	285 000
Water flow, m^3	39 400 000
BOD_7, mg/l	4.5
BOD_7, tonnes	190
Tot N, mg/l	9.8
Tot N, tonnes	380
Tot P, mg/l	0.36
Tot P, tonnes	17

Normally the Himmerfjärd plant exhibits N-values well below 5 mg/l but in 2001 an experiment was implemented to increase the nitrogen load during the summer months in order to reduce the blooming of bluegreen algae during that period. Comprehensive research on the water recipient, the Himmerfjärden bay, has given evidence to support the notion that an improper balance between phosphorus and nitrogen (NH_4-N) in the summer gives rise to harmful algae blooming.

At the same time it is important to control the transportation of nitrogen into the open waters of the Baltic where nitrogen loads should be kept at a minimum throughout the year. It should be emphasized that the increased release of nitrogen from the plant is restricted to the summer period, and that the nitrogen load during the rest of the year is kept at a minimum.

The content of heavy metals in the sludge generated by the plant was as follows (average values for 2001).

	Himmerfjärd	Swedish Limit value
TS %	24	-
Pb mg/kg TS	33	100
Cd -	1.3	2
Cr -	86	100
Cu -	330	600
Hg -	0.9	2.5
Ni -	24	50
Zn -	820	800

As can be seen the Swedish environmental requirements for sludge discharges, except for zinc, have been satisfied.

The Stockholm wastewater treatment plants were consequently removed from the Hot Spot list in 2002.

Gothenburg (Hot Spot No. 127)

Hot Spot No. 127 comprises one wastewater treatment plant, Ryaverket, operated by the GRYAAB municipal company. This plant has been restructured to reduce nitrogen discharges, however, due to special circumstances the HELCOM requirement for nitrogen content in the treated wastewater, is still not fully met.

The plant receives wastewater from seven municipalities in the Gothenburg region, and is equipped with mechanical, biological and chemical treatment units. The biological treatment process involves a combination of biological bed-activated sludge with integrated nitrification-denitrification for removal of nitrogen. In the chemical treatment stage iron sulphate is utilized for the removal of phosphorus.

The cost of the final upgrade of the treatment plant from 1995 - 1998 to reduce nitrogen discharges was SEK 350 million. To satisfy more stringent phosphorus requirements (0.3 mg/l) and to increase nitrogen removal capacity, additional investments of some SEK 300-500 million are necessary.

The flow-weighted annual average values for discharges of wastewater from the Ryaverket treatment plant to the outlet point for the year 2001 are shown below:

Load, pe	620 000
Water flow, m^3	111 000 000
BOD_7 mg/l	6.4
BOD_7, tonnes	766
Tot N, mg/l	10.6
Tot N, tonnes	1204
Tot P, mg/l	0.38
Tot P, tonnes	44

Total overflow for the year 2001 was 2.04 million m^3, or less than 2 % of total flow, and was subjected to mechanical treatment before discharge. The wastewater and storm water networks are being improved continuously, gradually reducing overflow. In addition to this, for many years, separated systems have been selected for new developments.

Industries connected to the Rya plant pre-treat their effluents when necessary and a systematic programme is being implemented to improve the quality of wastewater discharged into the municipal sewerage network.

The content of heavy metals in the sludge generated from the plant was as follows (average values for 2001).

	Rya	Swedish Limit value
TS %	54.3	
Pb mg/kg TS	27	100
Cd “	0.7	2
Cr “	38	100
Cu “	305	600
Hg “	0.6	2.5
Ni “	19	50
Zn “	368	800

As can be seen the Swedish environmental standards for sludge discharges have been met.

Industrial Hot Spots in Sweden

There were seven industrial Hot Spots, five of which were pulp and paper industries, one metal smelter and one location with old mine wastes.

The most important reason for including the pulp and paper industries in the list of Hot Spots was the discharges of AOX and the discharge of nutrients from one of the plants. Since then, the pulp and paper industries have been deleted from the Hot Spots list.

Stora Enso Nymölla AB (Hot Spot No. 131)

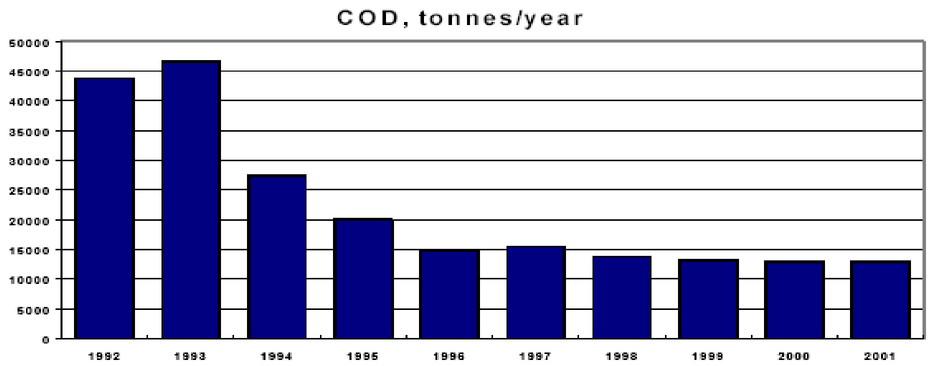
Nymölla Mill was deleted from the list of Hot Spots in 1996. Its main problem was the discharge of nutrients.

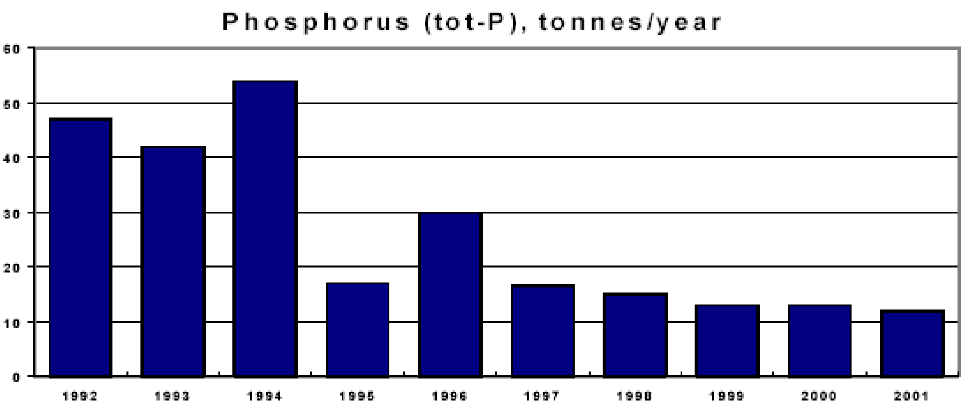
Treatment plants and emissions into water

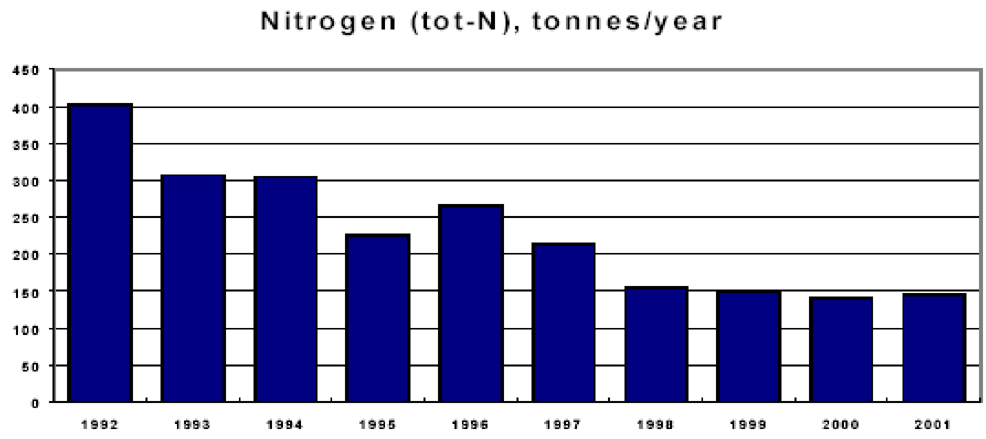
All wastewater is treated mechanically in precipitation basins and biologically in an activated sludge plant; a substantial portion of the bleach plant wastewater also receives preliminary treatment in an ultra-filtration plant.

The activated sludge plant was commissioned in 1994, replacing an aerated lagoon, which had been operating since 1985, and in 1995 the ultra-filtration plant was put into operation. The investments for these altogether amounted to approximately SEK 160 million, while annual operating costs are approximately SEK 35 million..

The figures below show emissions to Hanö Bay over the past ten years (1992-2001) of COD, phosphorus and nitrogen in tonnes per year. The activated sludge plant and the ultra filtration plant had a notable effect on the emissions into Hanö Bay, as the diagram clearly shows. Emissions of COD have declined by 71 %, phosphorus by 75 % and nitrogen by 72 %. This has been achieved alongside increases of 10% and 72% in the production of pulp and paper respectively.







Stora Enso Skoghalls Bruk (Hot Spot No. 126)

Store Enso Skoghalls Bruk was deleted from the list of Hot Spots in 1994; its main problem was the emission of AOX.

The old bleaching plant in the kraft mill comprised six stages, using chlorine gas, hypochlorite, chlorine dioxide and alkali. During 1990 -1992 the alkali processes were reinforced with oxygen and peroxide, the use of hypochlorite was stopped and the usage of chlorine gas was reduced as more chlorine dioxide could be charged. The use of chlorine finally ended in 1992, with the installation of an oxygen delignification stage.

In 1997 a new bleaching plant, including a second oxygen delignification stage, was put into operation. In the bleaching plant chlorine dioxide, complexing agent, and peroxide (oxygen reinforced) are used.

The size of the investments for these actions is in the range of 600-700 million SEK.

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AOX (kg/t)	3	1.35	0.2	0.16	0.15	0.12	0.07	0.06	0.05	0.07	0.08
COD (kg/t)	49.7	45.5	42.9	37.8	28	29.6	22.7	17.5	16.9	16.7	20.8

M-real Sverige AB Husum Mill (Hot Spot No. 3)

M-real Sverige AB Husum mill produces bleached kraft and paper, and its main environmental problem was the emission of AOX. It was deleted from the list of Hot Spots in 1994.

Remedial action and results

Introduction of oxygen delignification also on hardwood in 1990.
ECF introduced in 1992 and partial closure of the bleach plant on hardwood.
Peroxide reinforced bleaching processes implemented during the 90s.
Reduced washing loss added to the bleach plant in 1998.

Results:

Year	1991	1994	2000
AOX, kg/t	1,0	0,55	0,30
AOX t/year	530	250	200

The Rottneros AB Vallvik Mill (Hot Spot No. 5)

The Rottneros AB Vallvik mill produces bleached and unbleached kraft pulp; its main problem was the emission of AOX. It was deleted from the list of Hot Spots in 1994.

Remedial action and results

Use of ECF and partly TCF from the early 1990s.
Introduction of peroxide reinforced bleaching stages.
Changes in AOX emissions for bleached kraft pulp:

	1991	1994	2000
Kg/t bleached kraft pulp	1,0	0,5	0,3
t/year	150	70	40

SCA Östrand Pulp Mill (Hot Spot No. 4)

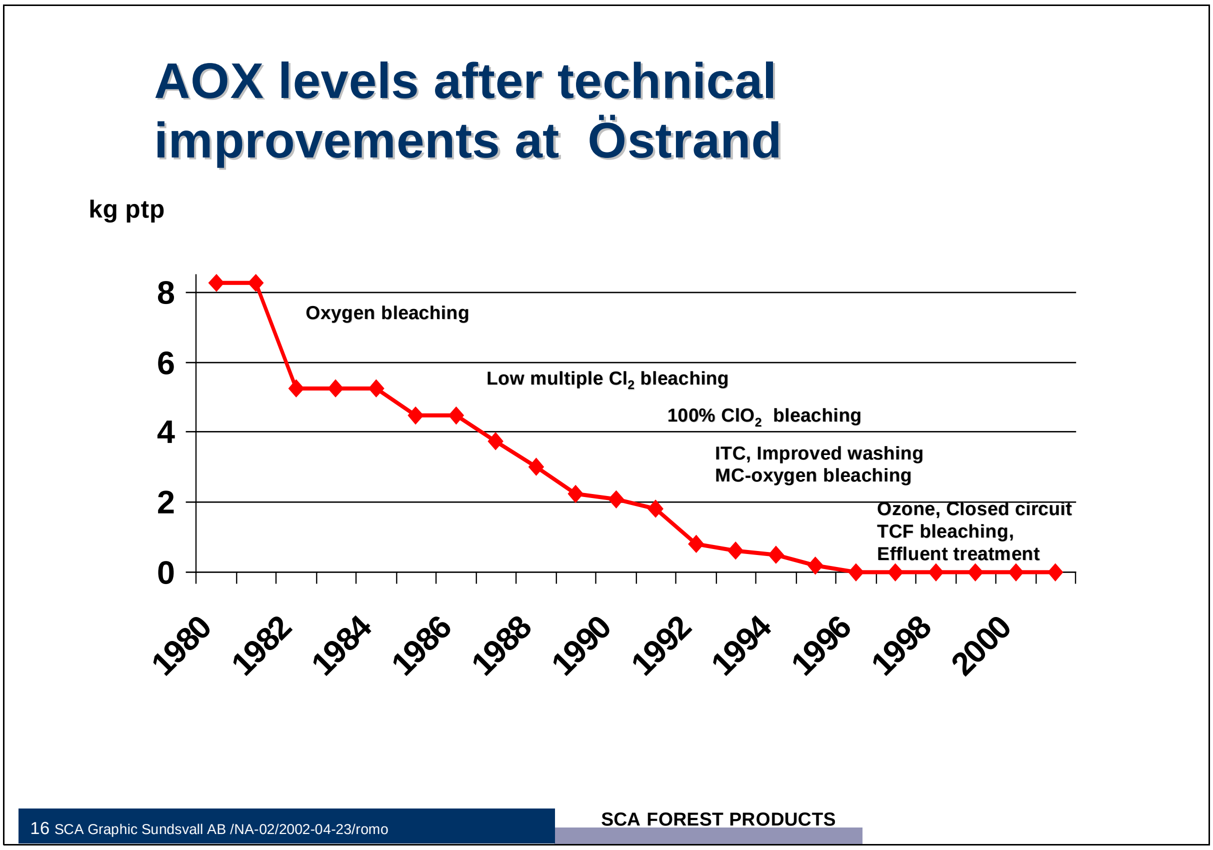
SCA Östrand Pulp Mill was deleted from the list of Hot Spots in 1994.

SCA Östrand pulp mill is situated in the municipality of Timrå close to the city of Sundsvall. Sundsvall Bay is the recipient of effluent from the mill, and is located in the southern part of the Gulf of Bothnia.

In 1992 SCA Östrand pulp mill was identified as a “hot spot” because of high quantities of AOX in the effluent in recorded in 1990 – up to 2.1 kg per ton of pulp (ptp) or 636 tonnes per year.

A program to minimize the mill’s environmental impact decreased emissions to 0.8 kg (ptp) or 241 tonnes per year. Today the bleaching process is totally chlorine free (TCF) and AOX emissions have been reduced to zero.

The following figure representing development since 1980 shows that AOX emissions have been non-existent since 1996.



Oxygen bleaching was established at the mill from as early as 1982.In 1986 environmental research revealed that kraft pulp bleaching was one of the most significant sources of dioxin emissions. As a result, low multiple chlorine bleaching was introduced in the late eighties to help eliminate the release of dioxins. AOX emissions were reduced to approximately 2 kg per ton of pulp.

In 1991 100 % ClO_2 bleaching (ECF) was introduced and AOX emissions were substantially lowered to roughly 0.6 kg per ton pf pulp.

In 1994 the fibre line constituted modernized iso-thermal cooking (ITC), and medium consistency oxygen bleaching was installed, while the brown stock wash was improved. The result was a further reduction of AOX emissions, down to 0.3 kg ptp.

With the installation of a new highly secure totally chlorine free (TCF) bleaching plant in 1995, emissions of AOX ceased. There was also an overall decline in effluents from the bleach plant, down from 45 m^3 ptp to 5 – 7 m^3 ptp. Because the TCF process produces very small quantities of chlorides, it is possible to vaporise most of the white water from the bleaching plant. However, the problem of calcium scaling makes total closure of the bleach plants white water system impractical at the moment.

The following table shows the difference between ECF and TCF:

Environmental improvements ECF vs TCF

Chemical charact.	ECF -94	TCF -96	Reduction
Flow, m^3/d	38 110	6 928	82%
BOD_7, t/d	13	6	49%
COD_{70}, t/d	33	17	48%
NO_{23}-N, kg/d	15	2	85%
tot-P, kg/d	33	17	49%
AOX, kg/d	674	0	100%
Σ-resin acids, kg/d	29	8	73%
Σ-Fatty acids, kg/d	39	11	71%
PBS[1], kg/d	866	7	99%

1) **P**otential **B**ioaccumulative **S**ubstances.

17 FÖRETAGSNAMN /Presentationens namn/Datum/Initialer   SCA FOREST PRODUCTS

Rönnskär Metal Smelter (Hot Spot No. 1)

The Rönnskär smelter in Skelleftehamn, northern Sweden, extracts metals and chemicals from mineral concentrates and various recycling materials. The main products are copper, lead, gold, silver and zinc clinker, and by-products include liquid sulphur dioxide, sulphuric acid, selenium and nickel sulphate, among others.

Production capacity

The table below presents actual production capacity compared to permitted capacity for each product.

Product	Actual capacity	Permitted capacity
Copper	240,000 tonnes	300,000 tonnes
Lead	40,000 tonnes	120,000 tonnes
Gold	14,000 kg	30,000 kg
Silver	450,000 kg	750,000 kg
Zinc clinker	41,000 tonnes	80,000 tonnes
Sulphuric acid	600,000 tonnes	---
Liquid sulphur dioxide	60,000 tonnes	---

Extraction of metals

The sustainable use of metals is based on profitable production, efficient use of resources and minimal environmental impact. Rönnskär makes this possible with a combination of low costs, recycling, high recovery rates and environmental care.

Emissions and their environmental impact are continuously monitored according to a detailed programme, which includes the preparation of monthly reports for the county authority.

Energy

Despite continuing increases in metal production, energy consumption has decreased steadily since the 1980s. New processes, cost-consciousness and better procedures have reduced the consumption of electricity, oil and coal. Furthermore, waste energy is recovered as electricity and is also used for district heating.

Reuse of Slag

The treatment of the by-product Boliden Iron Sand (granulated slag) is an example of the sustainable reuse of slag and resulting conservation of natural resources. Slag cleaned in the fuming plant is granulated for further use, and the product's favourable insulating and draining properties make it particularly suitable for road construction and blasting. The low leachability of Boliden Iron Sand is recognised and well documented.

Best available proven technology

Currently the Rönnskär smelter plant comprises a multitude of different process facilities that meet BAT standards.. Gradual improvement of the plant has resulted in the introduction of a modern smelter with excellent environmental standards.

The environmental modifications were estimated to have cost approximately 700 million SEK (roughly 30% of the total project cost).

Emissions

Emissions from the Rönnskär plant flow into the Bothnian Bay. Emissions for the year 2001 are presented in the table below, and show that all recommended environmental limits have been satisfied.

Emissions to air and water (2001) compared to limit and guideline values:

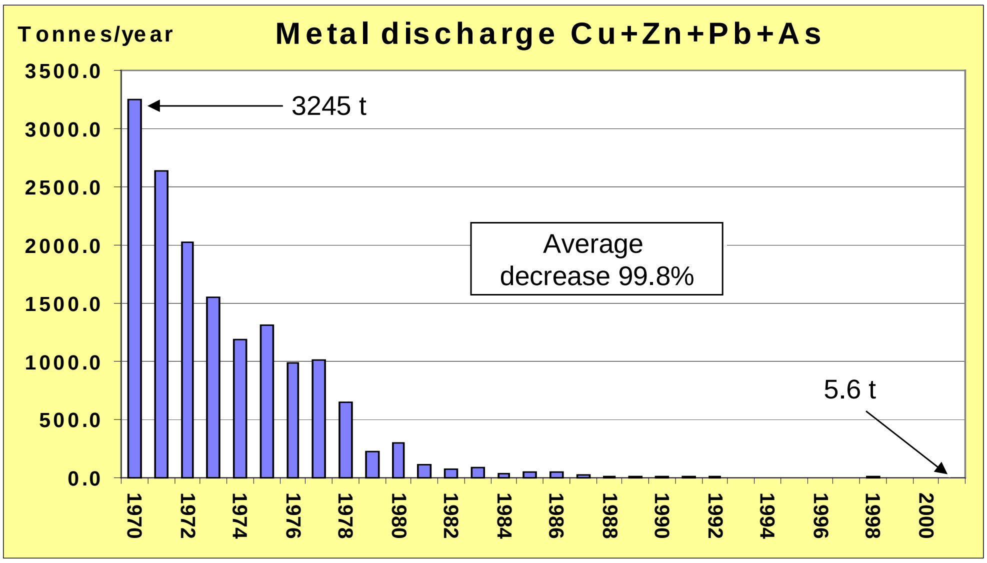
Substance (ton)	Dust	Cu	Pb	Zn	Cd	As	Hg	SO_2	NO_x
Emissions to air	57.8	1.6	5.0	9.0	0.14	0.36	0.11	3,954	116
Limit values (air)	75 *)	8 *)	12 *)	20 *)	0.3 *)	1.0 *)	0.2 *)	4,500	250 **)
Discharge to water	-	0.98	0.72	3.23	0.057	0.65	0.035	-	-
Limit values (water)	-	2.0	2.0	4.0	0.1	1.0	0.070	-	-

*) Guideline value 1999 – 2000, limit value from 2001
**) Guideline value

A historical review of the discharges to water is presented in the figure below. Since 1970 metal discharges have fallen by 99.8 %, mainly as a result of effective water purification measures.

During the last decade (1992-2001) the quantity of metals discharged into the sea decreased from 7.9 tonnes to 5.6 tonnes or by 30 %.

Metal discharges from Rönnskär to the Bothnian Bay 1970-2001:



A review of emissions to the air reveals that substantial reductions have been achieved. This has been the result of large investments in filter equipment, new processes and the closure of some plants, as well as improved maintenance and the training of process operators. During the last decade (1992-2001) the dust discharge to the air has decreased from 200 tonnes to 57 tonnes or 70 %.

Green liquor containing sulphide from the pulp and paper industry is used as a precipitation agent in a highly effective purification process. The analyses of cleaned water are displayed in the following table, along with assays for discharged cooling water.

Assays of discharged water 2001 from Rönnskär:

Parameter (mg/l)	Cu	Pb	Zn	Cd	As	Hg	Ni	COD
Cleaned water	0.015	0.014	0.158	0.001	0.126	0.0007	0.005	n.a.
Cooling water *)	0.022	0.016	0.073	0.001	0.015	0.001	0.008	13
Guidance value for cleaned water according to permit	0.05	0.1	0.5	0.005	0.5	0.005	---	---
HELCOM Recommendation	0.5	0.5	2.0	0.2	---	0.05	1.0	250

*) Cleaned water is mixed with cooling water before effluent sampling

The assays show that the metal content of the discharged water does not exceed the HELCOM Recommendations.

Conclusions

The Rönnskär smelter has undergone substantial environmental improvements since it was labelled ”Hot Spot No.1”. Today the smelter is a world-class facility with highly developed and environmentally sensitive processes. Radically reduced emissions from the plant have produced positive environmental effects in the surrounding areas, including the Bothnian Bay, and local studies show that the recovery process is ongoing, although the effects of historical discharges can still be observed.

Rönnskär was deleted from the Hot Spot list in 2002.

Mine waste at Dalälven - Falun Area (Hot Spot No. 6)

Following a series of investigations into metal deposits in the Dalälven River it has been concluded that the mining activities in Falun are the main sources of metal discharges in the river.

Mining in the area dates back to the 13th century, but there are indications that it may have started as early as the 7th century. Mining has focused mainly on sulphide ores containing copper, lead, zinc and also silver. There were several mines in the area, but the largest was the Falun copper mine. Mining activity in Falun expanded in the 16th century and by the 17th century Falun was the world's largest copper producer. Activity declined during the 19th century and the mine eventually closed in 1992. The area around the Falun copper mine and parts of the city of Falun have since been declared United Nations World Heritage Sites.

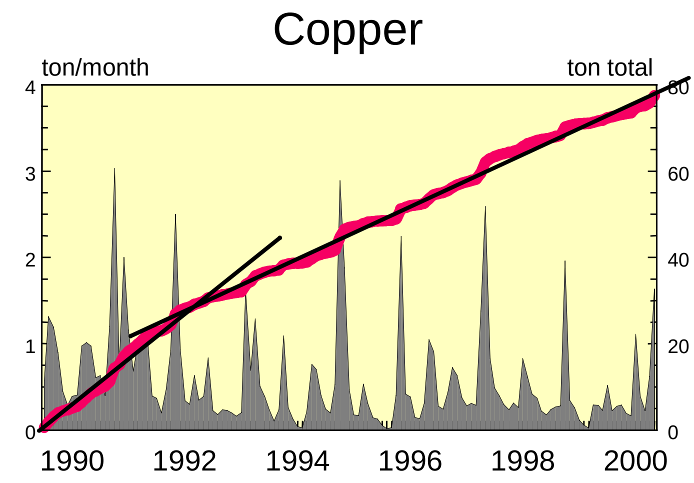
The mining of sulphide ores generates wastes that are unstable in atmospheric conditions, producing sulphuric acid and metals which contain leachates when oxidised. In bygone days, the smelters were more numerous, and often located close to waterways. In addition to this, the discharges from the mining activities comprised waste rock from the mine and slag from the roasting and smelting processes. Weathered waste rock is used as raw material for paint production and the tailings from more recent concentrating processes are deposited mainly in two dams in Falun. A fourth mining waste in Falun is the roasted pyrite residue from the production of sulphuric acid from pyrite. According to the Dalälven Commission's Mine Waste Project the wastes in Falun constituted 0.6 Mm^3 waste rock, 3,8 Mm^3 slag, 0,4 Mm^3 roasted pyrite residues and 2,6 Mm^3 tailings from concentrating of ore. Approximately 2 Mm^3 slag was found in areas outside of Falun and Garpenberg.

According to the Dalälven Commission's Mine Waste Project, the primary annual metal discharge to water from mining areas consisted of roughly 16 tonnes copper, 325 tonnes zinc and 0,49 tonnes cadmium in 1989/1990, with the discharges from Falun accounting for 87 %, 95 % and 90 % respectively of these amounts. The main sources of metal effluents were identified as the roasted pyrite residues (mainly zinc and cadmium), from recent sediments in the settling pond, and from waste rock around the mine, used as raw material for paint.

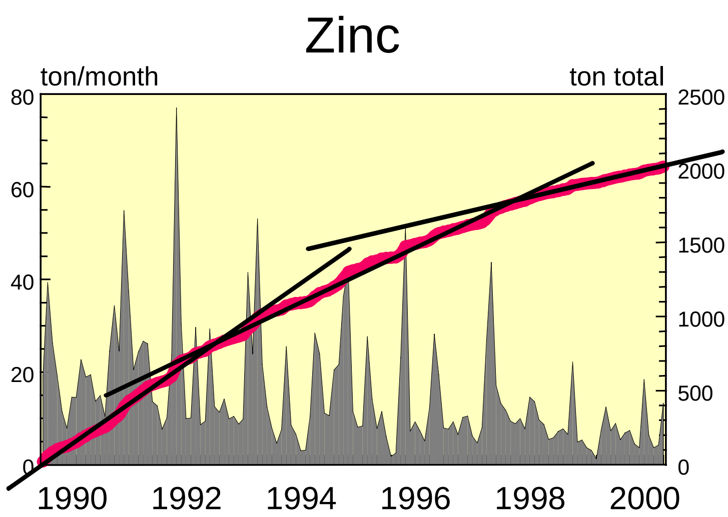
In 1992 an agreement was made between the Swedish authorities and the mining company in Falun to conduct remedial actions to reduce metal discharges into Dalälven. The total cost of these actions was estimated at 100 million SEK, with the mining companies responsible for contributing some 60 million SEK. Of the remedial actions, the highest priority item was the roasted pyrite residues and the settling pond, Ingarvs magasinet. Second on the list was the waste rock in the area of the Falun mine, followed by other industrial mining areas and the larger slag heaps in Falun. The time frame for implementing these actions was 15 years.

The counter measures were initiated in 1995, and are expected to continue until 2006 with activities focusing on the urgent items up to the present time.. The roasted pyrite residues have been washed to dissolve and further precipitate the water-soluble metals, and as a result, approximately 1,200 tonnes of zinc have been removed from the waste - this represents 68 % of the water-soluble zinc in the pond. The task of sealing and covering Ingarvs magasinet to decrease the impact of weathering started in 1997 and will be finalised by 2004. The material used for the sealing layer is a mixture of bio sludge and bio ash from a nearby paper mill, and will eventually be covered with till.

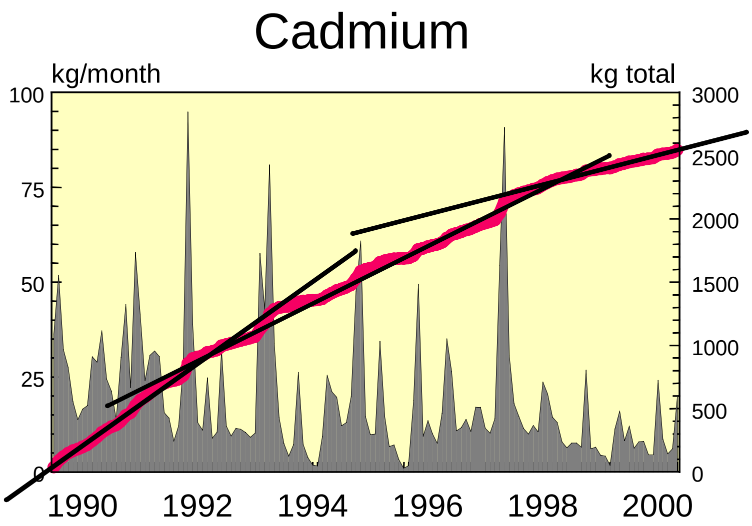
The outflow of metals from the mine waste in Falun is measured as an increase in transported quantities in the Falun River. Transported quantities of copper, zinc and cadmium decreased between 1990 and 2000, and are illustrated in the following 3 figures. The first sign of a decrease in the emission of metals came after the closure of the mine in 1992 and could be seen in the outflows of copper, zinc and cadmium. The second time a reduction in discharges was observed, was after the commencement of treatment of roasted pyrite residues in 1995 and could be seen in the quantities of zinc and cadmium. As the remedial actions proceed, further decreases in the outflow of metals can be expected.



Outflow of copper into the Falun River between Lake Varpan and Slussen



Outflow of zinc into the Falun River between Lake Varpan and Slussen



Outflow of cadmium into the Falun River between Lake Varpan and Slussen

Concentrations of metals downstream in Lake Runn have also been measured. The decrease in metal concentrations in the surface water in Lake Runn between 1990 and 1997 was statistically significant and measured roughly 50 % for copper and 65-75 % for zinc and cadmium.

Agriculture and livestock farming in Sweden

Introduction

Sweden's total land area covers 45 million hectares with the northern parts lying north of the Polar Circle. Sweden is divided into three regions: Götaland in the South, Svealand in the middle and Norrland in the North. The total agricultural land area (arable land plus semi-natural grasslands) is 3.15 million hectares, or 7 % of the national territory. Total arable land amounts to approximately 2.75 million hectares, or 6 % of the total national territory, 60 % of which is situated in Götaland, 30 % in Svealand and 10 % in Norrland.

National territory	45 million hectares
Agricultural area	3.15 million hectares
Arable area	2.75 million hectares
Number of agricultural holdings	80,400 holdings
Number of livestock holdings	30,500 holdings

In Sweden there are some 80,400 holdings, more than 55 % of which are part-time operations (less than 800 standard man hours). Approximately 30.500 of the holdings are dedicated to rearing livestock, with most of the animal production concentrated in the Götaland region, where 77% of the pigs, 70% of the cattle and 80% of the poultry are reared.

Cereals are cultivated on 1.23 million hectares and ley and green fodder on 0.93 million hectares. Cereal production is concentrated on the plains of Götaland and Svealand while ley cultivation is common in the central and forest districts of Götaland, Svealand and Norrland.

Annually approximately 3.3 billion kg of milk, 0.15 million kg slaughtered cattle, and 0.28 million slaughtered pigs are produced in Sweden.

Environmental objectives

During the past few decades, several international agreements have been signed with the aim of reducing plant nutrients leaching into the sea. Signing of these agreements, coupled with various signs of eutrophication in coastal areas in the 1980s and evidence of death of the seabed in nearby deep seas, led the Swedish Parliament to adopt a programme to reduce plant nutrient losses from agriculture in 1988.

One target for the programme was to reduce nitrate discharges from agriculture to 50% of their 1985 levels by the year 2000.

In 1990 a government bill proposed that the ammonia emissions in south Sweden should be reduced by 25 % within 5 years. Subsequently, in 1995 measures to reduce ammonia losses were included in the programme.

In 1999 the Swedish Parliament adopted 15 environmental quality objectives focusing on the ecological dimension of sustainable development. The 15 environmental quality objectives replaced former objectives, describe the desired environmental state, and are meant to be achieved within one generation. The most important objectives relating to the agricultural sector are “Zero eutrophication”, “A varied agricultural landscape” and “A Non-Toxic Environment”.

To reach these environmental quality objectives, in 2001 the Swedish Parliament adopted interim targets, measures and strategies, which in most cases relate to the situation in 2010. Two of the interim targets for the environmental quality objective “Zero Eutrophication” are:

- By 2010 waterborne anthropogenic nitrogen emissions in Sweden into the sea south of Åland Sea will have been reduced by 30 % compared with 1995 levels, to 38,500 tonnes
- By 2010 ammonia emissions in Sweden will have been reduced by at least 15 % compared with 1995 levels to 51,700 tonnes

Since the agricultural sector is responsible for large quantities of nutrient leakage from Sweden into the marine environment, the Baltic Sea and the North Sea, taking action to reduce the leakage is a high priority.

Programme to reduce plant nutrient losses from agriculture

The Swedish programme to reduce nutrient losses from agriculture consists of the following measures:

- Legislation
- Environmental taxes
- Voluntary instruments
- Extension service and information
- Research and development
- Monitoring

All legislative measures listed below are included in the Swedish Code of Good Agricultural Practice.

Legislation

Since 1 January 2000 all legislation concerning environmental matters in Sweden has been combined into one Environmental Code adopted by the Swedish Parliament.

Some of the legislation regulates agricultural activities in the vulnerable zones as defined by the Nitrates Directive 91/676/EEC. These areas comprise the counties of Blekinge, Skåne, Halland and Gotland and the coastal areas in the counties of Stockholm, Södermanland, Östergötland, Kalmar and Västra Götaland and the island of Öland. These regulations are indicated with one asterisk (*) in the following text.

The area of application for some of the other regulations concerns agricultural activities in the three southernmost counties, which are Blekinge, Skåne and Halland. These regulations are denoted by two asterisks (**).

Further regulations are applicable to agricultural activities in the entire southern and central part of Sweden, which consists of the counties of Stockholm, Uppsala, Södermanland, Östergötland, Jönköping, Kronoberg, Kalmar, Gotland, Blekinge, Skåne, Halland and Västra Götaland and the plains in the counties of Värmland, Örebro and Västmanland. These regulations are marked with three asterisks (***).

Finally, other regulations apply to agricultural activities in the whole country, and are marked with four asterisks (****).

A further clarification of the rules relates to the definition of animal units. In Sweden one animal unit corresponds to one dairy cow, one horse including foals up to 6 months of age, six calves one month or older, three other cattle 6 months or older, three sows including piglets up to 12 weeks of age, 10 fattening pigs 12 weeks or older, 10 fur animals (females), 100 rabbits, 100 laying hens 16 weeks or older, 200 young hens up to 16 weeks old, 200 slaughter chickens, 100 geese and ducks, 15 ostriches, 10 sheep and 40 lambs up to 6 month of age.

1. Livestock density

To ensure that no excess manure is produced in relation to arable land on the farm, it is important to maintain a balance between the number of animals on the farm and the amount of land available for the spreading of manure. Swedish legislation on livestock density cites phosphorous as a critical factor, and specifies a maximum allowable quantity of 22 kg P/ha. This level satisfies the crop requirements for phosphorus in Sweden's agricultural districts. Managing manure use by monitoring phosphorous ensures that the recommended nitrates level of 170 kg N/ha is not exceeded.

These regulations apply to the entire country (****) and stipulate the maximum number of animals permitted on each hectare of land that is available for the spreading of manure e.g. 1,6 dairy cows, 10,5 fattening pigs and 100 laying hens. Land available land for spreading manure consists of: arable land used for crop production on the farm, arable land located elsewhere if there is a contract for manure spreading for a period of at least 5 years, and parts of grazing land and pastures on farms with grazing animals.

2. Manure storage requirements

To comply with the rules governing spreading periods for manure and to achieve optimum plant nutrient utilisation, the farm must have sufficient capacity to store manure.

Farms in the vulnerable zones with more than 10 animal units are required to have adequate storage facilities for 8 months of manure production for cattle, horses, sheep or goats, and 10 months of storage for manure from other types of animal production.
This regulation also applies to farms in other parts of the country with more than 100 animal units. Holdings in the vulnerable zones with 10 animal units or less, should have adequate storage facilities for 8 months of manure production.

There are no specific rules concerning storage capacity in the rest of the country, however, the general rule stipulates that "persons who pursue an activity or take a measure, or intend to do so, shall implement protective measures or other precautions that are necessary in order to prevent or hinder damage or detriment to human health or the environment." Statistics indicate that storage facilities in these areas normally accommodate from 6 to 10 months of manure production.

3. Application of manure, other organic and commercial fertilizers

The first set of guidelines governing the application of manure was introduced in 1989 and the most recent in 1999. For each rule, the field of application corresponds to those areas already described in the section entitled “Legislation”.

- Fertilizer may not be spread in amounts exceeding the crop’s nitrogen requirements for the growing season. The amount of fertilizer applied should be based on a balance between the crop’s estimated nitrogen requirements and the nitrogen supply from all potential external nutrient sources, and should also take into account: soil conditions, climatic conditions, land use and agricultural practices (*)
- Fertilizer may not be applied on water-saturated or flooded ground (*)
- Fertilizer may not be applied on snow-covered or deeply frozen ground (*)
- Nitrogen containing commercial fertilizers may not be applied from 1 November - 15 February (*)
- Manure and other organic fertilizers may not be applied from 1 January – 15 February (*)
- Manure and other organic fertilizers may be spread from 1 August – 30 November and only on a growing crop or before sowing (*)
- Manure and other organic fertilizers may not be applied during the period 1 December - 28 February unless they are incorporated into the soil on the same day (****)

4. Agricultural waste water and silage effluents

The general rules relating to storage capacity apply to wastewater and silage effluents. This means that waste water and silage effluents should be collected and treated appropriately to avoid negative impacts on human health or the environment.

For example, waste water from the milking room is usually collected and stored in the slurry or urine pit; when silage effluents are generated, they are treated in the same way. Washing-up detergent used for cleaning the milking equipment generally has a low phosphorous content.

5. Winter crop cover

Green cover is one way to reduce nutrient losses from arable land during autumn and winter, particularly in areas with light soils and a mild climate. In southernmost Sweden (**), farms with more than 5 hectares must have crop coverage over at least 60 % of the cultivated area during autumn and winter. In the rest of southern Sweden, that is, in the counties of Östergötland, Jönköping, Kronoberg, Kalmar, Gotland and Västra Götaland, 50 % of the cultivated area must be covered.

Crops accepted as green cover are grassland on arable land, winter cereals, winter oil seeds, energy woodland on arable land, sugar beets, carrots or similar root crops (not potatoes), perennial fruit and berry crops, catch crops and set-aside arable land with covering plants. Additionally, for certain crops to be approved for autumn and winter crop cover, guidelines for first tillage must be followed.

6. Measures reducing ammonia emissions

Ammonia emissions could lead to acidification and eutrophication of land and waters.

According to the Convention of Long Range Transboundary Air Pollution (LRTAP) and the Ceiling directive 2001/81/EC total ammonia emissions in Sweden shall not exceed 57,000 tonnes in year 2010. In 1999, total ammonia emissions from Sweden amounted to 55,500 tonnes, with approximately 90 % of this figure originating from agriculture. The Swedish programme against nutrient losses and legislation introduced certain measures to reduce ammonia emissions in 1995 and again during 1997-98.

7. Storage requirements

To reduce ammonia emissions during storage, slurry and urine pits must be covered with a stable surface crust layer or other coating that effectively reduces ammonia emissions; filling must therefore take place beneath the covering. This requirement affects farms with more than 10 animal units in the southern and central parts of Sweden (***). Slurry pits can either be covered with a natural crust, straw peat, plastic, leca pebbles, a roof or any other material that effectively reduces ammonia emissions. Filling beneath the covering prevents the slurry or urine from breaking the cover or spilling on of the surface of the cover.

8. Requirements during application of manure

Measures to reduce ammonia emissions when applying manure in the southernmost parts of Sweden (**):

- Manure must be incorporated within 4 hours after application on bare soils,
- Slurry must be spread on growing crops using techniques that effectively reduce losses of ammonia.

Suitable techniques are:

- Band spreading techniques or other similar procedures where slurry is placed directly on the ground beneath the crop cover,
- Injectors or other similar techniques, where slurry is injected directly into the soil,
- Techniques in which one part slurry is diluted with at least one half part water before application (broadcasting),
- Techniques that are followed by irrigation with at least 10 mm water within 4 hours (broadcasting).

9. Permits

Farms with more than 200 animal units are required to apply to the County Administrative Board for a permit to operate. Farms with 100-200 animal units and greenhouses with an area exceeding 5,000 m^2 are required to register with the relevant municipal authority for permission to operate. In cases where there may be special environmental considerations, the authorities may stipulate regulations for the farms concerned, which go beyond the general requirements. Such discretion may be exercised by the authorities even if no permit or registration is required.

Farms which require an official permit to operate must submit annual environmental reports to the supervisory authority.

10. Other water protection measures

Apart from the legislative measures already outlined, the relevant authorities may also designate land or water areas (for example for drinking water purposes) as environmental protection zones if this is necessary to protect the area or part of the area from pollution. The authority may then introduce directives regulating the use of plant protection products, manure, and other organic or commercial fertilizers, if needed.

11. Supervision and sanctions

Typically, municipal authorities are the supervisory authority and have the responsibility to monitor compliance with regulations, judgments and decisions and to intervene to ensure rectification. The supervisory authority shall also by advice, information and similar activities create the conditions required to achieve the objectives of the legislation.

A supervisory authority may issue the orders and prohibitions necessary in an individual case to ensure compliance with the legislation, permits, conditions or other decisions.

An environmental sanction fee may be imposed for various kinds of violations, for example if livestock density is too high, or if manure storage capacity is too low. It is the supervisory authority that decides on the environmental sanction and its decision may be appealed at the environmental court.

Furthermore, if a person intentionally or as a result of negligence commences or conducts an activity without having acquired the necessary permit or similar approval or violates the conditions of a permit, this is considered an unlawful environmental activity and could lead to prosecution. A person, who intentionally or negligently fails to provide information to an authority or provides incorrect information, may be prosecuted for impeding environmental control.

The County Administrative Board has a regional supervisory role and may advise, inform and evaluate the measures undertaken by the municipal authorities. The Swedish Board of Agriculture is the central authority for agricultural issues and may give advice and provide guidelines on how to interpret the legislation. It has also the responsibility to monitor and evaluate the implementation of different legislative measures.

Environmental taxes

Since 1994 Sweden has applied an environmental tax to help reduce the use of fertilizers. The nitrogen tax is 1.80 SEK per kg of nitrogen in the fertilizer, if the content of nitrogen exceeds 2 %. There is also a tax and a limit value on the cadmium content in fertilizers. The cadmium tax is 30 SEK for every gram of cadmium, if the content exceeds 5 grams per tonne of phosphorus. The Swedish limit value is 100 grams of cadmium per tonne of phosphorus and fertilizers containing more than 100 grams of cadmium per tonne of phosphorus may not be offered for sale or transferred.

The taxes on fertilizers and plant protection products are under revision by a Governmental committee; and one of the committee's objectives is to determine if it is possible to improve the efficiency of the tax regime as a cost effective environmental protection instrument.

Voluntary instruments

Apart from regulations there are various actions governed by the Environmental and Rural Development Plan for Sweden 2000-2006 established in accordance with regulation 1257/99/EC.

The following sections outline those measures, which could help reduce nutrient losses and the risks to human health and the environment posed by plant protection products. Additionally, there are measures aimed at conservation of biodiversity and cultural heritage values in the farmed landscape, open and varied agricultural landscape, and the establishment of young farmers.

1. Support for investments

To accelerate the conversion to sustainable and environmentally friendly agriculture and environmentally sustainable production support may be available for investments which improve animal welfare, food hygiene, natural and cultural heritage environments and working environment. The types of investments, which have earned such support, include investments in manure storage, changes from solid manure to slurry-based systems, equipment for manure injection and changes in animal housing.

2. Reduced nitrate leaching

Farmers in the counties of Kalmar, Gotland, Blekinge, Skåne, Halland and Västra Götaland may apply to receive compensation for cultivation of cash crops and spring cultivation. The compensation is paid to farmers who undertake to carry out at least one of the cultivation measures on an area corresponding to at least 20 % of the spring sowing acreage on the holding; this must be carried out each year during the five year period 2001-2006.

There was a very positive response to this compensation programme in 2001 resulting in approximately 150,000 hectares being cultivated in this way; it is estimated that the programme will help to reduce nitrate leaching by 1,400 tonnes per year.

3. Riparian strips

Compensation is provided for riparian strips i.e. strips of arable land planted with vegetation alongside watercourses, lakes or the sea. The strip must be at least 6 metres wide to be eligible for compensation and strips exceeding 20 metres are not compensated. This compensation is provided in Götaland, Svealand and the county Gävleborg except for some minor areas. In 2001 approximately 6,000 hectares were cultivated as part of this compensation programme.

4. Wetlands and ponds

Project aid may be provided for investments in wetlands and ponds. The aim of the aid programme is to establish 6,000 hectares of wetlands and ponds on agricultural land or on land directly connected to agricultural use to reduce nutrient leakage into watercourses, lakes and the sea during the period 2001-2006. The project aid is given to the same areas where support for riparian zones is available, but with higher compensation levels for the southern parts of Sweden.

During 2001 a decision was taken to establish approximately 600 hectares of wetlands and ponds and during the term of the last environmental program about 1,800 wetlands and ponds were established. The creation of 6,000 hectares of wetlands and ponds is calculated to reduce nitrate leaching by 1,200 tonnes.

Compensation is also provided for management of wetlands and ponds in the same areas. In 2001 approximately 1,800 hectares was associated with this compensation programme.

5. Organic production methods

Organic farming is regarded as one technique for realising sustainable agriculture, and to meet growing consumer demand for organic products, organic production methods are eligible for support. The Swedish Government has also projected that by 2005, 20 % of arable land should be farmed organically and that 10 % of cattle and sheep should be in organic production. In 2001, 13 % of the arable land and more than 10 % of cattle and sheep were produced according to the directives stipulated in the regulation 2092/92/EEC and consequently received official support.

6. Other voluntary agreements

There are many voluntary agreements governing agricultural production in Sweden, one example of which is the Swedish Seal of Quality (Svenskt Sigill). A number of requirements must be met before a farmer can be awarded a Swedish Seal; these include but are not limited to environmental checklists, buffer zones, edge-zones, nutrient balance on field and farm scale, choice of fertilising and crop protection, and storage and transport of contacted products. Another example is the “Environmental Audit Scheme”, a tool developed by the Federation of

Swedish Farmers to help agriculturalists manage their agricultural production according to the requirements of different pieces of legislation, and using annual monitoring as part of the programme. Specific company eco-management and audit schemes require that farms with sugar beets must submit annual reports according to the "Danisco Miljöledningssystem". Farmers may also participate in a watershed group and some farms are certificated according to the ISO 9000 or ISO 14000 systems.

Extension service and information

Since the 1980s, the County Administrative Boards have offered advice on environmental matters to farmers, free of charge. Training has been offered both in the form of advising individual farmers and arranging classes for groups of farmers. In contacts with individual farmers it has been possible to design environmentally safe solutions for handling manure and other plant nutrients, all based on the needs of the individual farm. At organised classes, County Administrative Boards and other operators have shared information and demonstrated the best ways to treat manure and fertilizers to reduce the risk of plant nutrient losses. Of high priority for farms with animals has been the question of phosphorus application that corresponds with the demands of different crops on different soils. During the period 1996-1999 some 12,700 farmers were provided with individual advice on plant nutrients.

In 2000 a project entitled "Focus on Nutrients" was initiated in the southernmost parts of Sweden with the aim of addressing the entire flow of nutrients on the farm and providing personalised advice to the farmer. The counselling covered areas such as the establishment of nutrient balance, nitrogen and phosphorus strategy, measures to prevent soil compaction, planning of wetlands, and advice concerning feeding strategies. The programme is conducted in co-operation with regional authorities, the Federation of Swedish Farmers and companies operating in the agricultural industry.

It is estimated that this project will reduce nitrogen leakage by 2,600 tonnes mainly by reducing over-optimal fertilisation, and ensuring more efficient feed and manure management.

The Board of Agriculture produces brochures and other information material, and apart from regional activities, makes plant nutrient advisors available at three locations. The task of these advisors is to help ensure the efficient implementation of the plan of action for reducing plant nutrient losses. They are also responsible for sharing the results of applied research and development as well as other important information with operators in the region, and supporting other advisors, participating in various regional projects and providing expert opinion.

Research and development work

Parallel with the introduction of the plan of action, research and development activities were initiated to find methods for reducing plant nutrient losses from agriculture. The main focus of the plan was to reduce losses to water and the atmosphere. The task was to speed up the technical development primarily relating to the handling of manure and the use of catch crops in cropping systems. Research and development form an important foundation influencing the design and choice of measures and means of control.

Monitoring

Monitoring is carried out in drainage basins and in observation fields throughout the country. The influence of agriculture on the quality of water is studied in 35 relatively small drainage basins measuring between 2 and 15 km^2. Water samples are taken and field and weather data are collected. There are also 16 observation fields separated from the drainage basins where the quality of ground water and drainage water is checked. The data are evaluated continuously and in most cases are available from as far back as 1972.

In all of the drainage basins except one in the vulnerable zones, annual average nitrate concentration in the discharge water calculated as a long time value was below 50 mg NO_3-N/l.

In the observation fields annual average nitrate concentration in the drainage water calculated as a long time value has been more than 50 mg NO_3-N /l in three fields, two of which are situated in the vulnerable zones.

In addition to the preceding measures, a number of programmes monitoring water courses, lakes and groundwater may also be used for evaluating the effect of agriculture on the environment.

Most of the drinking water production in Sweden emanates from groundwater of a high quality; however groundwater with nitrate concentrations above 50 mg NO_3-N/l occurs in some areas, particularly south western Sweden.

In addition to monitoring activities, different statistical inquiries are carried out regularly, for example inquiries on the sale of fertilizers, the use of fertilizer and manure, and so on.

Results

The use of nitrogen fertilizers has decreased by approximately 20 % since 1985, with year to year variations in usage depending on factors such as the winter cereal grown and price effects. The use of phosphorus fertilizer has decreased by approximately 70 % since mid-1970.

The nitrogen leaching from agriculture has been simulated with the computer program SOIL-N, and the resulting calculations show the effect on root-zone leaching caused by changes in agricultural management.

These simulations indicate that nitrate leaching from the root-zone has decreased by slightly more than 25 % during the period 1985 to 1995. The decrease was more significant in the eastern parts of the country than in the west, and in some regions particularly Svealand and northwest Götaland, there was nearly a 45 % reduction in the root-zone leakage during these years. In the western parts of south Sweden the reduction was more moderate and in some cases measured only about 15 %.

New simulations by the same model with certain improvements show that nitrate leaching from arable land remained unchanged during the period 1995 to 1999. Unfortunately there exists no comparison between 1985 and 1999 using the same model.

The new model showed that leaching is generally higher in western Götaland than in the east. The reason for this is that drainage influences the rate and level of leaching, and drainage flows are larger in western Götaland. Regionally also, there have been some changes with respect to the load of nitrogen, and availability of arable land has played an important part in bringing about these changes. In the flat county of Götaland, the decrease in available arable land was the main reason for a very limited reduction in the load, whereas in the western parts of the forested areas of Götaland the load has increased slightly. The reason for this has been an increase in livestock density. Estimated leaching in kg/hectare has increased almost one kg in the plain areas of Svealand, the underlying reason being that the area of ley and fallow land has decreased in the region. Since the arable land area in this region is both large and unchanged the increase in animal production has a significant impact, resulting in a 6 % higher nitrogen load.

Ammonia emissions from agriculture have fallen in recent years and was calculated to be 49,000 tonnes in 1999, or a 12 % decrease from 1995 levels. The decline was caused by a reduction in the numbers of cattle and pigs and a shift away from solid manure to slurry management systems, as well as more frequent use of better application equipment for manure and a faster incorporation into the soil.

Programme to reduce risks connected with the use of plant protection products

In 1986 a programme was introduced to help reduce the risks to human health and the environment from the use of plant protection products in agriculture and horticulture. An important objective was to reduce the quantity of active ingredients used by 50 % over a five-year period. The starting reference point was the average usage level between 1981 and 1985. In 1990 the Swedish Parliament passed a new food policy, the aim of which was a further reduction of the health and environmental risks and a further 50 % reduction in the active ingredients used in plant protection products by 1996. In 1997, the Swedish Parliament decided on a new programme for the period 1997-2001, that would focus primarily on health and environmental risks.

The Government has commissioned The Swedish Board of Agriculture and the National Chemical Inspectorate together with the Swedish Environmental Protection Agency, the Swedish Work Environment Authority and the National Food Administration to develop a new programme to further reduce the risks of using plant protection products.

1. Registration and approval

Chemical products and biotechnological organisms, as well as chemical products that are manufactured industrially or imported into Sweden are listed in a product register. Chemical or biological pest control agents may not be placed on the market without prior approval. Approval may be given if the pest control agent is acceptable from the point of view of health and environmental protection and is needed for control purposes.

In 1985 new legislation was introduced in Sweden stipulating that all plant protection products must be re-registered every five years. A new process to evaluate new and old products with regard to risks, benefits and needs was developed. By 1994 all old plant protection products had been reviewed; in 1995 a second re-registration of insecticides was conducted and in 1996 the same procedure was completed for fungicides. Compared with 1985, 64 active ingredients in plant protection products were no longer recommended for use because of health and environmental risks or lack of documentation. At the same time the Inspectorate also improved the quality of product information available to farmers and the number of plant protection products available to the general public decreased substantially.

Today the process of prior approval is based on two parallel systems, the national system and the system stipulated in the directive 91/414/EEC.

2. Certificate

Plant protection products approved for use are divided into three classes. The general public may use products in class 3. Persons who meet certain qualification requirements and have attained a certain age may use products belonging to class 1 and 2. Since 1990 all farmers and farm workers who carry out pesticide spraying professionally need a certificate. To get the certificate four days training is required and at the end of the courses the participants must pass a test to get the certificate. The mandatory training courses include subjects regarding risks to human health, risks to the environment and opportunities to promote an integrated crop protection programme with chemical control adjustments. The certificate is valid for five years and an additional one-day course is required for its renewal. In Sweden there are approximately 29,000 holders of this certificate.

3. Storage and handling

In Sweden there are regulations governing how to store and handle plant protection products. Rules about filling and cleaning equipment and about disposal of waste from plant protection products are also in force. For example the filling and cleaning of equipment near lakes and watercourses is prohibited.

4. Application technology

Generally plant protection products are applied to prevent damage to human health or the environment or cause any other nuisance and to minimise any environmental impact. When using plant protection products farmers should conform to the principles of good plant protection practice and their use should be consistent with the principles of integrated pest control.

More specific rules are that farmers must define and use protection zones when spreading or in other ways handling plant protection products. The protection distance should take into account variables such as air temperature, wind, and soil to protect water resources, lakes, streams and landscape. The spraying equipment should be suitable for the purpose, kept in prime condition and properly calibrated. Application equipment should include apparatus for measuring temperature,, wind direction and wind speed in order to define an appropriate protection area.

The application of chemical or biological pest control agents by aircraft is prohibited. Only in very exceptional cases, might the Government or the authority appointed by the Government grant exemptions from this prohibition.

5. Supervision and sanctions

Supervision and sanction measures are essentially the same as those described in the section dealing with the programme to reduce plant nutrient losses. The Chemical Inspectorate is the main authority responsible for the regulation of plant protection products but the Board of Agriculture and other authorities also have central responsibilities.

Other measures to reduce the risks and the use of plant protection products

1. Voluntary tests of sprayers in operation

A special programme for voluntary testing of sprayers has been in operation since 1988, in which approximately 50% of the sprayers in operation are tested every third year. Between 1988 and 1998 roughly 18,000 tests were performed and some 305 test examiners have been trained. The purpose of this programme is to reduce risks to the environment (also the working environment) by testing and control, and also to give the owners information about the conditions for achieving the best spraying results.

2. Integrated crop protection, pest forecast and early warning

The Board of Agriculture has established three regional plant protection centres to promote integrated crop protection with chemical control used as necessary. The centres offer pest prognoses and early warning services, strategies to combat pests, reports, development and some experimental work, and the target group includes advisory officers in state, private and commercial organisations. An advanced information management system has been established to handle the very large amount of data generated. There is, in addition, close collaboration with the staff at the Swedish University of Agricultural Sciences.

3. Advisory services for the reduced use of herbicides

Research tests on cereals have indicated that the best yields are obtained at half the recommended herbicide dose and at 70-75 % efficiency. Crop stress and lower yields can occur if an unnecessarily high dose of herbicide is used. The use of crops which are able to compete with weeds, as well as a long term and efficient weed control strategy, can also make it possible to lower dosage rates. Test results have shown that to restrict weed growth, it is important to use herbicides every year. It has therefore been concluded that herbicides should be used annually, at low dosage rates. This has been the most important strategy in the reduction of the use of plant protection products. A critical part of the programme has been to relay the information on reduced herbicide usage to Swedish farmers. The Swedish Board of Agriculture has in various ways initiated and given support to the advisory services in the different counties. Demonstration experiments and field courses have been some of the important tactics to help focus on the benefits of reducing dosage rates. The ideas have been easy to implement, mainly because it is economically beneficial to the farmers. In recent years information about new technology, environmental and personal protection, as well as flora and fauna, has also been important.

4. Flora and fauna

Extensive research has been conducted to gain more knowledge and a better understanding of the use of unsprayed edge zones. The work has consisted of experimental fields and development work with the purpose of demonstrating the advantages and disadvantages of using unsprayed edge zones, as well as to offer solutions to problems associated with the use of this strategy. The aim has been to find out how unsprayed edge zones affect flora and fauna.

In 1998 almost 40 % of cereal production occurred in holdings using edge-zones.

5. Bio-beds

One of the measures in the Swedish Environmental Programme in line with Regulation 2078/92/EEC included support for building bio-beds and establishing unsprayed edge zones.

Environmental tax on plant protection products

Currently the environmental levy is 20 SEK per kg of active ingredients in the plant protection product. The section on “Environmental taxes” under the Programme to reduce plant nutrient losses from agriculture is also relevant here.

Control of pesticide residues in food and water

New methods for analysing pesticide residues have been introduced during the reduction programme. The purpose has been to develop cost-efficient, quality proven and environmentally friendly methods. The number of residue samples taken from food and drinking water has been increased and in some water samples, plant protection products such as bentazon, atrazine, MCPA etc. have been identified, mostly in very small quantities.

Research and development

Weed, pest and technical research and development are essential parts of the plant protection products programme. Some activities in the programme are based on new findings and others require new knowledge or new techniques. The main factors under consideration include the opportunities for reducing the risk posed by plant protection products, options for better chemical control based on need, alternative methods, and the impact on flora and fauna.

Results

The objective in the first part of the programme was to reduce the quantity of active ingredients used by 50 %, and this was achieved in 1990 but the second reduction goal of a further 50 % was not fully met. Up to1996 there was a reduction in the use of plant protection products but this was followed by a slight increase and in 2000 the usage was about 38 % of average rates for the period1981-1985. A large part of the reduction outcomes depends on the reduced use of herbicides on cereals, caused by the more widespread use of lower dose rates, pest prognoses and early warnings, among other factors.

Current trends indicate an increased use of herbicides during recent years; this in turn reflects rising sales of glyphosate. A possible explanation for this is that it is more economical to use glyphosate than it is to use mechanical methods, the requirement for fallow land and requirements relating to winter crop cover.

To quantify the reduction of the risks posed to human health and the environment, the National Chemical Inspectorate has determined one health and one environment index for each active ingredient. Together with the annual statistics for amounts of each active ingredient sold, the Inspectorate calculates a value that gives an indication of the potential risk to human health and the environment. Since 1986 the risk to health has been reduced by approximately 75 % and the environmental risks by roughly 65 %.

Part B: Finland

The Baltic Sea Joint Comprehensive Environmental Action Programme (JCP) identified 10 Hot Spots in Finland. An overview is provided in table 1.

Table 1. Finnish Hot Spots under the JCP

Hot Spot No.	Location	Site name	Site type
2	Bothnian Bay	Metsä-Botnia Oy Kemi	Industry (Pulp & Paper)
7	Bothnian Bay	Outokumpu Group, Harjavalta	Industry (Metal Smelter)
8	Bothnian Bay	Kemira Oy Vuorikemia	Industry (Titanium oxide)
9	Archipelago and Åland Seas	Fish Farming	Fish Farming
10	Archipelago Sea	Agriculture	Agricultural Runoff
11	Lake Saimaa	YPT Joutseno	Industry (Pulp & Paper)
12	Lake Saimaa	Kaukas Lappeenranta	Industry (Pulp & Paper)
13	Lake Saimaa	E-G Kaukopää	Industry (Pulp & Paper)
16	Gulf of Finland	Sunila Oy Kotka	Industry (Pulp & Paper)
17	Gulf of Finland	Helsinki Region	Municipal

Municipal Hot Spots in Finland

Helsinki wastewater treatment plant in Viikinmäki (Hot Spot No. 17)

Viikinmäki wastewater treatment plant in Helsinki has been the target of expansion and supplementary work since the year 2000. The biological capacity of the wastewater treatment plant has been increased with the addition of an eighth active sludge line; and excavation for the ninth line has already been taken place. The new line was commissioned in March 2004. to improve the efficiency of the nitrogen removal process, a biological post-denitrification unit has been built and put into operation in December 2003.

In December 2003, Helsinki Water submitted an environmental permit application to West-Finland Environmental Permit Authority for the new Viikinmäki wastewater treatment plant. The application offers the following limit values for the wastewater treatment plant as of 2004:

Parameter	Residual concentrations mg/litre	Purification efficiency %
BOD 7	< 8	> 95
N tot	< 8	70 - 80
P tot	< 0,3	> 95

Following a trial run of over one month's duration, the results indicate that the target values can easily be achieved. This also means that the nitrogen load in the Gulf of Finland will be reduced by approximately 50 % and the loads of phosphorus and BOD7 by 30-40 % of their current levels.

With the completion of the expansion and supplementary work, Helsinki and its partners would have invested a total of EUR 225 million in protecting the Gulf of Finland.

Figures 1-2 chart the development of the history of the total nitrogen and phosphorus loads in the Gulf of Finland. A remarkable reduction in the total phosphorus load has occurred since 1979 and since 1997 for the nitrogen load.

The quarterly permit results for total nitrogen, total phosphorus and BOD7 in concentrations and reduction percentages are indicated in figures 3-5. Similar information for the first four months of 2004 is shown in figures 6-7.

The location of the outlets of the treatment plants 20 years ago and today as well as the improvements in water quality around the City of Helsinki are shown in figure 8.

The operation of the Viikinmäki wastewater treatment plant and the positive trend in the water quality makes a compelling case for the use of the best available technology.

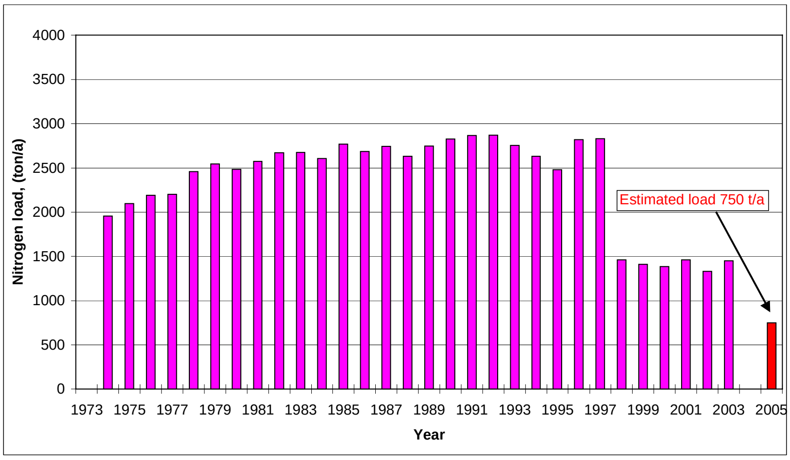


Figure 1. Helsinki wastewater treatment plant. History of the total nitrogen load in the Gulf of Finland

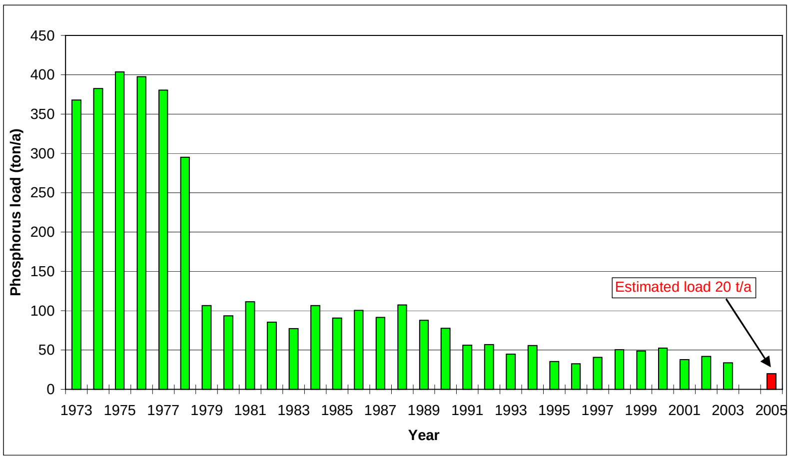
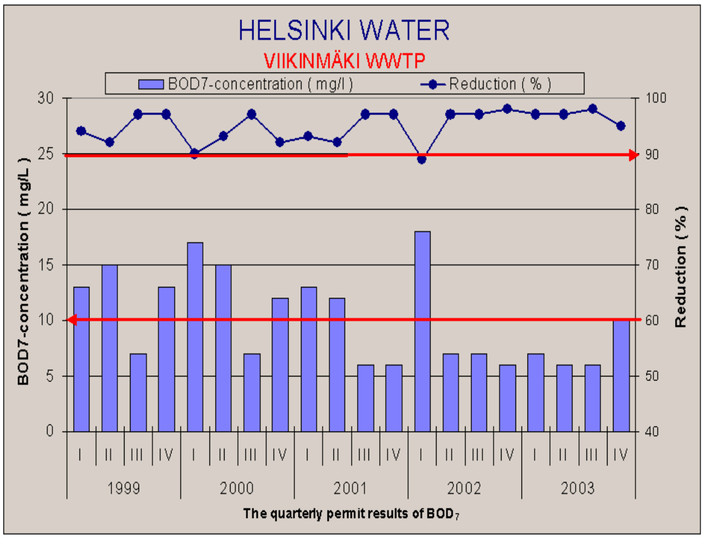
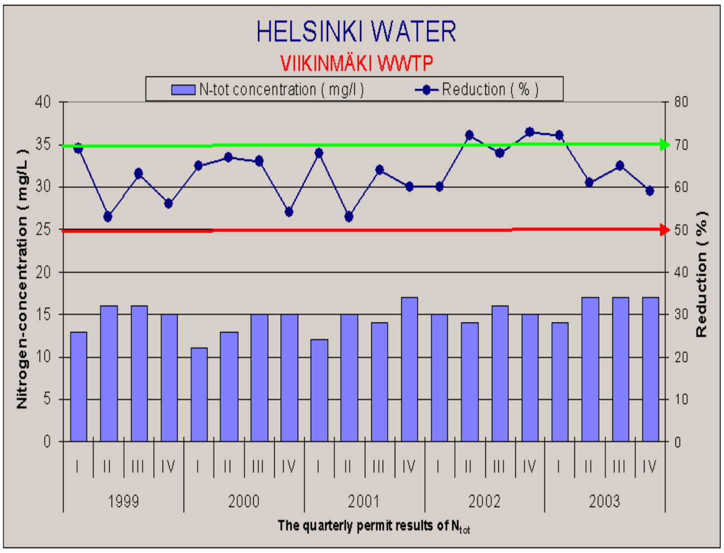
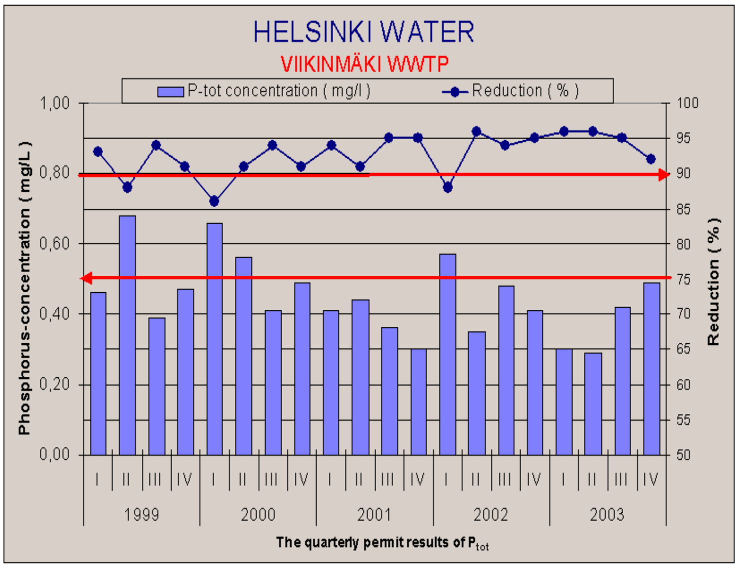


Figure 2. Helsinki wastewater treatment plant. History of the total phosphorus load in the Gulf of Finland







Figures 3. – 5. Concentration of discharged BOD7, Total N and Total P, reduction (%) and limit values in permit (1999-2003)

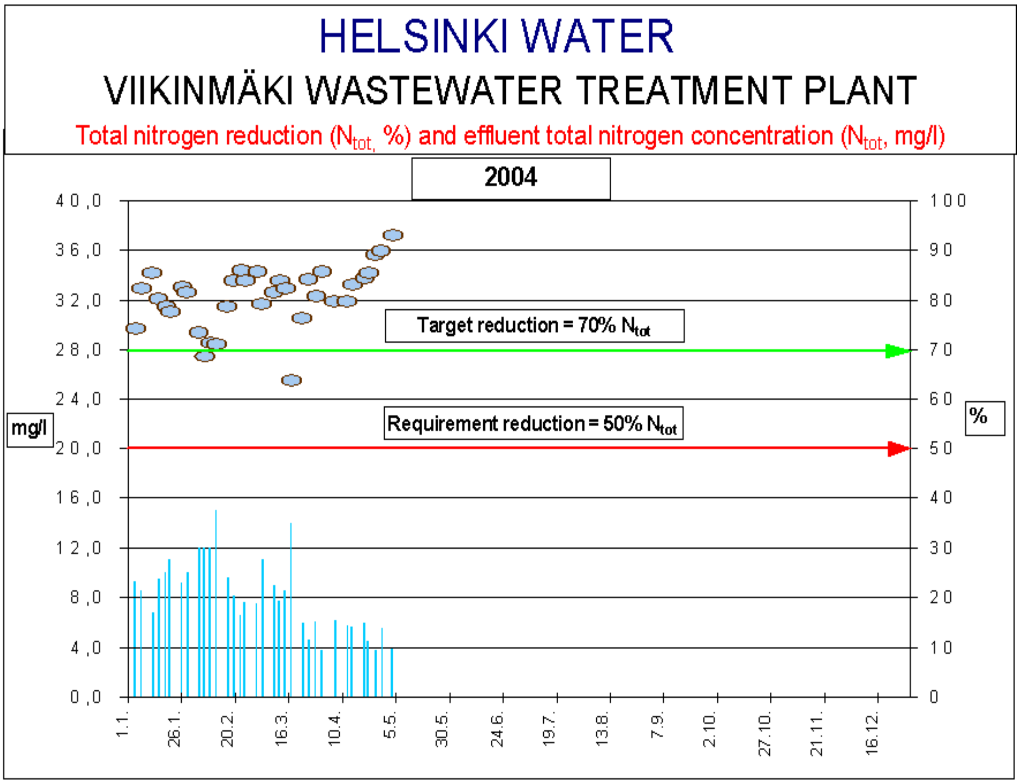


Figure 6. Discharge performance (total N) from January to May 2004

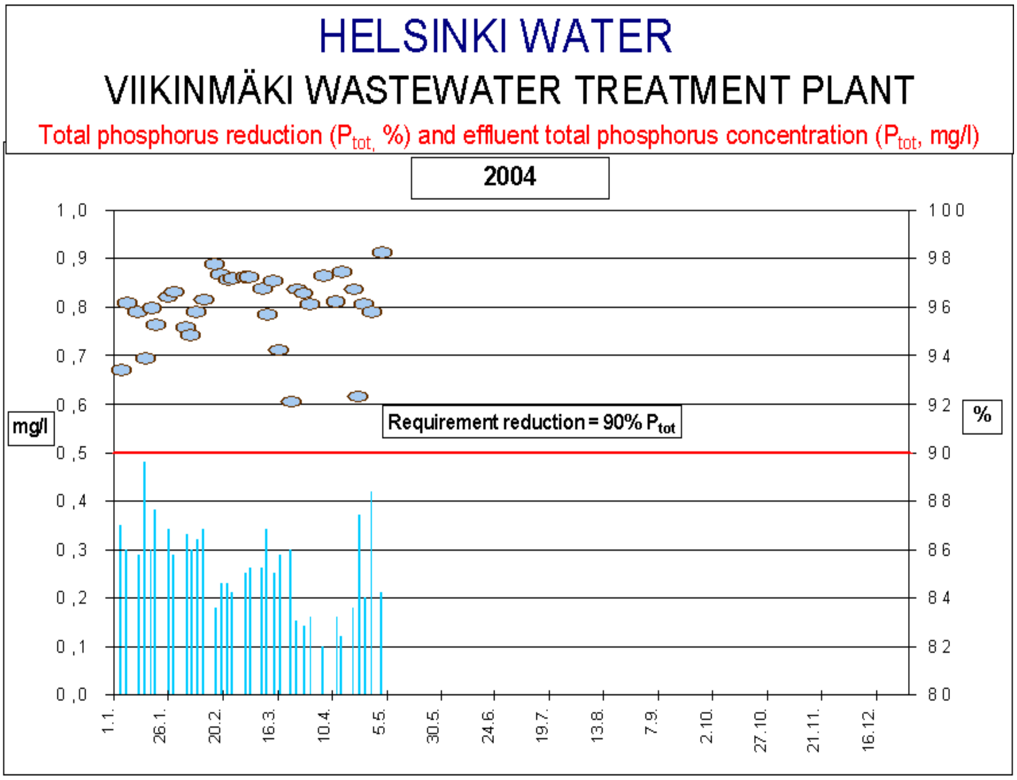


Figure 7. Discharge performance (total P) from January to May 2004

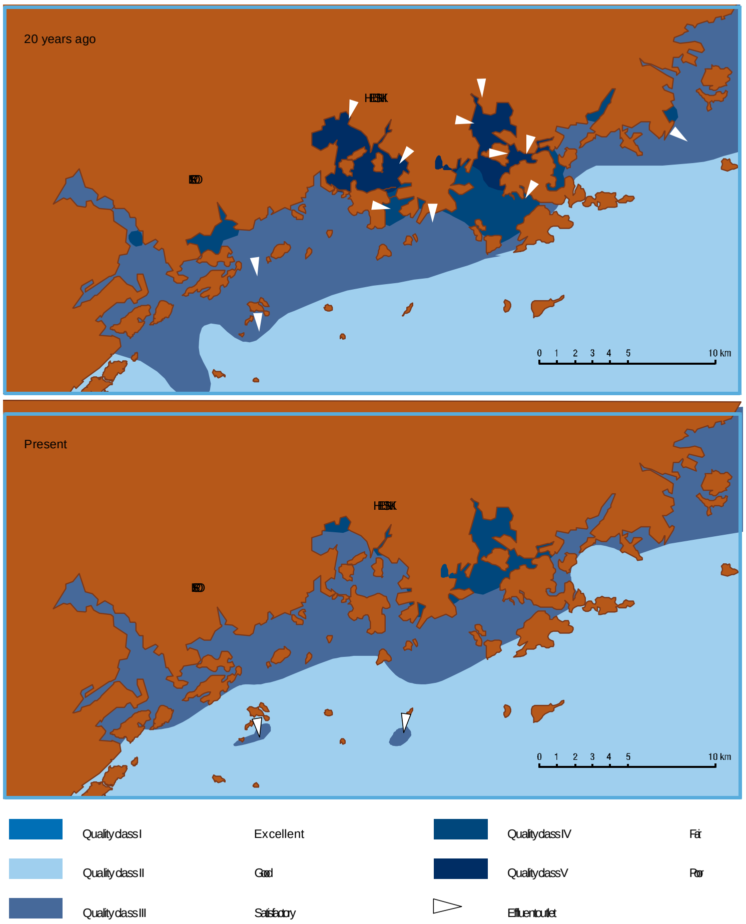


Figure 8. The outlets from treatment plants in front of the City of Helsinki 20 years ago (above) and in 2004 (below)

At present the Hot Spot is under review in order to be removed from the List of Hot Spots.

Industrial Hot Spots in Finland

Outokumpu Harjavalta Metals Oy, Harjavalta Plant (Hot Spot No. 7)

Significant reductions in emissions into air and water from the Harjavalta smelters have been accomplished by continuous and focused environmental investments. Additionally, continuous and long term technological development work has resulted in a flash smelting technology process, which has become a primary means of copper and nickel production worldwide.

Today, the Harjavalta smelters are operated according to non-ferrous BAT and they have an outstanding environmental performance compared to other similar plants. Outokumpu Harjavalta Metals Oy implements certified management systems and other voluntary environmental programs.

Reduced emissions are reflected in the rapid improvement of the condition of the environment.

Outokumpu Harjavalta Metals Oy was deleted from the HELCOM Hot Spot List in April 2003.

General

Outokumpu Harjavalta Metals Oy is a part of the Outokumpu Group. The company processes copper and nickel concentrates in Harjavalta and refines copper cathodes in Pori, while the production-supportive operations are outsourced to a cooperative network of companies. The company has operations in Harjavalta, Pori and Espoo, with the copper and nickel smelters and the sulphuric acid plant located in Harjavalta. The Harjavalta plant employs 325 persons.

Figure 1. Harjavalta industrial area

The production plants are situated close to the centre of the city of Harjavalta.where industrial activity has occurred since the 1940’s. The nearest residential area is situated 0.4 kilometres from the smelter.

Besides the Outokumpu smelters, other metal and chemical industrial companies are located in the same industrial area (Figure 1). The Harjavalta industrial area employs a total of over 1,000 people.

History of copper and nickel production at Harjavalta

The copper smelter that was started in 1936 in Imatra, Finland, was transferred to Harjavalta in 1944. In 1949 the autogenous flash smelting of copper concentrates was invented and introduced in Harjavalta. Since then the process has become a primary means of copper and nickel production worldwide and the model for copper smelting activities throughout the world.

The Copper Refinery started in Pori in 1941. Nickel concentrate flash smelting started in 1959 and 1960 in Harjavalta.

Considerable expansion of the smelters was carried out in the early 1970's and the first oxygen plant was built. The second oxygen plant was introduced in the mid 1980's and the third in 1995. The sulphuric acid plants located in the neighbourhood were acquired in 1987.

Significant investments were made in the expansion of both copper and nickel production in Harjavalta during 1993-95. The capacity of the copper smelter was increased by 60 % and that of the nickel smelter by 100 %. Large investments were also made to reduce emissions to air. A new converter unit was built in the converter area and a new 140 m high stack to carry away exhaust gases from the smelter and the sulphuric acid plant. In 1995 a new sulphuric acid plant (RH7) representing the newest technology was established to replace the two older ones.

A new method of copper concentrate drying was introduced (indirect steam drying) which meant that there were no longer any sulphur dioxide emissions emanating from the drying process. Outokumpu invested 72 million euros in the protection of the atmosphere in the 1990´s, and total environmental investments amounted to approximately EUR 100 million .

In 1999 the company outsourced the production-supportive operations to a cooperative network of companies. In 2000 the nickel refining operations after concentrate smelting were sold to OMG, an American company which operates in Harjavalta under the name of OMG Harjavalta Nickel Oy.

The main milestones of copper and nickel production at Harjavalta are:

- 1945 Commencement of copper production
- 1949 Commencement of flash smelting of copper concentrates
- 1959 Commencement of flash smelting of nickel concentrates
- 1960 Commencement of production of nickel cathodes
- 1987 Outokumpu acquisition of sulphuric acid plant
- 1990-1991 Modernization of nickel smelter and implementation of environmental investments for reducing emissions to air
- 1993–1996 Expansion of copper smelter and implementation of environmental investments for reducing emission to air and water
- 2000 Sale of nickel plant to OM group.

Copper production has increased since the 1950's from 20,000 tonnes up to the present capacity of 170,000 tonnes of copper.

Production processes

Copper concentrates are used as raw material at the plant. Copper is separated from the concentrates in a flash smelting furnace. It is then converted and further refined in anode furnaces and cast into copper anodes. The anodes are transported by rail to the copper refinery in Pori.

The slag coming out of the flash smelting furnace and the converters is treated at the slag concentrator from where the copper containing slag concentrate is taken to the flash smelting furnace together with other concentrates.

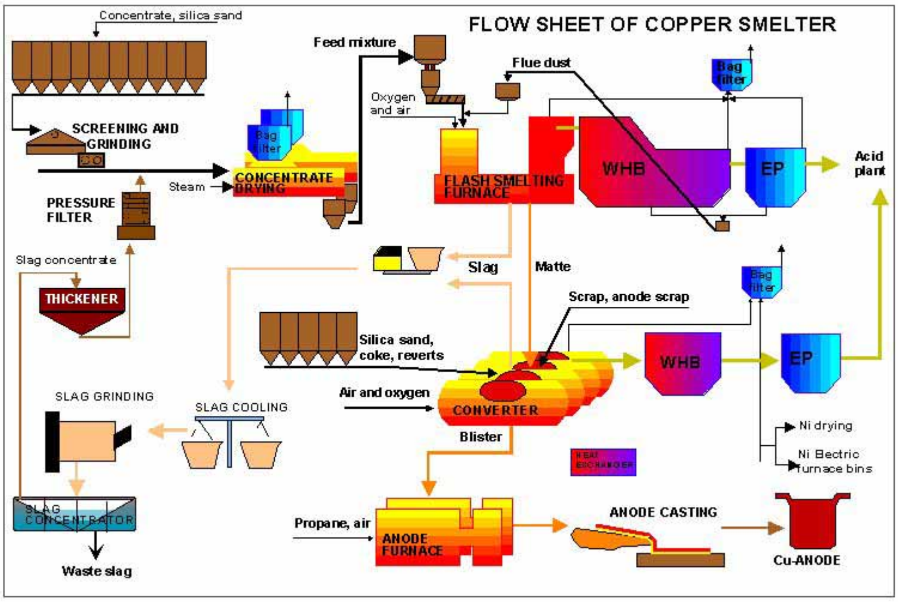


Figure 2. Flow chart for copper smelter at Harjavalta

Outokumpu Harjavalta Metals Oy refines nickel concentrates into nickel matte for OMG Harjavalta Nickel Oy. The DON process (Direct Outokumpu Nickel) based on the flash smelting method is used for making granulated nickel from the nickel concentrates. Granulated nickel matte is then taken for further refining to OMG Harjavalta Nickel Oy's nickel plant in Harjavalta. The slag that is formed during smelting is purified in an electric furnace.

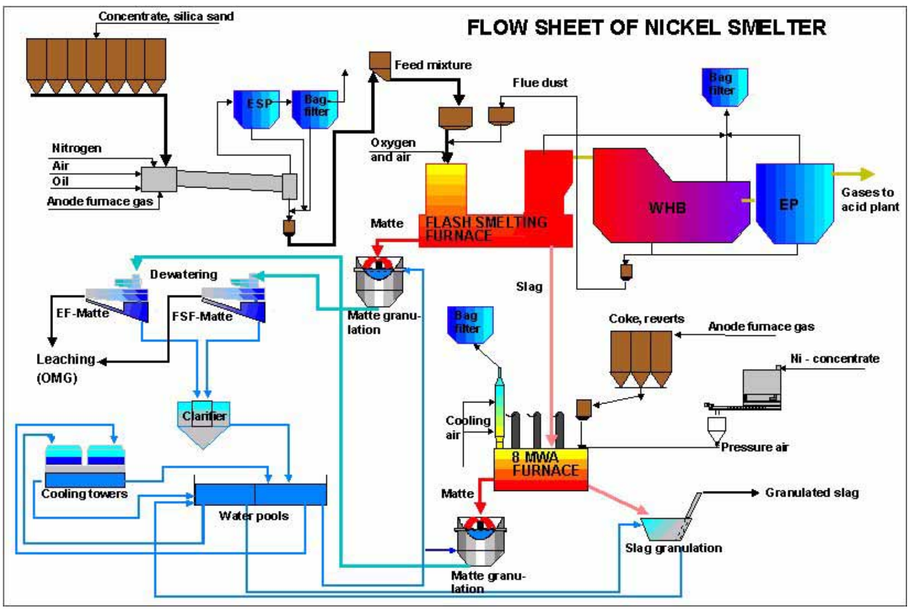


Figure 3. Flow chart for nickel smelter at Harjavalta

Sulphur dioxide-containing gases are used for producing sulphuric acid and liquid sulphur dioxide at the sulphuric acid plant.

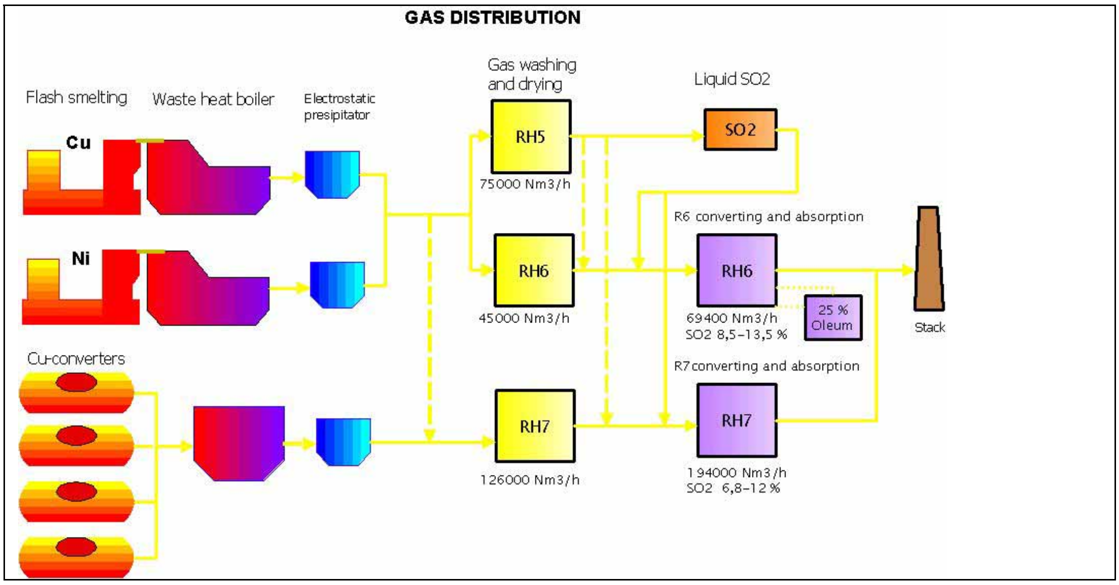


Figure 4. Flow chart for sulphuric acid plant at Harjavalta

Outokumpu and OMG have a common sewer system and water treatment plant as well as a common water permit. Process and rain waters are treated at the water treatment plant located in the plant area before flowing to the Kokemäenjoki River. The operation of the water treatment plant is based on the precipitation of metals using sodium hydroxide. Water is directed from sewage reactors to the settling pond. The overflow from the settling pond is pumped to sand filters. Filtered water then flows into the sewage system and from there into the river.

Management systems

Several voluntary management systems are used to improve environmental performance by ensuring control of environmental matters and continuous improvement of procedures.

Outokumpu Harjavalta Metals Oy has been granted a Quality Management System Certificate as proof of attainment of the ISO 9002 Standard. The Occupational Health and Safety System is certified and based on the OHSAS 18001 Specification. The Harjavalta plant's Environmental Management System was certified in accordance with the ISO 14001 standard in 2001. The Copper Refinery in Pori uses the registered EMAS environmental management system, which complies with the appropriate EU directive.

Energy consumption is governed by voluntary energy savings agreements.

Best available techniques

According to the BREF document of the non-ferrous metal industry, use of the Outokumpu flash smelting method and the Peirce-Smith converting method in the production of primary copper are classified as BAT. As the process is not continuous, it is stipulated in the document that collection of both primary and secondary gases are properly arranged and purified at the Harjavalta plant. In addition, the document recommends that dust and evaporating metals must be removed from the gases during primary smelting and converting, heat or energy collected, and sulphuric acid made from sulphur dioxide in the sulphuric acid plant using the double contact method. All of the preceding BAT conditions are fulfilled by Outokumpu Harjavalta Metals. BAT conditions are also satisfied when drying concentrate in steam dryers, refining copper in the anode furnace, casting anodes and concentrating slag by flotation.

The best available techniques to produce copper from sulphuric concentrates at Harjavalta are presented in a document entitled “Finnish Expert Report on Best Available Techniques in Copper Production and By-production of Precious Metals”, which can be found on the internet: (http://www.vyh.fi/eng/orginfo/publica/electro/fe316/fe316.htm).

The best available techniques to produce nickel from sulphuric concentrates at Harjavalta are presented in a document called “Finnish Expert Report on Nickel Production” which can be found on the internet: (http://www.vyh.fi/eng/orginfo/publica/electro/fe317/fe317.htm).

The most recent tribute to the Outokumpu flash smelting method occurred when Outokumpu received the ASM Historical Landmark Award in 2002. It is an acknowledgement of continuous and long term development work, which has brought both economic prosperity and environmental conservation to its users all around the world. At present, this Finnish technology is the most advanced in the world.

The ASM awards have been granted since the year 1972. Before the flash smelting method was recognised, only 11 other places in Europe received the ASM reward. One of them was the Eiffel tower in Paris in 1989. ASM International, the Material Information Society that grants the awards, is a global network of material manufacturers and scientists. The society is dedicated to promoting manufacturing technology and the applications of metals and other materials. Historical Landmark awards are granted to places which have special historical significance.

Energy consumption

Of the total energy consumption in the factory area, process maintenance, transport and smelting of concentrates consume the largest proportion.

Flash smelting of concentrates is an exothermic process, and the energy released by the raw materials used is almost sufficient for the smelting of concentrates. Energy generated by the flash smelting furnaces, copper converters and the process gases of the sulphuric acid plant is collected.

Energy consumption is regulated by voluntary energy savings agreements. Energy savings studies indicate that the energy efficiency is satisfactory, since there is minimal need for an external power source in the production processes. This is because the energy released by the raw materials is used in the smelting operations.

Emissions

Historical review

Substantial environmental investments have resulted in considerable reductions in emissions to air as well as discharges to water during the plants' history. This is a remarkable achievement considering that production has multiplied at the same time.

Sulphur dioxide emissions have decreased significantly since the 1950's, and during the last decade, from 1990 to 2002, sulphur dioxide emissions decreased by 63 % (Figure 5).

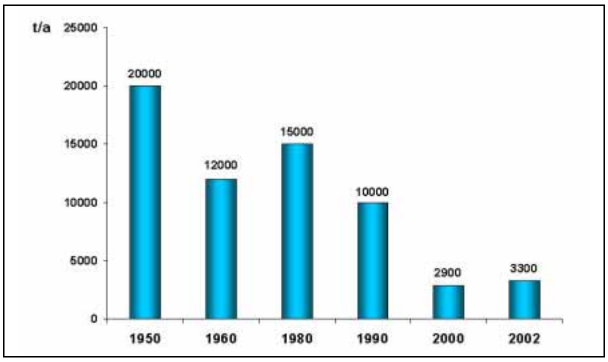


Figure 5. SO_2 emissions from the smelters and sulphuric acid plant including fugitive emissions

During the same period the nominal emissions decreased even more dramatically while production doubled. Today the nominal emission (kg SO_2/metal-t) is about 15-16, which is an excellent achievement (Figure 6).

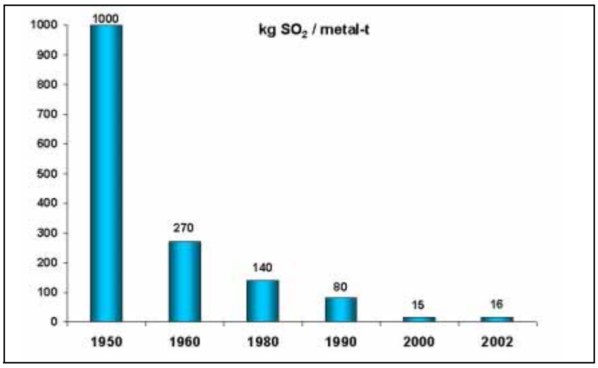


Figure 6. SO_2 nominal emissions at Harjavalta 1950 - 2002

During last decade, from 1990 to 2002, dust emissions fell by 95 % (Figure 7). For different metals the development has been as follows: copper –89 %, nickel –98 % and arsenic –98 %. This is a remarkable achievement considering that production has doubled at the same time.

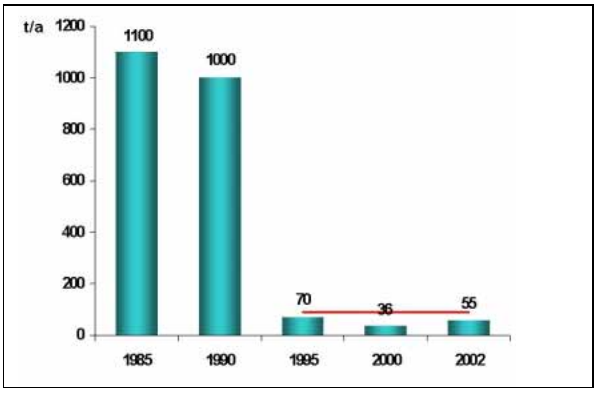


Figure 7. Dust emission from smelters to air including fugitive emissions 1985-2002.
The limit value has been 90 tonnes since 1997

From 1990-2002 metal discharges into the river Kokemäenjoki decreased by 78 %. For different metals and arsenic the development has been as follows: copper –64 %, arsenic -94 %, lead -94 % and mercury –83 %.

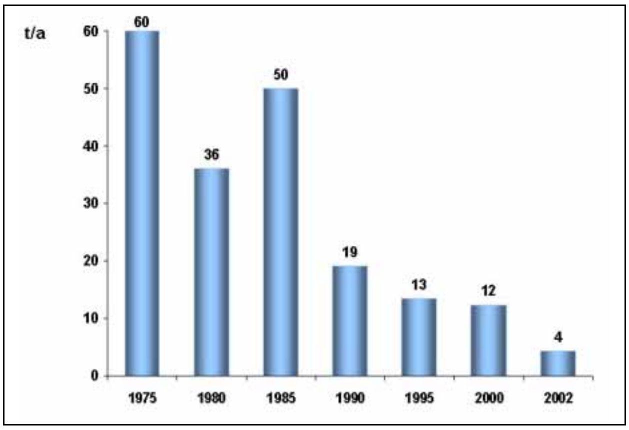


Figure 8. Metal and arsenic discharge to river from smelters and nickel plant 1975-2002

Emissions to air

Last year both SO_2 and dust emissions into air were well under the limit values (Table 1). SO_2 emissions into air were 3,300 tonnes while the limit value is 4,500 tonnes; dust emissions were 55 tonnes and the limit value is 90 tonnes. The values include emissions from the smelters and sulphuric acid plant as well as fugitive emissions.

Table 1. Emission to air for 2002 with limit values at Harjavalta smelter

	SO_2 (t)	Dust (t)	Cu (t)	Ni (t)	Zn (t)	Pb (t)	As (t)	Cd (t)	Hg (kg)
2002	3 300	55	11.6	0.6	1.5	0.4	0.5	0.1	1.8
Limit	4 500	90	12.0	5.0	10.0	5.0	2.0	0.5	20.0

Discharges to water

Water emissions have been shared by Outokumpu and OMG Harjavalta Nickel since the year 2000 when Outokumpu sold its nickel business to OMG.

At present the focus of environmental investments has been on more efficient treatment of waters. An expansion of the water treatment capacity was commissioned in 2000 and an anode casting cooling water circulation system was commissioned in 2001. Several additional improvements have been made to reduce water discharges.

In 2002 the emissions were well below the limit values (Table 2 and Figure 9). As a result of recent investments, the load decreased extensively. The investments and alterations initiated in 2000 to reduce emissions to water have contributed to the reduced metals and arsenic load.

Table 2. Emissions to water are denoted in kg/year. Limits are indicated in kg/day every quarter of a year. The permission limit in the table is numerical kg/year calculated from daily limits.

Kg/year	Cu	Ni	Zn	As	Pb	Cd	Hg
2002	1 460	1 420	680	510	99	46	5.2
Limit	3 600	3 600	1 800	1 800	1 080	108	10

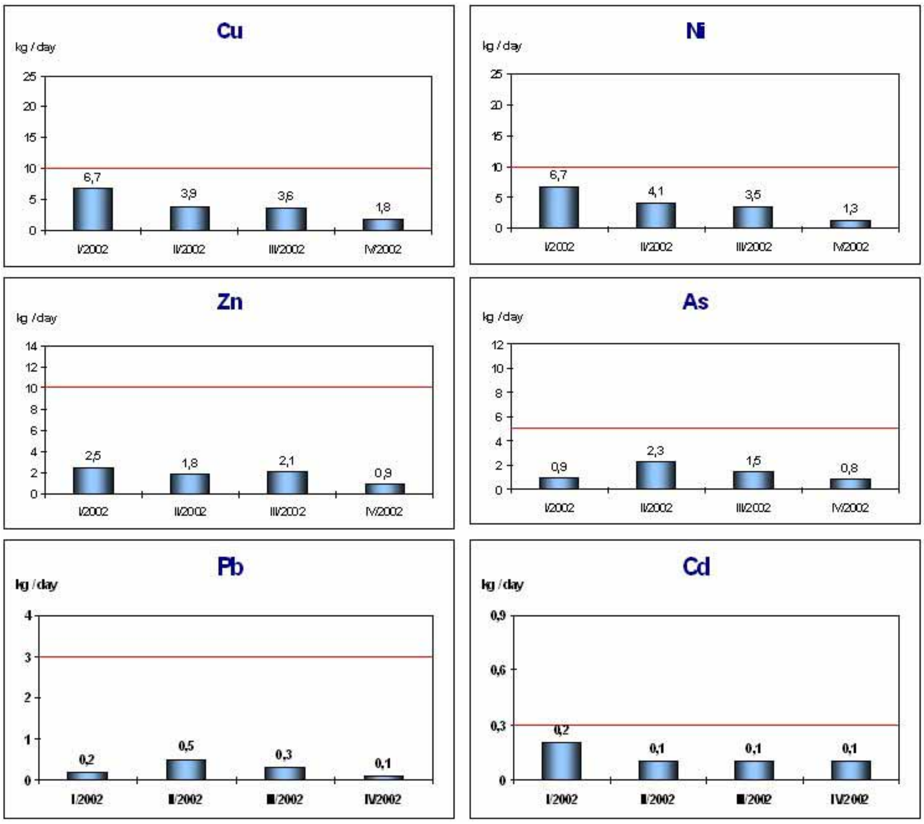


Figure 9. Discharge of metals and arsenic (kg/day) during 2002. The red line indicates the permission limit value.

Compared to HELCOM recommendations the assays (mg/l) are well below the recommended values (Table 3).

Table 3. Assays (mg/l) of discharges from Outokumpu smelter and OMG nickel plant in 2002 compared to HELCOM recommendations

	Cu	Ni	Zn	Pb	As	Cd	Hg
Sewage 1	0.1	0.13	0.056	0.007	0.044	0.002	0.00055
Sewage 2	0.03	0.01	0.009	0.002	0.006	0.001	0.00003
HELCOM Rec.*)	0.5	1.0	2.0	0.5	-	0.2	0.05

*) Recommendation for the chemical industry

Future environmental investments

In future the focus of environmental investments will be on expanding the storage areas for process slag.

Outokumpu Harjavalta Metals Oy plans to increase its production. At the same time nominal emissions into air and water will be reduced from the present level. The environmental investments required to accomplish these targets will be roughly EUR 75 million, however no decision has been taken about realizing these objectives.

Environmental monitoring

The Harjavalta smelters are operated in accordance with environmental permits from the Finnish environmental authorities. The permits provide regulations and limit values for emissions into air and water as well as environmental monitoring.

The monitoring programme of the Harjavalta smelters includes:

- Regular follow-up studies in cooperation with other companies in the area
- Emission control carried out regularly on a daily, weekly or monthly basis.

Regular follow-up studies include: hydrological, bio-indicator and air quality studies. These are typically conducted by universities and research institutes.

Daily emission control includes the following programmes:

- Ambient air control
- Control of emissions to air
- Control of discharges into water
- Control of factory area groundwater
- Quality control of process slag
- Control of process slag storage areas

The laboratory at the Outokumpu smelter conducts daily emission control sampling and analyses. At the laboratory more than 18,000 analyses are performed and 3,800 hours are spent on monitoring the environment annually.

Local ambient air surveys

Local industry has conducted regular air quality surveys at Harjavalta for over 20 years. There are three permanent measuring stations situated from 0.2 to 1.4 kilometres from the industrial area. Sulphur dioxide content is recorded on-line at all the measuring stations, while particulate matter in ambient air is quantified at the nearest measuring station.

<u>Sulphur dioxide in ambient air</u>

The on-line sulphur dioxide measurements have determined that air quality has improved significantly in the Harjavalta area. The air quality is reported by measuring the second highest daily average (ug/m^3) as presented in Table 4. The ambient air quality is much better than the air quality limit value.

Table 4. Development of sulphur dioxide content (second highest daily average) in the ambient air at Harjavalta during 1991-2002.The limit value has been 80 μg/m^3 since 1997.

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
μg/m^3	84	72	60	59	29	15	17	13	17	21	19	17

The average sulphur dioxide content in 2002 was 4.3 μg/m^3 measured at a distance of only 200 meters from the plant area, and 2.5 μg/m^3 measured 1.4 kilometres from the plant area.

Particulate matter in ambient air

The measurements are conducted at a distance of only 200 meters from the plant area. Total suspended particles (TSP) and particulate matter (PM) smaller than 10 micrometers in aerodynamic diameter (PM_{10}) are measured.

These studies have shown that ambient air quality has improved considerably all through the 1990's. The copper content analysed from the particles has correspondingly fallen from the values measured in the early 1990's (Table 5). These results conform to the overall emissions development.

Table 5. TSP and PM_{10} measured 200 meters from the plant area in 1990, 1995 and 2000-2002.

	TSP µg/m³	PM10 µg/m³	Copper TSP µg/m³	Copper PM10 µg/m³
1990	31	19	0.8	0.2
1995	28	16	0.3	0.2
2000	19	7	0.23	0.08
2001	17	8	0.28	0.07
2002	17	9	0.19	0.04

The TSP annual average in 2002 was 17 $\mu g/m^3$ and the PM_{10} annual average was 9 $\mu g/m^3$. Since 1996 the air quality reference value has been 70 $\mu g/m^3$ for TSP and 50 $\mu g/m^3$ for PM_{10}.

Although the measuring point is situated very close to the industrial area the air quality is well below the reference value.

Local water quality surveys

The condition of the river Kokemäenjoki has been followed jointly by industry and the municipality.

Results of testing indicate that the quality of the river water was at its worst in the early 1970's, however this improved towards the end of the 1970's and the beginning of the 1980's. 1985 was a crucial time as operations at two pulp mills along the upper course of the river were closed down. This led to improved oxygen levels in the water and the image of the river as a refuse heap for the pulp and paper industry began to fade. The nutrient contents of the water have also decreased dramatically in comparison with the situation of the early 1970's.

At present oxygen levels in the river Kokemäenjoki are favourable and do not appear to be falling. The phosphorous content of the water has declined to less than half the level recorded at beginning of the 1970's. On average, the general quality of the river water is satisfactory.

Apart from the issue of decreased loads, another essential improvement has been in the recreational use of the river. The problems caused by the smell and taste of the pulp and paper industry's wastewaters have disappeared. The metal load is smaller and the mercury problem has been eliminated. Additionally, the impact of temporary discharges can be more easily discovered now that the quality of the water can generally be regarded as good.

Nationwide bio-monitoring surveys

The Forest Research Institute has conducted nationwide bio-monitoring studies in Finland. The survey of the atmospheric accumulation of metals was conducted by sampling mosses, lichens, pine bark and humus collected from permanent nationwide sampling areas every five years since 1985.

These studies reveal that during the survey period the copper load decreased in the areas surrounding Harjavalta in Finland's South Western point (Figure 10).

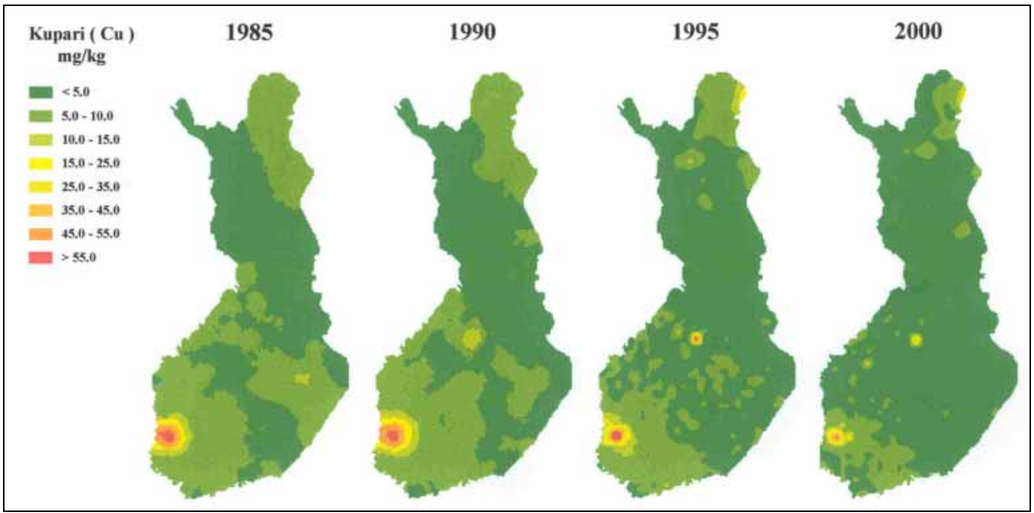


Figure 10. Copper accumulation in Finland 1985–2000; Kubin *et al*. (Finnish Forest Research Institute)

Finnish Pulp and Paper Industrial Hot Spots (Hot Spots No. 2, 11, 12, 13 and 16)

There were five pulp and paper industry Hot Spots in Finland:

- Oy Metsä-Botnia Ab Kemi pulp and paperboard mill (2)
- OY Metsä-Botnia Ab Joutseno Pulp mill (formerly YPT Joutseno) (11)
- UPM-Kymmene Oy Kaukas pulp and paper mill, Lappeenranta (12)
- Stora Enso pulp, paperboard and paper mill, Imatra (formerly E-G Kaukopää) (13)
- Sunila Oy pulp mill, Kotka (16).

The first four mills were removed from the list in 1994 and the last in 1997.

Environmental protection by the pulp and paper industry in Finland, 2001

During 2001 the output of the pulp and paper industry decreased compared to previous years. Output reached 4.6 million tonnes of mechanical and semi-mechanical pulp, 6.5 million tonnes of sulphate pulp, 9.9 million tonnes of paper and 2.6 million tonnes of board. Sulphate pulp production included 3.3 million tonnes of bleached soft-wood pulp and 2.6 million tonnes of bleached hard-wood pulp.

Efficient use of energy and raw materials
Pulp and paper mill raw material consumption amounted to 26 million cubic metres of Finnish wood and 10 million cubic metres of imported wood, plus another 11 million cubic metres of sawmill by-products (chips and sawdust). A total of 712,440 tonnes of recovered paper was also used in paper and board production. Consumption of minerals such as talc, calcium carbonate

and china clay, used as fillers and coating agents in the paper and board industry, reached approximately 3.8 million tonnes.

In 2001 the operation rate decreased from 95 % to 87 %. At the same time electricity consumption in the forest industry fell by 3 % from the previous year. Total consumption in 2001 reached 25.5 billion kilowatt hours, representing 59 per cent of consumption in the industry and 31 % of total national consumption.

Preliminary estimates of electricity consumption suggest some 10.4 billion kWh was generated in-house and 15.1 billion kWh procured externally. A considerable proportion of the latter came from energy companies in which the forestry companies are shareholders. Most in-house electricity was derived from wood, with outside power coming mainly from hydroelectric and nuclear plants.

As noted earlier, fuel consumption in the forestry industry in 2001 reached 256,000 TJ, down almost 3 % from the previous year. The industry's main fuel source is wood in the form of bark and chips and black liquor in the pulp industry, with wood constituting 71 % of the fuel consumed at forestry power plants. There was a slight decrease from the previous year in the consumption of oil and coal; consumption of peat remained constant, while consumption of natural gas increased.

Forestry companies have been actively involved in voluntary energy-saving measures based on an agreement between the Ministry of Trade and Industry and the Confederation of Finnish Industry and Employers. Energy surveys and analyses have been conducted at many mills to investigate and identify ways of saving energy as required by the agreement. A key element of the agreement is the monitoring of energy saving measures and the progress made in promoting energy efficiency. Companies that are party to the agreement report annually on their energy consumption and production, on steps taken to improve energy efficiency, and on the resulting energy savings.

The annual report on the energy saving agreement for Finnish industry was released at the end of 2001; the report was compiled by MOTIVA, the Information Centre for Energy Efficiency, in cooperation with the Ministry and the Confederation of Finnish Industry and Employers. According to the report, by the end of 2000 the agreement covered 97 % of electricity consumption in the forestry industry, compared to 77 % for industry as a whole. The approximate figures for fuel consumption were 99 and 92 % respectively.

Only summary information is available on the measures introduced to improve energy efficiency in all sectors of industry. The companies involved reported a total of 200 measures which have either been already implemented or approved for implementation. Annual savings from these measures will be in the region of 0.5 billion kilowatt hours for heat and fuel consumption, and over 0.26 billion kilowatt hours for electricity consumption.

Recovered paper

Recovered paper and board represents an important source of raw material for the paper industry. Its use in papermaking and board making has increased all over the world. In 2001 paper and board recovery in Finland amounted to739,000 tonnes (143 kg per capita), while the recovery rate was 74 %, an increase of 7 percentage points over the previous year. This is partly explained by a decrease in paper consumption in Finland. The average recovery rate world wide is around 40 %.

Only around one tenth of the paper and board produced in Finland is consumed in the country. This means that even with a very high recovery rate there is little chance of large quantities of recycled fibre becoming available for reprocessing in Finland. Indeed, the Finnish paper industry specializes in grades of paper which rely on a raw material which is in plentiful supply in Finland and its neighbouring regions: t- wood. In densely populated mainland Europe, the situation is different, and production by Finnish-owned mills in these countries is largely based on recycled fibre. Thus the Finnish forestry industry uses considerably more recycled fibre outside of Finland than is possible domestically.

During the course of the year, the Finnish paper industry used 83,290 tonnes of imported recovered paper, while a total of 100,300 tonnes was exported. The paper and board industry used nearly 713,000 tonnes of recovered paper as raw material, and recycled fibre accounted for 5.6 per cent of the fibre raw material used by the industry. The board industry used recycled corrugated board, board containers and other cardboard packaging in the production of cardboard. The board industry used 40 % of all recovered paper and board, with a further 36 % being used in newsprint production and 21 % in tissue products.

Environmental investments mostly for water protection

The forestry industry spent almost EUR 95 million in 2001 on environmental protection at pulp and paper mills in Finland, accounting for 8 % of all domestic investments by the pulp and paper industry, a slight decrease from the previous year.

Environmental investments were broken down as follows:

- water protection 66%
- waste management 16%
- air protection 13%
- other 5%

The bulk of investments focused on improving wastewater treatment plants. Plant capacity was expanded and efficiency improved by increasing aeration and purchasing new analysis equipment. Investments were also made to reduce water consumption and to better control water circulation in certain processes.

Air protection projects focused mainly on reducing smells. The filtering of malodorous air emissions was improved and measures were taken to ensure the reliability of filtering systems. Investments were also made to reduce noise levels.

As in previous years, the focus on waste management was on reducing landfill waste and improving waste sorting. Measures were taken to promote recycling, landfills on factory sites were reconditioned and a number of old landfills were landscaped.

Environmental protection also creates expenses other than investment costs for Finnish companies. Operating costs and other environmental expenses such as licence and water protection fees, the costs of discharge measurements, monitoring the condition of waterways and costs relating to the use of landfills totalled EUR 79 million in 2001. Forestry companies also paid out roughly EUR 100 million in energy and other environmental taxes during the course of the year.

Discharges into waterways

Total biological oxygen demand (BOD7) amounted to 14,956 tonnes and represents a 16 % drop in non-persistent organic pollutants compared to the previous year. Chemical oxygen demand (CODCr) measured 178,246 tonnes, down11 % from the previous year. 18,560 tonnes of suspended solids such as bark, fibres and residues from filling and coating materials was discharged into waterways, the same as the previous year. There was a slight increase of nutrients discharged into waterways. Phosphorus discharges reached 206 tonnes, a 2 % increase from the last year. There was also a 10 % increase in nitrogen, with discharges totalling approximately 2,673 tonnes. The chlorine compound load on waterways (AOX) averaged 0.16 kg per tonne of bleached pulp. Discharges of organic chlorine compounds were 949 tonnes, roughly 4 % less than the previous year.

Air emissions
In 2001sulphur emissions from sulphate pulp production totalled 3,580 tonnes S (elemental sulphur), an average of 0.6 kg S/tonne of pulp. Sulphur emissions were 72 % sulphur dioxide (SO_2) and 28 % total reduced sulphur compounds (TIRS). Sulphur dioxide emissions from chemical and semi-chemical pulp processes measured 2,560 tonnes, an increase of more than 20 % over the previous year. In contrast, there was a considerable reduction (42 %) in emissions of malodorous sulphur compounds. Apart from this, nitrogen oxide emissions due to pulp production decreased by 14 %, as well as particulate emissions,, which fell 27 % from the previous year. Airborne sulphur emissions from energy generation decreased by 11 % to 2,719 tonnes, while nitrogen oxide emissions fell by 10 %. Particulate emissions declined by 13 % to 1, 338 tonnes.

Data on carbon dioxide emissions from individual mills are based on fuels consumed and calculated using emission coefficients recommended by the Intergovernmental Panel on Climate Change (IPCC). CO_2 emissions from pulp and paper mills as a result of burning fossil fuels (oil, natural gas and coal) and peat totalled approximately 3.8 million tonnes. This represents a reduction of 28 % from the previous year. In addition to the emissions from the mills themselves, estimated CO_2 emissions from the generation of purchased electricity remained at the same level as previous years (2.6 million tonnes).

Waste
Landfill waste from pulp and paper mills declined slightly from the previous year, to 423,000 tonnes (dry weight). This consisted of the following substances:

- ash from energy generation 153,000 tonnes
- soda dregs and lime sludge 68,000 tonnes
- de-inking sludge 50,000 tonnes
- fibre and coating colour sludge 39,000 tonnes
- sludge from wastewater treatment plants 27,000 tonnes
- wood waste 22,000 tonnes
- non-recyclable waste paper 346 tonnes
- other waste (incl. household waste, metals, earth and stones) 63,000 tonnes

945 tonnes of hazardous waste was dispatched for final treatment and 1,926 tonnes for re-utilization (primarily the re-refinement of waste oils).Much of the waste generated by pulp and paper production can be used and should really not be referred to as waste at all. On average, some 85 % of this by-product is reused. The utilization rate for wood-based materials produced primarily as intermediate products in wood processing (bark, chips, sawdust, and building timber) was roughly 98 %. The recovery rate for paper and board in the mills was also excellent, with 99 % of it reused as raw material. More than 90 % of sludge from wastewater treatment was also used, in addition to over 70 % of fibre sludge. The lowest utilization rates (10 - 50 %) were for ash from energy generation, soda dregs, lime mud and de-inking sludge. Methods to improve the utilization of these wastes are currently being studied.

Environmental management systems as a means of promoting environmental protection
Many of the resources allocated to environmental protection at pulp and paper mills are currently being used to establish and develop environmental management systems. Environmental training for employees is a key element in setting up such systems. Environmental management systems are based on each company's environment policy, which is in turn formulated by the company's directors and sets out guidelines for their operations well into the future.

The company then begins the process of establishing its environmental management system by identifying environment-related aspects of its own activities and setting targets to reduce what it sees as the most significant adverse impacts on the environment. This work usually involves representatives from all personnel groups and as with quality systems, the key elements are written guidelines setting out issues such as the organization of environmental protection, job descriptions and related responsibilities, and procedures governing the main areas of environmental protection. Environmental considerations are also written into the instructions regulating work procedures where necessary.

To monitor the standard of environmental protection and to help maintain the system itself, a database is compiled with information such as statutory obligations, customer requirements, emission figures and any complaints by local residents. The documentation supporting the environmental management system ensures that the company complies with its published environment policy and continuously strives to improve its standard of environmental protection.

The obligation to conduct audits is an essential component of an environmental management system. Both the company itself and an external body conduct regular audits once or twice a year to ensure that the company's activities are in compliance with its environmental policy, guidelines and targets. Any deviations noted during such audits are recorded and corresponding remedial actions stipulated. A review is conducted during the next audit to monitor and ensure follow-up.

The environmental management system is also inspected by an independent body, which grants the company a certificate as proof that the system has been reviewed and approved. An environmental management system can only be successfully introduced if the company's directors are fully committed to its implementation. It is also a good way to educate the entire workforce about environmental issues and build their commitment to achieving the company’s environmental protection goals. The system, complete with its written documentation, also means that in the event of uncertainty, the prescribed procedure can easily be checked and verified.

Companies set up their environmental management systems to comply with the international standard ISO 14001. The European Communities' Eco Management and Audit Scheme (EMAS) supports voluntary environmental management and auditing by industry and also requires companies to make their environmental matters public. An industrial plant can be placed on the EMAS register if, in addition to an environment policy and an environmental management system, it also has a public environmental statement audited and verified by an independent body. This statement describes the plant's main environmental impacts and targets, and details proposed and implemented measures to reduce adverse impacts.

By April 1 2002, 42 pulp or paper mills had adopted a certified environmental system and 19 of these were also EMAS-registered (see table opposite). According to the survey conducted for this year's report, three mills are currently in the process of establishing an environmental management system and would also like to fulfill the EMAS requirements. There is also an environmental management system that targets energy and forestry operations.

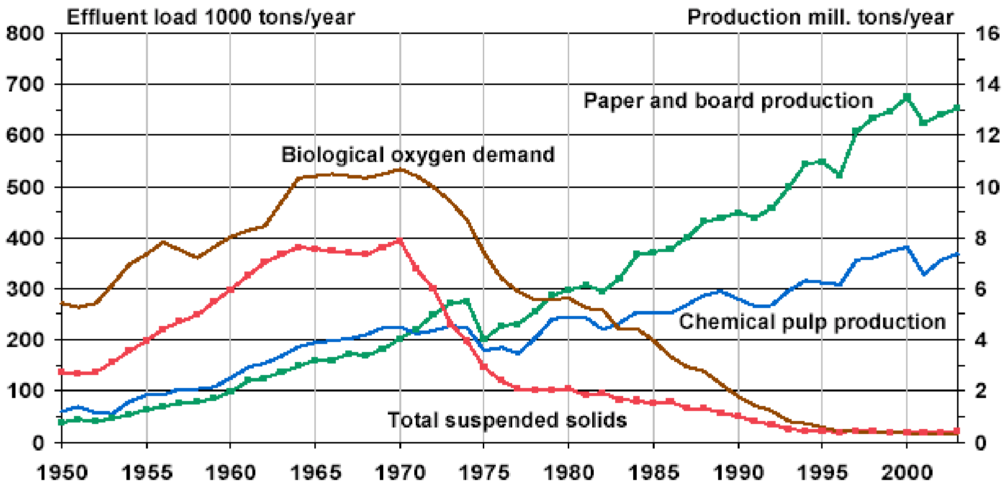


Figure 1. Production of the Pulp and Paper Industry in Finland and waste water load 1950-2003 (Source: Finnish Forest Industries Federation and Finnish Environmental Institute)

Wastewater discharges from the former Hot Spots

The wastewater discharges in 2001 were as follows:

Oy Metsä-Botnia Ab (Hot Spot No. 2)

	Discharges	Permit
Suspended solids	748 t/a	
BOD7	252 t/a	4 t/d
CODCr	12 406 t/a	50 t/d
AOX	0,18 kg/t	0,35 t/d
P	8 t/a	70 kg/d
N	145 t/a	0,65 t/d

Oy Metsä-Botnia Ab (Hot Spot No. 11)

	Discharges *)	Permit **)
Suspended solids	274 t/a	
BOD7	165 t/a	3 t/d
CODCr	9 032 t/a	50 t/d
AOX	0,24 kg/t	0,35 t/d
P	10,3 t/a	50 kg/d
N	92 t/a	

*) also includes discharges from M-real Oy's BCTMP mill
**) new permit entered into force December 1, 2001

UPM-Kymmene Oy (Hot Spot No. 12)

	Discharges	Permit
Suspended solids	997 t/a	
BOD7	755 t/a	5 t/d
CODCr	14 106 t/a	65 t/d
AOX	0,16 kg/t	0,5 t/d
P	8,1 t/a	35 kg/d
N	247 t/a	

Stora Enso (Hot Spot No. 13)

	Discharges	Permit
Suspended solids	2 108 t/a	
BOD7	2 778 t/a	13 t/d
CODCr	19 388 t/a	110 t/d
AOX	0,26 kg/t	0,85 t/d
P	16 t/a	100 kg/d
N	233 t/a	

Sunila Oy (Hot Spot No. 16)

	Discharges	Permit
Suspended solids	348 t/a	
BOD7	188 t/a	2 t/d
CODCr	6 507 t/a	25 t/d
AOX	0,2 kg/t	0,5 t/d
P	8,9 t/a	35 kg/d
N	35 t/a	

Kemira Oy Vuorikemia (Hot Spot No. 8)

Kemira Pigments Oy (former Kemira Oy Vuorikemia) was deleted as a Hot Spot in 1998.

In Finland the manufacture of titanium dioxide in the 1950s and 1960s was originally based on two "waste flows", the ilmenite by-product from mining and an excess of sulphuric acid raw materials. Quite soon water pollution problems developed. Nearly everywhere in the world, the discharges and waste acids from the sulphate process led to a wide public debate in which environmental organizations had an active voice. This resulted in exceptionally large environmental investments, with a gradual toughening of related legislation, one example of which was the European Union's titanium dioxide directive.

Production method and co-products

There are two methods of producing titanium oxide, the sulphate process and the chloride technique. Both consist of a number of technologically demanding stages and raise different challenges for environmental management. The sulphate method entails the use of rather large quantities of co-products and treatment of spent sulphuric acid. The major raw materials of the sulphate process are ilmenite ore – which contains titanium and iron – and sulphuric acid. Finely-ground feed stock is first digested in concentrated sulphuric acid in a strong reaction which turns the titanium into soluble titanium sulphate. Following purification, the iron is separated out as green ferrous sulphate crystals. Titanium oxide hydrate is then precipitated and calcined to form crystalline titanium dioxide pigments.

Kemira´s Pori plant was the first titanium dioxide producer to achieve the globally recognized ISO 9001 quality standard in 1992. At this plant ferrous sulphate is crystallized as a saleable co-product. Ferrous sulphate is used in the purification of municipal waste water and can be further processed into ferric sulphate to be used in the purification of drinking water. Ferrous sulphate is also used as a raw material in the production of colour pigments, for magnetizing video tapes, as a chromate-reducing cement additive and in cattle feed.

Co-product gypsum from waste water purification has successfully been used as a solidifying agent in road construction. It can also be used to reinforce dredging sludges. Another co-product binds more than 90% of phosphorus and is especially suitable for the removal of phosphorus from waste water in sparsely-populated areas with no public sewage systems.

Applying the life cycle analysis (LCA) technique to co-products it is possible to allocate the input and output flows according to material flow or commercial value. The titanium dioxide industry has agreed that inputs and outputs should not be split between titanium dioxide and the co-products, but charged to the titanium dioxide process only. Kemira Pigments has provided inventory data on raw materials, energy, transport, packing, emissions and effluents to customers and researchers conducting LCA studies on their products. Internal use of LCA as a product development tool has also been initiated.

Environmental Strategy

In the 1980s Kemira Pigments adopted the strategy of positioning itself at the forefront of environmental matters in the titanium dioxide industry. The implementation of the long-term environmental investment programme at the Pori plant and the development of a final solution to water pollution have therefore been important for the entire Kemira Group.

Operations at the Kemira Pori plant are committed to the manufacture and supply of products so that no hazard, harm or damage is caused to people, the environment or property. Kemira is continuously investing in environmental protection and total investments in this area between 1980 and 2001 have reached EUR 98.5 million. Milestones in environmental protection at the Pori plant during the recent years include: (a) ISO 14001 environmental certification in 1996, (b) new wastewater treatment plant in 1997, and (c) environmental award from the City of Pori in 1999.

Because there is no special HELCOM Recommendation on the titanium dioxide industry, comparison of the pollution load from the Pori plant is made with HELCOM Recommendation no. 23/11 on requirements for discharges of wastewater from the chemical industry as well as with the EU Directive 92/112/EEC. The figures in table 1 indicate that the loads in 2001 were clearly under the limit values.

Table 1. Kemira Pigments Oy discharges compared with HELCOM Recommendation 23/11 of 6 March 2002 and EU Directive 92/112/EEC.

HELCOM Recommendation 23/11		Kemira Pigments Oy, Pori (2001)		EU Directive 92/112/EEC	Kemira Pigments Oy, Pori (2001)
mg/l		Waste water (mg/l)	Cooling water (mg/l)	Weak waste acid < 0.5%	0%
Hg	0.05	< 0.00005	< 0.00005	SO4 < 800 kg/t TiO2	229 kg/t TiO2
Cd	0.2	< 0.0005	< 0.0005	SO2 < 10 kg/t TiO2	4.8 kg/t TiO2
Cu	0.5	< 0.01	< 0.01		
Ni	1.0	0.14	n.a.		
Pb	0.5	< 0.01	n.a.		
Cr	0.5	< 0.01	0.01		
Zn	2.0	0.005	0.02		

Ferrous discharges since 1998 have been only parts per mille compared to the early 1990s as illustrated below. At the same time, sulphate discharges have decreased to levels below 20 % of 1990 figures.

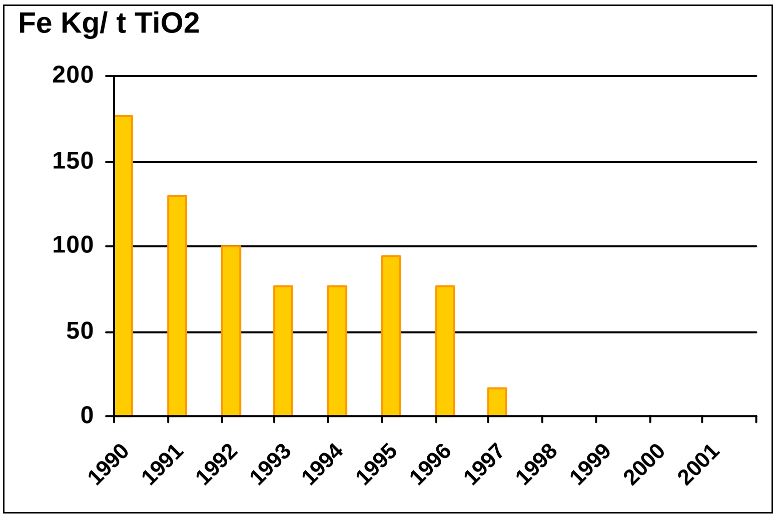


Figure 1. Ferrous (Fe) discharges from Kemira Pigments Oy (1990-2001). Since 1998 the discharges have been less than 0.03 kg/t TiO2

Agriculture and aquaculture in Finland

Fish farming (Hot Spot No. 9)

Background

Fish farming in the Archipelago Sea and the Åland Sea was included in the list of HELCOM Hot Spots in 1992 on the basis of considerable nutrient discharges (,i.e. phosphorus and nitrogen) although the environmental effects were visible only at the local level.

In March 1997 "Measures aimed at the Reduction of Discharges from Marine Fish Farming" was adopted as HELCOM Recommendation 18/3. One of the operative actions stipulates that "Nutrient discharges from fish farms should not exceed the annual average of 8 g phosphorus (tot-P) and 70 g nitrogen (tot-N) per fish (living weight) produced.

The general targets for water protection in Finland have been set by the Water Protection Target and Action with current objectives covering the period 1998-2005. In these Programmes the target for fish farming is to reduce nutrient load (phosphorus and nitrogen) by 30 % from the 1993 level by 2005 in the Archipelago Sea and the Åland Sea. In addition, specific nutrient discharges should not exceed 7 g P and 44 g N per fish (living weight) produced by the end of the Programme's implementation period. In 1997 the Government of Åland set the targets for water pollution from fish farming in the Åland Sea so that by 2005 phosphorous and nitrogen should be reduced from their 1996 levels by 30% and 20% respectively.

Measures to Reduce Nutrient Loads from Fish Farming

In recent years, the following measures have been taken to reduce nutrient discharges from fish farming in the Archipelago Sea:

- Permits: Fish farming is regulated by environmental permits which define the nutrient discharges of individual farms by limiting the annual total nutrient contents of fish feed. The Water Protection Target and Action Programmes 1998-2005 and local environmental conditions have provided the basis for granting the permit. The permits need to be renewed every 5-7 years, allowing the effects of farming and current BAT to be considered when re-issuing the permit.

- Improvement in feeds and feeding: Much of the reduction in the nutrient discharges from fish farming has been achieved by better quality fish feed and improved feeding practices. The fish utilize the nutrients in the feed better and modern feeding equipment responds more precisely to the appetites of the fish. As a result the specific nutrient load of fish farming has been reduced.

- Research: Considerable inputs (EUR 3.0 million) have been invested in research for developing more environmentally beneficial systems and practices in fish farming and in better understanding the processes involved. This research is ongoing and is expected to help further reduce the nutrient load and its effect on the water bodies.

Present Situation

Data for fish production and its associated loads as well as the specific discharges in the Archipelago and Åland seas are presented in Tables 1 and 2.

Table 1. Fish farming and nutrient loads in the Archipelago and Åland Seas in 2000 and 2001

Year	No of farms 2000	No of farms 2001	Production (t/a) 2000	Production (t/a) 2001	Load (t P/a) 2000	Load (t P/a) 2001	Load (t N/a) 2000	Load (t N/a) 2001
Åland Sea	45	45	5743	5300	36.0	34.0	305	277
Archipelago Sea	87	84	4553	4020	35.4	32.2	274	251
Total	132	129	10296	9320	71.4	66.2	579	528

Table 2. Specific nutrient discharges in 2000 and 2001

Year	P g/kg of living fish 2000	P g/kg of living fish 2001	N g/kg of living fish 2000	N g/kg of living fish 2001
Åland Sea	6.3	6.3	53.1	52.0
Archipelago Sea	7.8	8.0	60.2	62.4
Weighted average	6.9	7.1	56.2	56.7
Arithmetic average	7.05	7.15	56.7	57.2

The total nutrient discharge is now already below the 2005 target and the specific discharge is clearly lower than the HELCOM Recommendation in both the Archipelago and Åland Seas.

Between 1987 and 2001, phosphorous has fallen by 60% and nitrogen by 51% in Åland. The specific nitrogen discharge has been lower than the HELCOM Recommendation limits since the beginning of the 1990's and the phosphorus discharge since 1996 (Table 3).

Table 3. Production of fish and loads of nutrients from fish farming in Åland in 1987-2001

Year	1987	1989	1991	1993	1994	1996	1998	1999	2000	2001
Production t/year	3000	7000	5000	5000	4700	5200	5000	5270	5740	5300
Loads:										
Phosphorus t/year	42	84	55	50	41	42	36	34	36	34
Nitrogen t/year	240	560	350	320	273	302	275	270	305	277
Specific discharges:										
Phosphorus g/kg live fish	14	12	11	10	8,8	8	7,2	6,4	6,3	6,3
Nitrogen g/kg live fish	80	80	70	65	58	58	55	53	53	52

The contribution of local pollution sources to nutrient loads in the Archipelago Sea in 1991-2000 is shown in Tables 4 and 5.

Table 4. Average nutrient load of Åland in 1991-2001

Pollution source	Phosphorus (t P/a)	Nitrogen (t N/a)
Diffuse load	15.2	216
Fish farming	40.5	300
Municipalities and industry	5.5	95
Deposition	39	1700
Total	100.2	2311

Table 5. Average nutrient load in the Archipelago Sea in 1991-2000

Pollution source	Phosphorus (t P/a)	Nitrogen (t N/a)
Diffuse load	457	5441
Fish farming	45.6	332
Municipalities and industry	23.4	970
Deposition	80	4800
Total	606	11543

Condition of the Archipelago Sea and the Effects of Fish Farming

The condition of the Archipelago and Åland Seas is generally good, best in the outer areas but only satisfactory near the Finnish coast. Even though the total nutrient load in the last decade has decreased considerably, eutrophication has continued and spread to the middle and outer parts of the seas. The reasons for this are not fully known, but the general increase in the nutrient content of the Baltic Sea and the internal upwelling of nutrients from seabed sediments may be contributing factors.

The fact is that the majority of the total load, about 87 %, comes from diffuse sources such as agriculture, forestry and rural housing. The nutrient discharges from fish farming contributed 9 % of total local phosphorus discharges and 5 %f the total local nitrogen discharges in the Archipelago Sea during 1991-2000. It should be noted that it is estimated that about half of the nutrients in the Archipelago Sea originate from the Gulf of Finland and from the Baltic Proper.

In the Åland Sea, where other local discharges are small, fish farming is the largest local source of nutrients in the sea. Approximately two-thirds of local phosphorus loads and half of local nitrogen loads came from fish farming during 1991-2001.

This Hot Spot was removed from the List of Hot Spots in 2002.

Further development

In spite of the fact that this Hot Spot fulfils the criteria for deletion in terms of implementation of HELCOM Recommendation 18/3 and the use of best available technology, it does not mean that further remediation measures are not justified. Complete implementation of the Water Protection Target and Action Programmes 2005 as well as full implementation of the Action Programme for the Protection of the Baltic Sea is still required.

Agriculture (Hot Spot No. 10)

Background

Agriculture in the catchment area of the Archipelago Sea was included on the list of HELCOM Hot Spots in 1992.

Water protection measures pertaining to agriculture are included in the 1992 Helsinki Convention, the corresponding HELCOM Recommendations and the Ministerial Declaration of 1988. National targets are set and protective measures defined in the Water Protection Target Programme 1998-2005, which aims at a 50 % reduction in the nutrient discharge from agriculture.

The catchment area of the Archipelago Sea comprises roughly 500,000 hectares, of which 230,000 hectares are cultivated by 6,500 farms. Approximately 500 farms engage in animal husbandry, where there has been a movement away from cattle farming towards pig and poultry farming. The general trend has been towards larger and fewer units and this trend is continuing.

Measures to Reduce the Nutrient Load from Agriculture

Measures before 1995

Activities to improve water protection in agriculture began as early as the 1980's, when the emphasis was placed on animal husbandry, particularly manure handling. Protection methods included extension and planning support for farmers and financial support to improve manure handling facilities. Additionally, fertilisers and pesticides were subjected to a special environmental tax.

Measures 1995-1999

Following EU membership many of the environmental protection measures in agriculture were implemented through the Finnish Agri-Environmental Programme (FAEP), where the emphasis is on water protection.

In the Archipelago Sea catchment area farms covering 98 % of the area joined the Programme and assumed certain obligations, e.g. to reduce the use of fertilisers and pesticides and to establish buffer strips along main ditches and water courses. The supplementary scheme also gave farmers the option to implement additional measures for water protection and other environmental improvements.

Present situation

The main national results of water protection measures relating to agriculture are the reduction of nutrient levels in soils and a decrease in erosion. The effects of remedial measures on water courses are slow to be seen and real results take time to be realised, even if the measures themselves have been effective and have covered the majority of the catchment area. This essentially means that the reduction of nutrient discharges from agriculture has not yet developed as expected, and it is therefore not anticipated that the 50 % reduction target can be reached by 2005.

This is also the case in the catchment area of the Archipelago Sea where exceptionally high precipitation has had an additional negative impact on erosion and consequently on nutrient discharges from farmlands.

One of the more positive results has been the drastic decrease in discharges from animal husbandry. Construction of sufficient manure storage facilities and a ban on spreading manure in winter have been the main factors contributing to this development.

Measures during 2000-2006

The Finnish Agri-Environmental Programme (FAEP) will continue until 2006 and its scope will remain similar to that of the earlier programme.

Besides FAEP, certain legislative measures have been taken which will have the effect of reducing nutrient discharges from agriculture:

- The Nitrate Directive became effective in 2000 and will reduce the use of nitrates in farming

- New environmental legislation became effective in 2000, extending the issuing of environmental permits to large- and medium-sized animal husbandry units

In April 2002 the Government of Finland approved the so-called "Baltic Sea Programme", which defines the Finnish agenda for protection and improvement of the Baltic Sea during the next 15-20 years. That Programme and its implementation plan place great emphasis on the reduction of nutrient discharges from agriculture into the Baltic Sea. It is expected that funding of the FAEP will be guaranteed on the basis of this Programme. As the most intensively cultivated area in Finland the Archipelago Sea catchment area will be the main beneficiary of this programme.

In light of these developments, strong water protection measures will be implemented in the Archipelago Sea catchment area in the future and it is expected that the effects of lower nutrient levels in soils, decreased erosion, and increased coverage of buffer zones will gradually result in clear reductions of nutrient discharges into the water bodies.

Part C: Denmark

Denmark has four Hot Spots listed as part of the Baltic Sea Joint Comprehensive Action Programme. One of these Hot Spots (No. 123/ Copenhagen) has been deleted. The remaining Hot Spots (No. 122, 124 and 129) are agricultural Hot Spots and these were discussed at the workshop.

Danish agriculture is very intensive and is dominated by livestock production. One of the main problems resulting from agricultural activity is the loss of nitrogen through nitrate leaching into the aquatic environment. Several Action Plans - the first adopted in 1985 and the latest in 1998 - aim to implement the EU Nitrate Directive. When the action plans from 1991 and 1998 are fully implemented (by 2003) a 50% reduction of the loss of nitrate from agriculture is expected.

The Danish Code of Good Agricultural Practice is implemented in current legislation and comprises many of the measures outlined in the action programme. Farmers are informed and codes promoted by detailed guideline material communicated annually through local advisory service centres.

Good Agricultural Practice reflects the minimum protective requirements at the environmental level,,and essentially means observing the common Danish rules on environment, hygiene and animal welfare laid down in other legislation. The legislation encompasses several Statutory Orders and Acts.

The regulations stipulate the use of nitrogen quotas at the farm level, and nitrogen norms for crops and fertilizer accounts. Additionally, the excess application of nitrogen on farms is notified or fined according to fixed schemes.

Statistics for the period 1997/98, based on 43,847 fertilizer accounts, reveal that average usage for both livestock holdings and holdings with no livestock is 149 kg N/ha. Assuming that livestock manure is utilised on the basis of minimum demands, the average application of nitrogen per hectare is 130 kg N.

The general picture regarding nutrient loads and reductions is that during the late1980s and up to 1995 a 32% reduction in nitrogen discharges and a 13% reduction in phosphorus discharges from agriculture have been achieved.

The Danish nitrate policy

Summary
Widespread livestock production in Denmark has led to high levels of nitrate leaching from the agricultural sector into the aquatic environment. In the mid-80s the Danish government agreed on an Action Programme to reduce the loss of nutrients into surface water and ground water. The Action Programme has been revised regularly since 1985 with major steps taken in 1987, 1991 and 1998. A political discussion of the possibilities for further development will take place in 2004.

In implementing the Action Programme Denmark fulfils the EU Directive on the protection of waters against pollution caused by nitrates from agricultural sources (the Nitrates Directive 91/676/EEC).

Codes of Good Agricultural Practice with respect to fertilisation and the managing of nitrates are included in the present legislation and promoted in guideline material communicated to farmers through the farmers' advisory service. The legislation encompasses detailed regulations governing livestock housing, proximity to watercourses, spreading manure, plant cover,

livestock density, contracts for manure, farm nitrogen quotas, stipulated norms, utilisation requirements, fertiliser planning and accounting.

Apart from general regulations, there are several EU-subsidised programmes to encourage farmers to adopt environmentally friendly production methods.

Competent authorities inspect each farmer's total use of nitrogen fertiliser annually, and inspections are conducted as administrative appraisals for each of the roughly 65,000 holdings, as well as in random site visits.

Introduction

Because agricultural activity in Denmark is so widespread and livestock production is prevalent, one of the main environmental issues in Danish agriculture is the loss of nitrogen through nitrate leaching. This intensive agricultural production has led to high levels of nitrate leaching into the aquatic environment.

The total Danish land area measures 4.5 million hectares and arable land covers 2.7 million hectares, or more than half of the national territory.

• National territory	4.5 million hectares
• Agricultural area	2.7 million hectares
• Number of agricultural holdings	65,000 holdings
• Number of livestock holdings	30,000 holdings
• Annual production of pigs for slaughter	23 million pigs for slaughter
• Annual milk production	4.5 bn. kg milk

In Denmark there are approximately 65,000 agricultural holdings and roughly 30,000 of these are livestock concerns. Less than half of all the Danish agricultural holdings are full-time farmsteads.

Livestock production varies and the main products are milk, butter, cheese, beef, pork, poultry meat, eggs and mink pelts. Denmark produces some 23 million pigs for slaughter and 4.5 bn. kg of milk annually.

The loss of nitrate through leaching from arable land as a result of the intensive agricultural production is an important factor affecting the environment. In Denmark, nitrate leaching mainly causes problems in regard to ground water and in fjords, coastal waters and the open sea. In streams and lakes phosphorus is the main problem.

Nitrate pollution is reflected in severe algal growth in fjords and coastal waters. Occasionally during the summer months, this can cause a lack of oxygen and fish kills have occurred as a result. In ground water, nitrate leaching has led to a nitrate concentration higher than 50 mg NO_3 per litre in some drillings.

Improvement of the quality of the surface water and ground water has consequently been a high priority for the Danish Government for the last 15 years. Lakes, streams, fjords and coastal waters are important elements in the Danish natural environment, and nutrient losses from Danish agricultural production have a significant impact on the marine environment in the Baltic and the North Sea.

In Denmark non-purified ground water is used as drinking water, and is the only source of drinking water. There is no tradition of treating the ground water apart from straining it through sand filters.

The Danish Nitrate Programme
The action plans relevant to the Danish aquatic environment sector include:

- The NPO Action Plan of 1985
- The Action Plan for the Aquatic Environment of 1987
- The Action Plan for a Sustainable Development in Agriculture of 1991
- The Action Plan for the Aquatic Environment II of 1998

The NPO Action Plan of 1985, the Action Plan for the Aquatic Environment of 1987 and the Action Plan for Sustainable Development in Agriculture of 1991 meant that in effect, Danish implementation of the EU Nitrates Directive (91/676/EEC) began almost prior to the issue of the directive itself.

The action plans of 1985 and 1987 focused on reducing nutrient pollution from industrial wastewater, sewage from urban areas and the agricultural sector. The goals relating to wastewater and sewage were achieved following the implementation of the Aquatic Action Plan of 1987. But to achieve the goal of reducing nitrate losses from the agricultural sector by 50 %, the action plans of 1991 and 1998 were carried out.

By implementing the four action plans Denmark has fulfilled the requirements of the Nitrates Directive.

By the end of 2003 Danish research institutes (NERI and DIAS) would have conducted a scientific evaluation of the implementation of the action programme. If the results of evaluation shows that the reduction goals have not been reached then further initiatives will have to be developed.

Additionally, technical working groups appointed by the Danish government are reviewing the possibilities for development of a third generation Action Programme. The main focus will be development of the general regulations, management of losses of phosphorus and the possibility of a more regional regulatory model. A political discussion of the results of the working groups' findings is to take place in 2004.

Code of Good Agricultural Practice
The Danish code of good agricultural practice also includes the same set of measures contained in the Danish Action Programme, and is implemented in the current legislation. This means that all farmers in Denmark must operate according to the requirements of Good Agricultural Practice.

Farmers are informed and codes promoted using detailed guideline materials sent annually through the local advisory service centres. The Danish Advisory Agricultural Centre offers extensive information services and assists individual farmers in areas such as preparation of crop rotation, fertilisation plans, status accounts on the use of nitrogen fertiliser and calculation of sufficient storage capacity.

Students also learn about sound agricultural practice during apprenticeship programmes with farmers. Follow-on courses are also available after training programmes but are not widespread because information about the Code forms part of the basic training.

Good agricultural practice reflects the minimum requirements for ensuring environmental balance in Danish agriculture. It involves observing the common Danish rules relating to environmental protection, hygiene and animal welfare, which have been laid down in other legislation. As the code of good agricultural practice with respect to fertilisation and managing of nitrates is enforced by law, it is assumed that 100 % of Danish farmers adhere to the Code of Good Practice.

The relevant legislation includes:

- Statutory order on Professional Livestock, Livestock Manure, Silage etc. Ministry of Environment
- Act on the agricultural sector's use of fertilisers and of green fields. Ministry of Food, Agriculture and Fisheries.
- The statutory order on the agricultural sector's use of fertilisers and of green fields. Ministry of Food, Agriculture and Fisheries.
- Statutory order on application of waste products for agricultural purposes. Ministry of Environment.

General Regulations

Requirements for livestock houses and similar facilities

Livestock houses, outdoors runs, dung pits etc. must be designed in such a way that ground water and surface water is not polluted. In practice, this means that there should be a solid bottom and waste pipes.

Liquid manure, run-off from dung pits and silage seepage have to be collected.

In certain situations compost may be stored in field clamps. This applies to compost containing more than 30 % dry matter. Such field clamps have to be covered with either straw or plastic in order to prevent water from percolating through them.

Capacity, construction and inspection of manure storage

Storage capacity must be sufficient to ensure that application of manure takes place in accordance with the provisions for field application. At absolute minimum, storage capacity should be sufficient for to 6 months' production and in general 9 months, but most farmers provide for capacity of 10 months production or even more.

Tanks for liquid manure have to be covered with a tight floating layer or another type of tight cover. Dung pits must be laid out so that run-off from the pit is directed to and collected in a tank. Surface water from surrounding areas and from roof surfaces should not be allowed to run into the dung pit.

The user of a storage facility for liquid manure, silage effluent or wastewater is responsible for having the facility inspected every tenth year for strength and tightness. The farmer covers the expense of this inspection, which should be conducted by an expert.

Proximity to watercourses

Livestock houses and similar livestock facilities and open stores for farmyard manure must be placed at least:

- 50 m from the common water catchment facility,
- 25 m from single water catchment facility,
- 15 m from streams (including drains) and lakes.

Spreading of livestock manure

Livestock manure and silage effluent applied to the soil must be used only for fertilising purposes, so manure should be applied only in agricultural areas. Livestock manure must be applied in such a way that the crops can utilise the nutrient content. The manure must not be spread in such a way or in an area where it creates a risk of run-off to lakes, streams or drains in heavy showers.

From harvest time to 1 February it is not permitted to spread liquid manure, except for the period from harvest time to 1st October in over-wintering grassland crops or areas to be cropped with winter rape the following winter.

During the period from harvest time to 20 October it is not permitted to spread solid manure, except on areas to be covered by crops the following winter.

Application of livestock manure can only be carried out by means of trailing shoe or direct injection. Manure applied to areas without vegetation shall be ploughed into the soil without delay, and within 6 hours after application.

Green cover
One of the preconditions for effective nutrient management is to prevent nitrogen from leaching from the soil after harvest. On individual farms, there must be green cover during the autumn covering a minimum of 65 % of the cultivated or set-aside areas.

Grass, seed and catch crops are not considered cover crops in the autumn if they are ploughed in before 20 October.

It is possible to transfer the demand for green cover to another farm within a radius of 5 km.

6 % catch crops
Apart from the 65 % area with green cover an additional 6 % of the farming area must be sown with genuine catch crops such as seed crops or under-sown grass (not clover), grain and grass sown after harvest but before 1st August or cruciferous crops sown before 20 August.

Catch crops must not be ploughed before 20 October and a spring-sown crop must follow them.

Livestock density
The rule stipulates a maximum number of animals (LU) per hectare on a farm. The cultivated area of a farm, which requires manure, is included in the statement of area relative to the size of herd. Areas not requiring manure and areas where farmyard manure may not be spread under normal conditions are excluded.

This rule is called the "harmony criteria" in Denmark. The "harmony criteria" is an expression of the maximum amount of livestock manure that may be applied per hectare annually and hence is an expression of how much nitrogen may be applied per hectare annually.

As at 1 August 2002 the harmony criteria are:

Type of livestock holding	**Harmony criteria**
Cattle holdings in general	1,7 LU*) per hectare per year
Cattle holdings with more than 70% grass, grass catch crops and beet	2,3 LU per hectare per year
Al other livestock holdings	1,4 LU per hectare per year

*) One livestock unit (LU) equals 100 kg N ex storage

Written arrangement on livestock manure
If a herd is too large in relation to the available land, written agreements have to be available to ensure that surplus livestock manure can be transferred to, disposed of and utilised on other farms or in biogas plants.

Nitrogen quota on farm level
The nitrogen quota for individual farms sets the maximum level of nitrogen fertiliser the farmer is allowed to apply on his fields. For a given livestock holding this upper limit remains constant, and is not dependent on whether the harmony criteria is 1,7 LU per hectare or 1,4 LU per hectare. The nitrogen quota limits the application of nitrogen fertiliser regardless of whether the fertiliser is livestock manure or chemical fertiliser.

The farm quota is calculated using the obligatory nitrogen standards for individual crops and the number of hectares under cultivation with the different crops; the total is then calculated for the entire farm.. The farmer is required to do these calculations before the start of each season.

Standards for nitrogen demand for crops
Nitrogen standards or norms for crops are stipulated each year and are based on a number of fertilisation trials. The tradition of fertilisation trials has a long history in Danish agriculture, having occurred throughout the country since the 70s. In general a fertilisation trial is conducted annually for each 20,000 hectares of arable land. This means that information about different crops' nitrogen demands in Danish agriculture is well established and rather detailed.

The nitrogen norms are stipulated on the basis of the type of crop, the soil type, the amount of rainfall (Denmark is typically divided into 2 or 3 precipitation regions) and if the farmer has access to irrigation. Furthermore, the norms are stipulated at levels that are 10 % lower than the economic nitrogen fertilisation level. As a result, the upper limit of nitrogen fertilisation at farm level - the farm's nitrogen quota - is 10 % below the economic optimum.

Standards for nitrogen content in manure
Values for nitrogen content in manure are stipulated for types of animal as a function of the nature of the stable and storage facilities. The norms are based on Danish research results. The farmer is obliged to use these standards when calculating the nitrogen content of the manure produced on the farm.

In Denmark, there is a voluntary development towards more efficient protein feeding of livestock. The use of protein per kg of pig or poultry meat produced has been reduced by adjusting the amino acid composition of the diet to the needs of the animals.

Minimum requirements for the utilisation of nitrogen in manure
The rules also stipulate minimum requirements for the utilisation of nitrogen content in the applied livestock manure:

Type of manure	**Minimum requirements for utilisation**
Pig slurry	75 pct.
Cattle slurry	70 pct.
Other types of manure	65 pct.

The utilisation requirements take into account both first year and prior year utilisation.

Fertilisation plans and spreading records
To monitor the use of fertiliser there is an annual obligation for all Danish farmers to draw up crop rotation and fertiliser plans as well as fertiliser accounts. Use of the crop rotation and fertiliser plans are obligatory when calculating the quota of nitrogen fertiliser.

Fertiliser accounts
After the harvest the fertiliser accounts are submitted to the competent authorities for inspection. The authorities have access to information on the delivery of milk, animals for slaughter and on the sale of chemical fertiliser to each farmer. The authorities responsible for inspecting fertiliser accounts use this information, and farmers found to have used nitrogen fertiliser excessively are fined.

Nitrogen tax
Nitrogen fertiliser used for purposes other than agriculture and fruit and vegetable production, such as for private gardens and public parks, is subject to taxation.

Voluntary instruments
Apart from the general obligatory regulations, there are several programmes to encourage farmers to adopt environmentally friendly production methods. These programmes offer financial support and include:

- *Investment in farms*. On condition that the farm meets the minimum requirements relating to environment, hygiene and animal welfare.

- *Establishing young farmers*. Establishment support for young farmers is given only if the farm meets the minimum requirements relating to environment, hygiene and animal welfare.

- *In-service training*. Gives farmers information to restructure their production, and to use production methods which are consistent with the requirement for landscape conservation and improvement, environmental protection and hygiene and animal welfare standards. Gives farmers qualifications needed for operating an economically viable farm.

- *Settlement support in unfavourable areas* is offered to farmers who in accordance with good agricultural practice employ farming methods that are consistent with environmental protection and conservation of nature, especially in the form of sustainable farming.

- *Environmental friendly farming*. A duty to operate an environmentally friendly farm involves more than good agricultural practice. The lost income and the extra costs the duty involves are calculated and compared on a reference level. The reference level is good agricultural practice in the area where the arrangement is offered.

- *In the support for small islands (unfavourable areas)*. Environmentally friendly farming in good agricultural practice is defined as farming methods that are consistent with environmental protection and nature conservation, especially in the form of sustainable farming in relation to the environment, hygiene and animal welfare.

Inspection system and administration

By 1 September every year, a compulsory annual cycle of planning for and registration of the use of nitrogen starts. Farmers have to make a written crop rotation plan describing the composition of crops they plan to establish. The crop rotation plan must include a definition of the planting areas and associated crops that meet the requirements for green crops and catch crops. By 1 March, just before the season starts, the plan must be further developed to include information about the expected addition of livestock manure and commercial fertilisers.

In an annual publication, which is sent by mail to each farmer, the competent authorities inform farmers about nitrogen standards for crops and standards for nitrogen content in manure. On the basis of this information, the farmer must calculate the farm's nitrogen quota and the quantity of nitrogen in livestock manure that has to be utilised.

Each year by 31 March, after the growth season has passed, an annual fertiliser account containing key figures on the use of nitrogen and the farm's nitrogen quota is submitted to the competent authorities for registration and inspection. All Danish farmers submit an annual fertiliser account to the authorities.

The fertiliser account is prepared using a formula that is sent to each farmer. Individualised information about the farmer’s purchase of fertilisers, reported to the competent authorities by the dealers, and information about the amount of manure transferred from the previous period are given figures. The fertiliser account includes information about the quantity and type of manure that has been produced and transferred as well as the amount that is stored. The calculated nitrogen quota is also stated in the formula. Similarly the use and storage of commercial fertilisers and other sources of nitrogen such as sludge are included in the fertiliser account formula. Other key figures include the size of the farm, the areas with green cover and catch crops, the number of livestock units and a calculation of livestock density on the farm.

If manure is transferred to other farms a signed confirmation from the receiving farmer has to be provided with the account. It is possible to monitor the transfer of livestock manure by cross checking the amount of nitrogen sold and correspondingly received as manure, sludge or other sources of nitrogen.

All of the estimated 65,000 fertiliser accounts submitted to the competent authorities are inspected by computer analysis. On the basis of the analysis 2,000 farms are selected for a detailed site inspection and roughly another 16,000 accounts are subject to closer administrative scrutiny. The information in the account is compared to other available information regarding the size of the farm, the pre-crops, and the distribution of crops as well as information available from the EU market schemes, which lists the fields for which the farmers have applied for subsidies. Additionally, the transfer of manure and commercial fertilisers is registered and can be inspected by comparing the appropriate accounts. On the basis of this and other relevant information, it is possible to assess whether or not the use of nitrogen on a farm has exceeded the specified nitrogen quota.

If, after scrutinising the fertiliser accounts, the competent authorities find any infringements of the rules the farmer will receive a first letter of hearing to which objections can be raised. If the infringement is sustained after one or more letters of hearing the appropriate sanction is imposed.

175 inspectors operating from six regional district offices carry out the site inspections. Among other things the inspectors check the use of nitrogen in relation to the nitrogen quota by inspecting the farm. An appointment is made two weeks before the visit and at this point, the farmer is also informed about which documents the inspector will need in order to carry out the inspection. The scheduled duration of a site inspection is 5.6 hours. The inspectors examine the relevant documents and enter essential data in a computer programme designed for the particular inspection on a laptop computer. The report is electronically transferred to the central authorities for analysis and further inspection.

Violations of the rules - excess addition of nitrogen on farm level
As a rule all violations are penalised, however very small violations (from 0 to 1 kg excessive use of nitrogen per hectare) are not pursued. If the excess usage is between 1 and 5 kg N per hectare the farmer is notified that the rules have been violated, but there are no further consequences for the farmer. If the excess use of nitrogen is between 5 and 10 kg N per hectare the farmer receives a warning and it is emphasised that repeated violations will be penalised. In cases of repeat violations or systematic abuse of the limitations, the authorities are likely to penalise offenders to the full limit of the law.

If the excess use of nitrogen is above 10 kg N per hectare the infringement is handed over to the public prosecutors with a demand from the competent authorities that the farmer is fined according to the following guidelines:

Surplus addition Total kg N/ha	**Imposed fine DKr.**	**Imposed fine when the intensity is more than 60 kg N per hectare**
Less than 500	3,000 – 5,000	8,000
500 – 1,999	8,000	14,000
2,000 – 4,999	14,000	Individual decision
5,000 or more	Individual decision	Individual decision

A fine may also be imposed if the annual fertiliser account is not submitted to the competent authorities. These fines have attracted heavy publicity and much debate, and this has no doubt increased awareness of the consequences of applying excess nitrogen in farming.

The statistics for the period 1997/1998 are based on 43,847 fertiliser accounts out of a total of 62,860 accounts. The data reveal, among other things, that average usage among livestock holdings and holdings with no livestock is 149 kg N per hectare, and assuming that livestock manure is utilised according to the minimum demands, the average application of nitrogen per hectare is 130 kg N.

Distribution of farms with respect to excess use of nitrogen per hectare (1997/1998)		
Excess use (kg N/hectare)*)	**Number of holdings**	**Percentage of holdings**
< than -40	8,629	19.7
-40 to -30	3,104	7.1
-30 to -20	4,796	10.9
-20 to -10	7,609	17.4
-10 to -5	5,805	13.2
- 5 to 0	11,503	26.2
0 to 5	2,037	4.6
5 to 10	194	0.4
10 to 20	80	0.2
20 to 30	20	0
30 to 40	16	0
> than 40	54	0.1
Total	43,847	99.8

*) Negative values indicate that the use of nitrogen has been less than the norm.

Distribution of farms according to excess use of nitrogen per hectare					
Excess use (kg N/hectare)*)	**1993/94**	**1994/95**	**1995/96**	**1996/97**	**1997/98**
Less or equal to -20	5,802	8,974	8,891	8,274	16,529
More than -20 and up to -5	6,728	6,656	6,072	6,900	13,414
More than -5 and up to 5	8,818	7,437	7,632	7,768	13,540
More than 5 and up to 20	2,045	804	611	447	274
More than 20	1,081	284	139	257	90
Total	24,474	24,155	23,345	23,646	43,847

*) Negative values indicate that the use of nitrogen has been less than the norm.

The number of holdings where the nitrogen quota is exceeded has decreased markedly since 1993/94. In 1993/94 8 % of the holdings exceeded the quota with 5 to 20 kg N per hectare and 4 % used in excess of more than 20 kg N per hectare. In 1997/98 the corresponding percentages were 0.6 and 0.2, respectively.

Danish nutrient loads and reductions achieved

Description of calculation/assessment methods used

Denmark uses the load-orientated approach to measure riverine and direct discharges to coastal areas, and to quantify the various sources. The methodology is based on an extensive monitoring programme in rivers and streams (about 110) covering approximately 60% of the Danish catchment area draining into the Baltic Sea. In addition to this, loads from all point sources larger than 30 PE are monitored or measured including the part of the drainage area where the riverine load is not monitored. The Danish methodology also includes an estimation of retention in surface freshwaters (rivers and lakes), as well as background or natural losses from open land and atmospheric deposits on surface freshwaters. This extensive monitoring programme began in 1989 and has been conducted each year since then [1, 2].

The cost of this Danish monitoring programme is approximately DKK 240 million. Responsibility for conducting the monitoring programme is shared between the Danish counties and the Ministry of Environment. The National Environmental Research Institute undertakes co-ordination of the programme.

1. Direct and indirect municipal discharges

In the late 1980s, 93% of the Danish population was connected to sewage systems. Most sewage was therefore treated in municipal wastewater treatment plants before being discharged to surface freshwaters or directly into the sea. Information about the proportion of the population and number of industries connected to municipal sewage systems during the 1980s is known, as well as the type of wastewater treatment available during this period. Estimates of discharges from the mid- to late- 1980s include a combination of monitoring results from 1989, data on population and industries connected to systems, and the treatment of wastewater (Table 1.2).

Discharges from municipal wastewater treatment plants are monitored for each unit larger than 30 PE. Sampling frequency for different size classes is shown in Table 1.1. Losses from small municipal wastewater treatment plants are calculated from empirical equations or by using standard units (1 PE =4.4 kg N/year and 1.0 kg P/year in 1995, but in the mid- to late 1980s, 1 PE = 1.5 kg P/year). Losses from fish farms are calculated from feed consumption and fish production. Losses from rainwater collection are calculated based on empirical equations relating rainfall amount/intensity to the extent of the fortified area, and the construction and capacity of the rainwater retrieval system.

Table 1.1 Annual sampling frequency at municipal sewage treatment plants is included in the Danish Aquatic Environment Nationwide Monitoring Programme [3]. Municipal sewage treatment plants larger than 5,000 PE treat 92% of the total wastewater load for the plants shown in the table.

Treatment plant capacity (PE)	Number of municipal treatment plants	Sampling frequency (samples per year)
30-199	494	2
200-999	415	4
1000-4999	375	12
5000-9999	107	12
> 10 000	189	12

Table 1.2 Treatment at Danish municipal wastewater treatment plants

	Status in the late 1980s (%)				Status in 1995 (%)			
	M	MB	MBC	MBCN	M	MB	MBC	MBCN
2 000 - 10 000 PE	11	68	9	12	4	18	34	45
10 000 - 50 000 PE	23	62	6	9	7	1	10	82
> 50 000 PE	20	67	4	9	0	17	0	83
% of total load	21	64	6	9	2	14	5	79

2. Direct and indirect discharges from Danish industries not connected to treatment plants

In 1984 discharges for each Danish industrial activity not connected to treatment plants were estimated figures [4, 5]. Monitoring has been conducted since 1989, and the 1984 estimates were evaluated on the basis of the 1989 monitoring results [1].

Discharges from individual Danish industries not connected to treatment plants are monitored for each individual unit greater than 30 PE. Sampling frequencies for different size categories are shown in Table 1.3. Discharges from small Danish industries not connected to treatment plants are calculated from empirical equations or by using standard units (1 PE = 4.4 kg N/year and 1.0 kg P/year, but in the 1980s 1 PE= 1.5 kg P/year). In Denmark approximately 150 individual Danish industries are not connected to treatment plants, and approximately 115 of these are located in the Baltic Sea catchment area.

Table 1.3 Sampling frequency for Danish industries not connected to treatment plants

Effluent class	Total nitrogen (ton/year)	Total P (ton/year)	Sampling frequency (samples per year)
I	0.13-0.89	0.05-0.29	2
II	0.9-4.39	0.3-1.49	4
III	4.4-21	1.5-7.4	12
IV	>22	>7.5	12

3. Discharges from fish farms

Losses from fish farms are calculated from feed consumption and fish production, where feed consumption is multiplied by an emission factor. Fish farmers are obligated to report their annual feed consumption and fish production, and losses of nitrogen and phosphorus from fish farms are calculated as follows [6]:

Losses of nitrogen:
TN = (feed consumption x N content in feed) - (production of fish x N content in fish) (1)

Losses of phosphorus:
TP = (feed consumption x P content in feed) - (production of fish x P content in fish) (2)

The content of nitrogen and phosphorus is determined from the type of feed used and the content of nitrogen and phosphorus in the fish from some analyses. The N and P content in fish are approximately 30 kg N/ton and 5 kg P/ton, respectively.

In 1995 there were 475 freshwater fish farms in Denmark, approximately 40% of which were located in the Danish region of the Baltic catchment area. The number of freshwater fish farms has decreased since the late 1980s, and the number of marine fish farms has declined since the mid-1980s. In 1995 there were 44 marine fish farms in Denmark, of which 36 were situated in the marine waters of the Baltic Sea.

4. Discharges from agriculture

Discharges from agriculture are calculated using Equation (3) below by quantifying point sources, nutrient discharge in rivers, background load, and deposits on surface freshwaters and by further quantifying the retention rate in surface waters. Nutrient loads to coastal areas consist of riverine input and direct inputs from point sources. It is not possible to monitor the total catchment area in Denmark, as monitoring stations are located some distance from the coast to avoid the impact of tides. Furthermore, many streams are very small, and it is economically infeasible to measure several thousand small streams and brooks to cover the entire Danish territory of 43,000 km^2. The Danish territory is therefore divided into monitored and an unmonitored segments in relation to riverine loads.

Nutrient loads are determined using inputs from approximately 130 river monitoring stations situated downstream in rivers, but far enough from the coastline to prevent a tidal influence. Approximately 105 of these monitored streams discharge into the Baltic Sea, and sampling frequency generally ranges between 12 and 26 times each year, with an average of some 19 annual samples. Each monitoring site includes a stage recorder, and discharges are measured an average of 12 times annually.

In addition to the monitoring stations located as far downstream as possible, the Danish monitoring program includes many river monitoring stations in small catchments. Roughly150 of these stations are situated in small agricultural catchments of 5 to 60 km^2, with only minor input from point sources. Diffuse nutrient losses from unmonitored catchments are estimated by measuring flow-weighted concentrations or area-specific runoff coefficients from these agricultural catchments. The specific flow-weighted concentration is selected from catchments where the soil type, climate, run off and land use correspond to those of the non-monitored areas. The flow-weighted concentrations are then multiplied by measured or estimated runoff values. The following computations are then added to the calculated diffuse discharges: (1) the monitored and estimated discharges from point sources (without the load from scattered dwellings, which is included in the diffuse losses) and (2) the direct point source load, as these loads are also measured in non-monitored areas.

Since 1993, flow-weighted concentrations have been recommended for estimating the discharges from unmonitored areas. If there are no measured catchments without point sources within a county or a region, point source loads are deducted from the nutrient transport measured, before calculating the flow weighted concentrations. An average of flow-weighted concentrations from several measured catchments can often be used.

Source apportionment:
The total discharge to coastal areas (L_T) is determined as:

$$L_T = L_m + L_u + P_D \qquad (3)$$

where:
L_m is the total monitored discharge of either nitrogen or phosphorus
L_u is the total unmonitored discharge of either nitrogen or phosphorus
P_D is the discharge from point sources discharging directly to coastal areas (direct inputs).
The total discharge from unmonitored areas is determined as:

$$L_u = L_{Du} + P_u \qquad (4)$$

where:
L_{Du} is the calculated diffuse discharge from unmonitored areas
P_u is the total discharge from point sources in unmonitored areas.

To evaluate the significance of nutrient sources in the total discharge to coastal areas, source apportionment calculations are performed on L_T. Nutrient losses from diffuse sources such as agricultural land, forests and pristine areas are estimated as the difference between the gross discharge (defined as the sum of L_T and retention in surface freshwater), and the total discharge from point sources. In general the discharge from scattered dwellings is included in diffuse sources; therefore nutrient losses from cultivated areas include potential discharges from scattered dwellings entering the surface freshwater system. The model accumulates the uncertainty factors relating to total nutrient discharge from diffuse sources.

To calculate nutrient discharge from agriculture (A) to coastal waters, the following variables must be determined:

- Total discharge of a particular nutrient to coastal waters, consisting of the discharge from monitored catchments (L_m) and unmonitored catchments (L_u).
- Point source nutrient discharges to freshwater from sewage treatment plants, industrial plants, fish farms and urban storm water runoff consisting of the discharge from monitored (P_m) and unmonitored catchments (P_u) and point sources discharging directly to coastal areas (P_D).
- Discharge from scattered dwellings ($S_m + S_u$).
- Discharge from background/natural areas (B).
- Retention in lakes (R_l) and rivers (R_r).
- Atmospheric deposits on freshwater (D).

Nutrient discharges to freshwater from agricultural areas (A) in a specific catchment are then calculated as:

$$A = (L_m + L_u) - (P_m + P_u + P_D) - (S_m + S_u) - B + (R_l + R_r) - D \qquad (5)$$

Often it is not possible to separate discharges from scattered dwellings (S) from the discharge from cultivated areas, therefore A+S is usually given as the sum of discharges from diffuse sources (L_D):

$$L_D = A + S_m + S_u \qquad (6)$$

Calculation of background losses (B):
Natural background losses of nitrogen and phosphorus constitute part of the total estimated nitrogen and phosphorus inputs to primary surface water recipients, and include losses from unmanaged land and those portions of the losses of nitrogen and phosphorus from managed land that would occur regardless of anthropogenic activities.

Natural background losses are determined using measurements of the nutrient losses in 9 small non-agricultural catchments, which are further subdivided into sandy and loamy catchments. Each year the flow-weighted concentrations of N and P for sandy and loamy soils are calculated and then used to determine the background losses from unmanaged and managed land, depending on the dominant soil type. The mean median figure for the nine natural watersheds from 1989 to 1999 is:

1.50 ± 0.15 mg N/l	(2.20 ± 0.76 kg N/ha)
50 ± 6 mg P/l	(0.078 ± 0.04 kg P/ha)
5.8 ±1.3 l/s km^2	

Natural losses are calculated by multiplying the flow-weighted concentration by a relevant specific discharge.

<u>Calculation of atmospheric deposits (D)</u>:
Atmospheric deposits in Denmark are calculated using monitoring results. In the late 1990s typical values were:

15-20 kg N/ha year, with the highest deposits occurring during wet years.
1-2 kg P/ha year, with the highest deposits occurring during wet years.

<u>Calculation of catchment retention (R)</u>:
Nutrient losses to freshwater are often greater than the measured nutrient transport due to retention and cycling of the nutrients in lakes and rivers. Retention plays a key role in the amount and composition of fluxes through river systems, especially in the case of phosphorus. With respect to nitrogen and phosphorus retention takes place in all sources. We can assume that an equal proportion is retained from each source, if the sources are evenly distributed in the catchment, and if the proportion of dissolved and inorganic substances from each source is equal. However this is seldom the case.

Retention in the catchment area must be added to the measured load to estimate the diffuse source (natural background + agriculture + scattered dwellings) losses to freshwater. Examples of Danish monitoring results from 27 lakes are given in Tables 1.4 and 1.5.

Table 1.4 Retention of total phosphorus and total nitrogen in Danish lakes (1994-98)
Q1 = 25% quartile, Q3 = 75% quartile

Parameter	Units	Mean	Q1 (25%)	Median	Q3 (75%)
P retention (absolute)	mg P/m^2 day	0.80	0.00	0.32	1.75
P retention (relative)	% of loading	5.4	-5.0	3.3	18.6
N retention (absolute)	mg N/m^2 day	116	53	110	152
N retention (relative)	% of loading	39.5	20.5	40.5	58.3

Table 1.5 Median retention of total phosphorus and total nitrogen and the related 95% confidence limits

Parameter	Units	Median	Lower CL*) (95%)*	Upper CL*) (95%)
P retention (absolute)	mg P m^{-2} day^{-1}	0.32	0.05	1.55
P retention (relative)	% of loading	3.3	-3.7	15.4
N retention (absolute)	mg N m^{-2} day^{-1}	110	56	147
N retention (relative)	% of loading	40.5	23.7	57.7

*) CL = confidence level.

Alternatively, retention can be estimated from data on residence time, lake depth, lake surface area and concentration of nitrogen and phosphorus in the inlets. In-stream retention in Danish streams can also be significant (primarily during the summer), but over a number of years, this retention becomes negligible and therefore is not included in the calculations. On the other hand, in stream systems where flooding occurs, retention of phosphorus is especially important. In major rivers, nitrogen retention (as denitrification) can have a significant impact on the total load from the river system. Net retention of nitrogen and phosphorus in rivers and streams is less than 1 to 2 % of the total load to coastal areas in Denmark. Total riverine discharges before 1989 are estimated on the basis of correlations monitored in the 1980s and 1990s, as well as correlations between the diffuse discharges of nitrogen and phosphorus from 1989-1997 and runoff during the corresponding period.

5. Discharges from scattered dwellings and from storm water overflows

In Denmark the loads from scattered dwellings and from storm water overflows are also quantified.

Scattered dwellings:
There were approximately 350,000 scattered dwellings in Denmark in 1995, of which approximately 285,000 are located in the Danish region of the Baltic Sea catchment area.

Nutrient losses from scattered dwellings are estimated by:

- Multiplying the actual number of dwellings not connected to sewage plants > 30 PE by 2.7 (i.e. assuming 2.7 individuals per dwelling) or by using the empirical value for the percentage of the population not connected to sewage plants of > 30 PE.
- Assuming a wastewater production of 4.4 kg N/year and 1.0 kg P per person per year (in the mid- and late- 1980s 1 PE was 1.5 kg P/year).
- Assuming that on average 50% of the wastewater produced by scattered dwellings is lost to rivers and lakes (this figure differs depending on the type of treatment or discharge system at the individual scattered dwelling).

Since the mid-1980s, improved information has been collected from scattered dwellings concerning their treatment and discharge systems.

Storm water overflows:
In 1995 there were some 12, 000 storm water overflows in Denmark. Roughly 25% involved a rainwater basin, which reduced the discharge to surface waters. Approximately 85% of the storm water overflows occurred in the Danish region of the Baltic Sea catchment area, and roughly 5000 are combined storm water overflows.

Denmark uses two different models for measuring the nutrient loss from storm water overflows: (1) combined sewer overflow, and (2) separate sewer overflow. The calculations of nutrient discharges are used only to estimate the annual discharge from storm water overflows; monthly calculations of discharges are not made. Each county in Denmark calculates the nutrient loss from storm water overflows.

Combined sewer overflow:
Nutrient discharges from combined sewer overflow are estimated using the MOUSE-SAMBA models and measurements of rainfall. The unit figures used in these models are refined from measurements in three counties, where measurements are performed and used to extend and verify the calculations. The results from these measurements are used in all other counties, and the resulting unit figures are used in the MOUSE-SAMBA models. Calculations are then made for each drainage area. This programme has been used in Denmark since 1989 [1]. Currently the values in Table 1.6 are used.

Table 1.6 Recommended Danish unit figures for combined sewer overflow

	Annual discharges*)	**Off-line in sewage with basins above 3-5 mm**
Suspended solids (mg/l)	150-200	100-150
Total phosphorous (mg/l)	2-3	1.5-2.0
Total nitrogen (mg/l)	10	3-7
COD (mg/l)	160	

*) Flow-weighted average value

Separate sewer overflow
Nutrient discharges are basically calculated from measurements of rainfall, paved area, and a hydraulic reduction factor. Calculations are made for each drainage area using the recommended unit values shown in Table 1.7.

Table 1.7 Recommended Danish unit figures for separate sewage overflows

	Annual loads*)
Suspended solids (mg/l)	30-100
Total phosphorus (mg/l)	0.5
Total nitrogen (mg/l)	2
COD (mg/l)	40-60

*) Flow-weighted average value

A hydraulic reduction factor (0.8) is used most frequently.

Nitrogen and phosphorus discharges to the environment

1. Direct and indirect municipal discharges
Based on the database and monitoring and calculation methods described above, direct and indirect discharges of nutrients from municipal wastewater treatment plants are presented in Tables 1.8 and 1.9, respectively.

Table 1.8 Total discharges of nitrogen and phosphorus from Danish municipalities entering directly into the Baltic Sea

	Nitrogen			**Phosphorus**		
Size class (PE)	**N-Tot late 1980s (t/y)**	**N-Tot 1995 (t/y)**	**Reduction (%)**	**P-Tot late 1980s (t/y)**	**P-Tot 1995 (t/y)**	**Reduction (%)**
2 000-10 000	480	296	38.3	146	39	73.3
10 001-50 000	1 800	771	57.2	478	117	75.5
>50 000	8 561	4 139	51.7	2 007	634	68.4
Total	10 841	5 026	52.0	2 631	790	70.0

Table 1.9 Total discharges of nitrogen and phosphorus from Danish municipalities entering surface freshwater in the Baltic Sea catchment area.

	Nitrogen			**Phosphorus**		
Size class (PE)	**N-Tot late 1980s (t/y)**	**N-Tot 1995 (t/y)**	**Reduction (%)**	**P-Tot late 1980s (t/y)**	**P-Tot 1995 (t/y)**	**Reduction (%)**
2 000-10 000	1.005	709	29.5	346	1	76.6
10 001-50 000	1 516	540	64.4	419	50	88.1
>50 000	2 131	849	60.2	511	104	79.6
Total	4 652	2.098	54.9	1 276	235	81.6

2. Direct and indirect discharges from Danish industries not connected to treatment plants

Based on the data and monitoring and calculation methods described above, direct and indirect discharges of nutrients from individual Danish industries not connected to treatment plants are presented in Tables 1.10 and 1.11 respectively.

Table 1.10 Total discharges of nitrogen and phosphorus from Danish industries not connected to treatment plants entering directly into the Baltic Sea

	Nitrogen			**Phosphorus**		
Industry	**N-Tot late 1980s (t/y)**	**N-Tot 1995 (t/y)**	**Reduction (%)**	**P-Tot late 1980s (t/y)**	**P-Tot 1995 (t/y)**	**Reduction (%)**
Chemical		53			3	
Food processing		577			62	
Pulp and paper		458			44	
Other industries		545			11	
Total	4 000	1 633	59.2	1 000	120	88.0

Table 1.11 Total discharges of nitrogen and phosphorus from individual Danish Industries not connected to treatment plants entering surface freshwater in the Baltic Sea catchment area

	Nitrogen			Phosphorus		
Industry	N-Tot late 1980s (t/y)	N-Tot 1995 (t/y)	Reduction (%)	N-Tot late 1980s (t/y)	N-Tot 1995 (t/y)	Reduction (%)
Food processing		21				
pulp and paper		4				
Other industries		67				
Total	200	92	54.0	12	2	83.3

3. Discharges from fish farms

Based on data submitted by the Ministry of the Environment and Energy and the methodology described above, total discharges of nutrients from freshwater and marine fish farms were calculated. The results are presented in Table 1.12.

Table 1.12 Estimated discharges of nitrogen and phosphorus from Danish freshwater and marine fish farms

	Discharges in late 1980s (ton)	Discharges in 1995 (ton)	Reduction (ton)	Reduction (%)
N-Tot	2 650	1 735	915	34.5
P-Tot	295	144	151	51.2

4. Discharges from agriculture

On the basis of the methodology described above, nutrient loads from agriculture to the environment were estimated. The results are presented in Table 1.13. It should be emphasised that these agricultural loads include background losses, which are quantified in Table 1.14.

Table 1.13 Estimated discharges of nitrogen and phosphorus from Danish agriculture to surface fresh waters draining into the Baltic Sea

	Discharges in late 1980s (ton)	Discharges in 1995 (ton)	Reduction (ton)	Reduction (%)
N-Tot	79 000	53 750	25 250	32.0
P-Tot	670	580	90	13.4
Runoff 10^6 m^3	10 136	9 906	230	2.3

Natural background losses are calculated in Table 1.14 based on the methodology described.

Table 1.14 Estimated natural background losses from Denmark to surface fresh waters draining into the Baltic Sea

	Discharges in late 1980s (ton)	Discharges in 1995 (ton)	Reduction (ton)	Reduction (%)
N-Tot	10 900	9 650	1 240	11.4
P-Tot	342	313	29	8.5

Although runoff levels in the mid- and late- 1980s were slightly higher than in 1995, this does not explain the reduction in agricultural discharges. Subsequent measurements clearly indicate that no statistically significant reductions in nitrogen losses to surface waters were recorded before the late 1990s [7]. The figures in Table 1.13 can be explained by record high precipitation in 1994, during which most of the easily measurable soil nitrogen pool was lost to surface and groundwater. Precipitation in 1995 was approximately 10% lower than usual (1961-1990), but runoff was roughly 10% above normal, since much of the extensive rainfall in 1994 discharged in 1995. This also explains the quite high agricultural losses of phosphorus in 1995.

5. Discharges from scattered dwellings and storm water overflows

Losses from scattered dwellings and storm water overflows are based on the description above and information compiled in Table 1.15.

Table 1.15 Estimated direct and indirect discharges from Danish scattered dwellings and storm water overflows

	Discharges in late 1980s (ton)	**Discharges in 1995 (ton)**	**Reduction (ton)**	**Reduction (%)**
N-Tot	2 000	1 650	350	17.5
P-Tot	600	400	100	33.3

Overall reductions of nutrient load into the environment

At its ninth meeting (HELCOM 9/88), the Helsinki Commission adopted the Ministerial Declaration on reduction of the load of nutrients into the Baltic Sea by 50% of total discharges, as soon as possible, but not later than 1995.

During the period between the late 1980s and 1995, significant reductions were observed in the pollution load (Tables 1.16 and 1.17). The large decreases from point sources are attributable to large investments in wastewater treatment, as well as the elimination of high-phosphorus detergents. The reduction in nitrogen discharges from agriculture can be explained by unusual weather and runoff conditions in 1994 and 1995. Overall the objective to reduce pollution load by 50% was achieved for phosphorus, but not for nitrogen.

Table 1.16 Total discharges of nitrogen into the environment in the late 1980s and 1995 and reductions achieved after implementing the 1988 Ministerial Declaration

Source	**Load, late 1980's (ton)**	**Load, 1995 (ton)**	**Reduction (ton)**	**Reduction (%)**
Direct municipal discharge	10 841	5 026	5 815	52.0
Indirect municipal discharge	4 652	2 098	2 554	54.9
Direct industrial discharge	4 000	1 633	2 367	59.2
Indirect industrial discharge	200	92	108	54.0
Discharge from fish farms	2 650	1 735	915	34.5
Discharge from agriculture	79 000	53 750	25 250	32.0
Natural background discharge	10 900	9 650	1 240	11.4
Discharge from scattered dwellings and storm water overflows	2 000	1 650	350	17.5
Total discharge via rivers and direct discharge	106 000	69 000	37 000	34.9

Table 1.17 Total discharges of phosphorus into the environment in the late 1980s and 1995 and reductions achieved after implementing the 1988 Ministerial Declaration

Source	Load, late 1980's (ton)	Load, 1995 (ton)	Reduction (ton)	Reduction (%)
Direct municipal discharge	2 631	790	1 841	70.0
Indirect municipal discharge	1 276	235	1 041	81.6
Direct industrial discharge	1 000	120	880	88.0
Indirect industrial discharge	12	2	10	83.3
Discharge from fish farms	294	144	151	51.2
Discharge from agriculture	670	580	90	13.4
Natural background discharge	342	313	29	8.5
Discharge from scattered dwellings and storm water overflows	600	400	200	33.3
Total discharge via rivers and direct discharge	7 500	2 600	4 900	65.3

If the data are normalised to take into account variations in climate and runoff, Denmark can also be said to have achieved the 50% reduction target for phosphorus loading

Clarification of differences between discharge figures published earlier

There have not been any significant changes in the reported figures, rather only minor corrections. The present report notes that discharge from scattered dwellings and from storm water overflows are included in total discharges. Further, information concerning the natural background losses has been provided.

Action Plan for the Aquatic Environment III 2005-2015

A comprehensive evaluation of the implementation and impact of the Danish Action Plans carried out in 2003 showed that the reduction goal for nitrate leaching had been achieved. Furthermore, a major study was conducted with the purpose of analysing the most cost-efficient measures for the regulation of nutrient discharges from agriculture. As a result, a strategy was developed for the future regulation of phosphorus. Based on the results of this report, in April 2004, a Parliamentary majority agreed on a new Action Plan for the Aquatic Environment III 2005-2015. The text of the Agreement dated 2 April 2004, is presented below:

*" **Agreement on the Action Plan for the Aquatic Environment III 2005-2015 between the Danish Government, the Danish People's Party and the Christian Democrats"***

The Parties agree that the Action Plan for the Aquatic Environment III will continue the positive development started by the two first action plans for the aquatic environment. The aquatic environment must be further improved through reductions in discharges of nitrogen and phosphorous; nature conservation must continue to be improved; and nuisances experienced by neighbours to agriculture must be limited. Therefore, this Agreement encompasses broad efforts to reduce agricultural impacts on the aquatic environment, nature, and neighbours.

The Action Plan for the Aquatic Environment III is very closely related to the implementation of the EU Water Framework Directive and the Habitats Directive, which state that objectives and programmes of measures for individual water bodies and natural habitats to apply from 2009 must be laid down. The main rule is that the objectives must be met by 2015.

The individual elements of the Agreement:

1. 10-year agreement period - coordination with the Water Framework Directive
This Agreement runs from 2005 to 2015 with evaluations in 2008 and 2011 respectively. When carrying out these evaluations, progress with regard to the general reduction objectives will be assessed, and the need for further initiatives can be analysed. The regional objectives for the status of the individual water bodies and natural habitats are laid down in accordance with the requirements in the EU directives for the end of 2008. Therefore, at the evaluation in 2008, it will be possible to assess the effects of the efforts thus far in relation to these objectives.

2. Reduction of excess phosphorous - objective of 50 per cent reduction
Agriculture's excess phosphorous must be halved compared to the 32,700 tonnes P in 2001/2002. A reduction of the excess phosphorous of 25 per cent by 2009 will be achieved through a tax of DKK 4 per kg of mineral phosphorous in feed and through general improvement of the phosphorous balance by 3,000 tonnes on the basis of new knowledge acquired through the research programme. In the period from 2009 to 2015 there will be a further 25 per cent reduction. The Parties to this Agreement will discuss the possibility of tightening the reduction objective, if it appears that technological development permits this. The need for changed/new instruments will be assessed in the evaluations. Revenues from this tax will be returned to agriculture through a reduction in land taxes in accordance with the principles of the Government's tax freeze.

3. Reduction in discharges of phosphorous - 50,000 hectares of buffer zones
A focused effort will be made with regard to phosphorous discharges. Close to 30,000 hectares of 10-metre crop-free buffer zones along rivers and lakes before 2009 and a further 20,000 hectares before 2015 will be established. The buffer zones will be established by voluntary transfers of set-aside land along lakes and rivers. In order to support the establishment of crop-free buffer zones through siting set-aside land, an additional subsidy under the agri-environmental measures for crop-free buffer zones established along rivers and lakes will be introduced. The buffer zones will retain phosphorous from other areas and they will protect banks along rivers and lakes, and in this way the discharge of phosphorous will be reduced**.**

A total DKK 375 million including the expected EU co-financing will be allocated from 2005-2009 to special initiatives under the agri-environmental measures. Apart from covering the subsidies under the agri-environmental measures for establishment of the crop-free buffer zones along lakes and rivers mentioned above, the funds allocated can also be used for e.g. wetlands under the agri-environmental measures and other agri-environmental measures aiming at nitrogen and phosphorous.

The Parties to this Agreement wish to strengthen the basis for reducing phosphorous discharges from agricultural areas through research into the mapping of areas with an increased risk of phosphorous loss as well as through research that can strengthen the basis for implementation of the EU directives.

Freshwater fish farms constitute a significant source of phosphorous discharges into freshwater bodies. In connection with the current follow-up to the report by the ad hoc Advisory Board on Freshwater Fish Farming, the Parties will therefore consider the need to introduce a phosphorus tax on freshwater fish farming. In addition, the Parties will consider raising the taxes on separate industrial discharges, currently subject to reduced taxes or no taxes at all, if these phosphorous discharges impact lakes and enclosed fjords. Finally, the Parties will assess whether there is a need for further initiatives with regard to phosphorous discharges from municipal wastewater treatment plants. Initiatives already adopted, which are targeted towards a reduction of wastewater discharges from sparsely built-up areas in the open country, will contribute to reducing phosphorous discharges by approx. 45 tonnes P. In 2005, the Government will prepare a white paper regarding the progress in the reduction of wastewater discharges from sparsely built-up areas.

Although scientific fact-finding projects have not suggested a further reduction in discharges of nitrogen and phosphorous from wastewater treatment plants to the marine environment, the Parties to this Agreement consider it crucial to set up a working group to assess the technical possibilities of tightening requirements for treatment of wastewater from municipal treatment plants and separate industrial discharges, as well as the economic consequences of these.

4. Objective and instruments for a minimum 13 per cent reduction in nitrogen leaching

Nitrogen leaching from agriculture is to be reduced by a minimum of 13 per cent by 2015 compared to 2003.

The structural development, including setting aside land, improved feed utilisation, and the implementation of the new EU agricultural reform are expected to lead to a reduction in nitrogen leaching from agriculture of approx. 11,200 tonnes N before 2015. In addition, afforestation in the range of 20,000-25,000 hectares will contribute to reducing nitrogen leaching by approx. 900 tonnes N.

The following initiatives will also contribute to reducing nitrogen leaching:

- Regulations regarding late crops will be tightened. From 2005-2009, late crop requirements will be introduced corresponding to 6 per cent of the late crop basis for farms using livestock manure, corresponding to less than 0.8 LU/ha, and 10 per cent for farms using livestock manure, corresponding to more than 0.8 LU/ha. From 2009-2015, the late crop requirements will be tightened to 10 and 14 per cent respectively. In the future, maize will be included as a late crop. Cruciferous late crops sown before 20 August are equal to grass crops and other late crops with a large potential for nitrogen accumulation. This is expected to contribute to reducing nitrogen leaching by approx. 4,600 tonnes N. Annual costs for industry related to this initiative are expected to be in the order of DKK 30-60 million per year.

- A general tightening of requirements for utilisation of nitrogen in livestock manure with 4.5-5 percentage points concurrently with research creating a basis for this. This will be assessed in the evaluations in 2008 and 2011. This initiative is expected to contribute to reducing nitrogen leaching by approx. 2,900 tonnes N. Costs for industry in this connection are expected to be in the order of DKK 50-90 million per year.

- DKK 140 million will be spent on the establishment of a further approx. 4,000 hectares of wetlands in 2004 and 2005. This is expected to reduce nitrogen leaching by approx. 1,100 tonnes N.

- In accordance with element no. 3 above, a further up to DKK 375 million will be allocated in the period 2004-2009 including the expected EU co-financing to special initiatives under the Agri-environmental measures targeted towards phosphorous and nitrogen. Besides being spent on establishing crop-free buffer zones, the funds are expected to be spent on establishing wetlands under the agri-environmental measures and general set-aside of agricultural land. In order to achieve a higher degree of integration of protection of the aquatic environment and nature, and because several wetland projects have not been able to meet the relatively high nitrogen requirements in projects under the Action Plan for the Aquatic Environment II, the requirement for removal of nitrogen is reduced to 100 kg N/ha for future wetlands under the agri-environmental measures. The total nitrogen reduction resulting from the extra funds for agri-environmental measures is estimated at approx. 400 tonnes N.

- In the 2008 evaluation, the effect of the afforestation initiatives will be assessed in relation to the reduction in nitrogen discharges to surface water and groundwater.

- The requirements for utilisation of nitrogen in mink manure will be tightened so that they reach the same level as the current utilisation requirements for cattle manure. This way, leaching is expected to decrease by approx. 100 tonnes N. The costs for industry are estimated at approx. DKK 0.5 million per year.

- Initiatives already adopted which are targeted towards a reduction of wastewater discharges from sparsely built-up areas in the open country, will contribute to reducing nitrogen discharges by approx. 300 tonnes N.

If the evaluations show that there is a need for further initiatives in order to reach the objective of a minimum of 13 per cent reduction in nitrogen discharges by 2015, it will be necessary to discuss the introduction of other instruments or a tightening of some of the instruments already in use. The nitrogen excess in agriculture is a good indicator of agriculture's nitrogen impact on nature and the environment by nitrate and ammonia, and therefore it will be included as an important parameter in the evaluations.

A reduction in nitrogen leaching is an important factor in relation to both national and international objectives. The status of the Kattegat, the Baltic Sea, and a number of fjords was a cause for concern in assessments in a report from the UN environment body. Nitrogen discharges from land as a consequence of over-fertilising in agriculture are indicated in the report as a significant cause. With this Agreement on the Action Plan for the Aquatic Environment III, a further contribution is made to the reduction of nitrogen discharges and an improved aquatic environment.

Denmark is obliged to submit a four-year action programme for the implementation of the Nitrate Directive from 2004-2008. The Parties to this Agreement agree that the Action Plan for the Aquatic Environment III as well as the results achieved under the Action Plan for the Aquatic Environment II are included in the four-year action programmes and that Denmark will continue to meet the requirements for correct implementation of the Nitrate Directive.

The Parties will work for an extension of the Danish exemption cf. the Action Plan for the Aquatic Environment II, so that the opportunity to add up to 230 kg N to livestock manure per hectare in certain cattle holdings can be maintained.

A technical adjustment of the system to fix norms will be made so that, as a main rule, the norms will continue to be laid down without regard to protein content. However, the norm reduction will be subject to a maximum of 10 per cent below the business finance optimum, as laid down in the Action Plan for the Aquatic Environment II, but the total nitrogen quota will not be allowed to exceed the 2003/2004 quota after adjustments for the effect of crop displacement.

5. Protection of particularly vulnerable nature

With a view to protecting ammonia-sensitive habitats, the Wilhjelm Committee's model on the designation of 300-metre buffer zones around all raised bogs, all lobelia lakes, all – to start with - heaths larger than 10 hectares, and all endangered and low-nutrient dry grassland larger than 2.5 hectares, as well as all endangered heaths, dry grassland, and other particularly vulnerable types of natural habitat in the Natura 2000 sites. The total area where buffer zones are designated constitutes just over 7 per cent, corresponding to just over 180,000 hectares. Within this buffer zone and within the area itself, no extension of livestock farms can take place if such an extension would lead to increased ammonia discharges in natural areas vulnerable to ammonia. Application of new technology may be used in such an assessment. Final designation of these areas will take place through the natural planning by counties up to 2009.

This initiative is the Government's follow-up to its Action Plan for Reducing Ammonia Volatilization from Agriculture from 2002. Through the Action Plan for Reducing Ammonia Volatilization from Agriculture, a ban has been introduced on surface spreading. When the Action Plan for Reducing Ammonia Volatilization from Agriculture has been fully implemented in 2007, the total effect will be a reduction of about 9,500 tonnes of nitrogen per year.

The development of new technology is also important in relation to being able to limit odour nuisances from livestock farming. Authorisation to extend existing and establish new livestock farms should also be seen in the light of the ongoing structural development where livestock production is concentrated in fewer and larger farms.

Extension of existing livestock production and establishment of new ones are regulated under the Danish Planning Act (EIA) and the Danish Environmental Protection Act. This ensures that extension of existing livestock farms and establishment of new ones are assessed in relation to their impact on the environment and nature. After designating the buffer zones, the Government will prepare a white paper on the extent to which these buffer zones have created better regulation of livestock farming.

Approvals under part 5 of the Danish Environmental Protection Act must be reconsidered at least every ten years, and amended conditions can be determined in that connection. If there is new information about the adverse impacts of the pollution, new information about environmentally harmful effects that could not be predicted at the time of approval, or new knowledge about significant changes in the best available techniques, the authorisation may be taken up for reconsideration before expiry of the 10-year period. New and amended conditions do not lead to a new statutory protection period in relation to the original approval under part 5.

6. The research programme under the Action Plan for the Aquatic Environment III - including reduction of nutrient losses and odour emissions

The research programme aims at limiting odour nuisances, reducing excess phosphorous and phosphorous discharges, and improving methods for manure management. Limitation of nutrient discharges in a regional context is included in the programme as a separate element. Knowledge about the development and spreading of odours and instruments to limit odours from livestock production will be important elements in limiting nuisances experienced by neighbours. Research into odours is closely related to the development of technologies and knowledge about reduction of ammonia volatilization. Limiting ammonia volatilization, e.g. the potential for adding acid to manure, will also be included in the manure research programme, so will experiment projects regarding manure separation and bio-degasification, etc. The Government and agriculture together will allocate a total of DKK 155 million for this research programme. Thus, particular emphasis in the programme is being placed on developing the possibilities of limiting odour nuisances.

7. Strengthening organic farming
In addition, a new research programme will be carried out with regard to organic agricultural production - the so-called FØJO III. In future, an annual DKK 12 million of the funds originating from pesticide taxes will be allocated to research activities. Already now, the Parties are ready to earmark these funds for a future research programme aiming at organic farms, while a further DKK 28 million per year are expected to be raised through governmental research reserves so that new funds are expected to be allocated - a total of DKK 40 million per year from 2005 to 2009.

A framework has been ensured for the Organic House of an annual DKK 3 million for the period 2005-2009 for projects promoting organic farming. The projects will be implemented under the auspices of the Organic House.

In context with an adaptation of the "landdistriktsstøtteloven" (act on rural development) and the use of modulation funds under the rural-districts programme, funding of organic sales-promoting initiatives is being made possible.

8. The Manure Action Plan - new distance requirements
The Manure Action Plan builds upon the recommendations made in the report from the "Nabogeneudvalget" (committee on nuisances experienced by neighbours) of 29 January 2004. It should be noted that the first phase of the Manure Action Plan has already been implemented since the tightened distance requirements entered into force on Saturday 20 March 2004. Local authorities have been instructed to be extremely aware of avoiding future odour nuisances in their case administration. The Government has also initiated five development projects on odour for a total of DKK 1.5 million. The Minister for the Environment will ask the Nabogeneudvalget to prepare a report in 2005 studying whether the effects of the stricter distance requirements are sufficient.

In addition, new and updated odour guidelines for municipalities' treatment of applications for extension of existing livestock production and establishment of new ones will be prepared.

9. Further elements
The "gødskningsloven" (act on the agricultural sector's consumption of fertilisers and on plant cover) will be adjusted so that authorisation is granted for:

- Implementation of pilot projects with regulation based on balance models. The scientific elucidation work preceding the Action Plan for the Aquatic Environment III analysed the opportunities to use a balance model for regulation of agriculture's excess nitrogen and phosphorous and recommended carrying out pilot projects to document the advantages and disadvantages of the balance model, including determination of limit values for excess nitrogen and phosphorous. Farms participating in the pilot projects may use the balance calculation as documentation of a simultaneous correction of the farm's nitrogen norm based on the level of yield from feed crops used for feed on the farm and the nitrogen level in the livestock manure. Up to 1 per cent of the farms which are under an obligation to submit manure accounts may participate in the pilot projects. This scheme must be developed and is not expected to be implemented before the fertilising season 2005/2006.
- Determination of requirements for the establishment of winter green fields. Winter green fields may, if they constitute 100 per cent of the cultivated area alone or together with late crops, replace the requirement for late crops, cf. element no. 4.

The Action Plan for the Aquatic Environment III is supported by a rapid realisation of the farm advisory system, which is part of the EU reform. DKK 2 million will be allocated in 2005 within the rural areas programme for this development project.

10. A holistic approach
With the Action Plan for the Aquatic Environment III, there will be significant improvements in the status of lakes and fjords which are crucial in relation to the desire for a clean aquatic environment and will benefit both flora and fauna.

It should be noted that public interest in environmental issues in agriculture - apart from the wish for clean water and rich nature - is, to a high extent, also attached to the derived nuisances from pig production, including in particular odour nuisances. Technological development of e.g. biogas and manure separation, feed efficiency and acidification of manure may contribute to improving the environmental conditions of agriculture. Efforts to strengthen the protection of the aquatic environment and nature will therefore be combined with initiatives to limit odour nuisances.

The Parties therefore wish to use this Agreement on a new Action Plan for the Aquatic Environment III to initiate a more holistic approach to the protection of nature and the aquatic environment. Focus will no longer only be on a reduction in nitrate discharges. The instruments of the Action Plan for the Aquatic Environment III are based on an integrated approach where the protection of the aquatic environment and nature are combined. The instruments of the Action Plan for the Aquatic Environment III are also important in relation to the future regional objectives under the Water Framework Directive and the Habitats Directive - not least the designation of buffer zones and the continuation of wetland initiatives.

Minister for the Environment, Hans Christian Schmidt

Minister for Food, Agriculture and Fisheries, Mariann Fischer Boel

Danish People's Party, Christian H. Hansen

Danish People's Party, Jørn Dohrmann

Christian Democrats, Mogens Nørgaard Pedersen **“**

Part D: Germany

Hot Spots in Germany

Initially, Germany had nine Hot Spots listed according to the JCP (Table 1).

Table 1. German Hot Spots under the JCP

Hot Spot No.	Location	Site name	Site type
113	Oder/Odra	Odra Lagoon mgt.	Management Programme
114	Arkona Basin	Greifswald	Municipal & Industrial
115	Arkona Basin	Neubrandenburg	Municipal & Industrial
116	Arkona Basin	Stralsund	Municipal & Industrial
117	Arkona Basin	Stavenhagen-Malchin	Municipal & Industrial
118	Arkona Basin	Agriculture	Agricultural Runoff Prog.
119	Belt Sea	Lübeck	Municipal & Industrial
120	Belt Sea	Wismar	Municipal & Industrial
121	Belt Sea	Rostock	Municipal & Industrial

At the time of the Workshop four Hot Spots (Nos. 114, 116, 118 and 121) had already been removed from the List of Hot Spots after the implementation of pollution control measures. The remaining Hot spots (Nos. 113, 115, 117, 119 and 120) were considered by the Workshop, and experiences were shared from the Hot Spots which had already been deleted.

First, the Workshop was received a general presentation on wastewater treatment activities in Mecklenburg-Vorpommern. Altogether 1,370 wastewater projects were completed since 1990. Construction activities at the three remaining Hot Spots in the area are nearing completion and would be described in forthcoming presentations on the specific Hot Spot. Useful information about the supervision and control system in Germany was also presented. This information revealed that discharges exceeding the licensed limit values are penalised by high fees.

More detailed information on each of the Hot Spots was provided during the presentations that followed. The history and recent development and implementation of environmental measures were described and the water charges at the individual plants were presented. In general the remedial investments at most of the Hot Spots reviewed have been substantial..

The Workshop concluded that the presentations on investments in municipal wastewater treatment plants were encouraging. The remedial activities have raised the possibility that these areas will be removed from the List of Hot Spots within the next few years.

Hot Spot No. 113 (Odra Lagoon)
No information was presented to the Workshop

Hot Spots Nos. 114 and 116 (Greifswald and Stralsund)
Information about these treatment plants was presented. These Hot Spots have already been deleted.

Hot Spot No. 115 (Neubrandenburg)
This plant has been operating since 1999 and utilises Australian technology (CAST system). The treatment results were positive apart from a somewhat high Tot-N value of 10..99 mg/l (indicating a need for spot control). The reduction percentage achieved for all parameters is high. A proposal for removal from the List of Hot Spots is in preparation.

Hot Spot No. 117 (Stavenhagen-Malchin)
The plant receives wastewater from a population of 31,000 residents but has a design capacity of 260,000 p.e. due to its connection to several large industries. The plant has had P-removal since 1992 and has been fitted with N-removal processes in 2001 now in the testing phase. The reduction percentages were satisfactory but somewhat low in relation to nitrogen. This problem was expected to be solved by April 2002, when the plant would be fully operational.

Hot Spot No. 118 (Agriculture)
The site was listed as a Hot Spot due to the high number of animals in the Rügen area. The numbers have decreased substantially and the Hot spot was deleted two years ago.

Hot Spot No. 119 (Lübeck)
There are three wastewater treatment plants in Lübeck. The two smaller ones, Priwall and Ochsenkopf, have been completed and are functioning well. The third plant (Central Plant) treats approximately 80% of the wastewater and will have nutrient removal processes installed during 2003. Upon completion a proposal for deletion from the List of Hot Spots is to be prepared.

Hot Spot No. 120 (Wismar)
The installation of full nutrient removal technology will be completed in 2002. Once testing is completed an application for deletion is expected.

Hot Spot No. 121 (Rostock)
Details about the performance of the treatment plant in Rostock were presented. This Hot Spot has already been deleted.

Later in 2002 Hot Spots Nos. 117 and 120 were removed from the List after fulfilling the criteria for deletion.

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