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AN ASSESSMENT OF SELECTED POLICIES FOR CONTROLLING STATIONARY AND POINT SOURCE POLLUTION IN LATVIA

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I. PURPOSE OF THE STUDY

Latvia is in the process of reforming its Soviet-era environmental policy. The basic approach of controlling point/stationary source emissions through a combination of emission taxes and limits (standards) is being retained, but changes are being made to the levels of the taxes and limits. In addition, an emissions tax waiver intended to encourage investment in pollution-reduction measures is being implemented. Other policy changes include the introduction of taxes on products whose production or disposal generates pollution, and provisions for trading of emissions licenses among enterprises.

The study described in this report is one of a set of studies of Latvia's environmental policy that have been conducted as part of the Central and Eastern Europe Environmental Economics and Policy Project of the Harvard Institute for International Development (HIID). The study presented here has two objectives. The first is to develop a better understanding of the current system of emission taxes and limits in Latvia. As noted in Brunenieks, *et al.* (1996), there is little documentation of the workings of the current system. This study fills this gap, at least partially, by compiling and synthesizing information about the current system from a number of sources. This synthesis is accompanied by an assessment of the system's effectiveness and efficiency. The study's second objective is to assess the prospects for the emissions tax waiver provision. The waiver has yet to be fully implemented, and it is unclear how successful it will be in encouraging investment in pollution-reducing measures. There is a complementary concern about its effects on government tax revenues. We explore these concerns by evaluating the likelihood that the largest emitters of air and water pollutants in Latvia will take advantage of the provision.

The report is organized as follows. The next section provides some essential background on Latvian environmental policy. Section III then describes the recent reforms of relevance to this study. In Section IV we go on to provide a selective overview of environmental conditions in Latvia. Section V presents our findings on the implementation of the existing system of emissions taxes and limits. Based on these findings, we present an assessment of the system in Section VI. In Section VII we turn to an assessment of the emissions tax waiver. The final section contains a summary of our main recommendations.

II. BACKGROUND ON LATVIAN ENVIRONMENTAL POLICY

Latvian environmental policy is embodied primarily in the Natural Resources Tax Law. This law was originally promulgated in 1991, and was then extensively revised in 1995. Both the original law and the revised version retained many of the broad features of environmental regulation during the pre-1990 Soviet era. In particular, emissions of pollutants by point/stationary sources (e.g., factories and sewage treatment plants) are controlled by issuing permits that specify limits (standards) on pollutant emissions. These limits place restrictions, for each outfall (discharge pipe) or stack, on pollutant loads (e.g., tons of a pollutant emitted per year), as well as on other parameters, such as the concentrations of pollutants in waste streams. For common pollutants, taxes are also levied on pollutant loads. For emissions up to load limits, a "base" tax rate, which can vary across pollutants, is applied. For emissions above the load limit, a "penalty" tax rate equal to four times the base tax rate is levied. The effective difference between the base tax rate and the penalty rate is more than four-fold because tax payments for emissions within load limits can be deducted as costs of production for income tax purposes, whereas payments for emissions above limits can not (Brunenieks, *et al.*, 1996).

The system of limits and taxes is administered by ten Regional Environmental Boards (REBs). One of these boards is specifically dedicated to marine resources. The REBs are responsible for issuing permits and for enforcing the limits prescribed in permits. Limits are supposed to be chosen so as to ensure the maintenance of an extensive set of ambient quality standards that have been carried over from the Soviet era. For air, ambient concentration standards are specified for 33 key pollutants, with more than one type of standard for many pollutants (e.g., daily maximum and 20-minute maximum concentration standards). For water, both ambient concentration and waste stream concentration standards are specified for 36 key pollutants.

III. RECENT CHANGES TO THE NATURAL RESOURCES TAX LAW

The 1991 Natural Resources Tax Law was not very effective. It did not generate strong incentives to control pollution, nor did it yield significant tax revenues (Brunenieks, *et al.*, 1996). The law's lack of success can likely be attributed, in large part, to the low tax rates and the limited enforcement of its provisions. In addition, periodic adjustments to the taxes did not keep up with the high inflation rates Latvia experienced in the early '90s. The law was extensively revised in 1995. The new law technically went into effect on January 1, 1996. However, some of the regulations implementing the revisions are still being drafted. The revisions of interest to this study are the changes in tax rates levied on pollutant loads and the introduction of an emissions tax waiver intended to promote investment in structural measures for reducing pollution.[1]

A. New Emissions Tax Rates

Table 1 shows the 1995 (old law) and 1996 (new law) tax rates for air pollutants, and Table 2 shows the rates for water pollutants. The tax rates imposed under the 1991 law were revised periodically given the triple-digit inflation that Latvia suffered during the early '90s. The 1995 rates listed in the tables are those that were in effect in 1995. The tax rates for the 1995 law were supposed to go into effect on January 1, 1996. However, because of the burden of drafting the rules and regulations implementing the law, the new taxes will not go into effect until July 1, 1996.

The tables show that, with the exception of the tax on heavy metals, tax rates have gone up by a factor of roughly three. Given the estimated 25 percent inflation in 1995, this corresponds to a more than doubling of real tax rates. The heavy metals tax was lowered because the old tax rate was considered unrealistically high. The new taxes do not appear to be indexed to inflation.

The variation in tax rates across pollutants is intended to roughly reflect perceived differences in the damages they cause. The tax rates are not based on formal estimates of the marginal monetary damage associated with each pollutant. (Such estimates are very difficult to calculate even with the best of information.) The higher tax rates for water pollutants reflect concern about contamination of drinking water supplies.

Tables 1 and 2 also show that the set of pollutants subject to taxation has changed somewhat. Ammonia and "other inorganic compounds" have been added to the list of taxed air pollutants, and suspended

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[1]A comprehensive summary of the reforms incorporated in the 1995 law is provided by Brunenieks, *et al.* (1996).

solids have been added to the list of taxed water pollutants, while chlorides and sulfates have been removed. Ammonia and other inorganic compounds were added at the recommendation of the Baltic Sea Protection (HELCOM) program. Chlorides and sulfates were removed because the tax revenues generated from these two pollutants were not considered sufficient to justify the associated costs of administration and enforcement. The fact that these pollutants are no longer taxed does not mean they are unregulated: permits still contain limits on their emissions, as they do for other untaxed pollutants.

B. Emissions Tax Waiver

As noted earlier, the emission tax waiver introduced in the 1995 Law is intended to promote investment in structural measures that reduce pollutant emissions.[2] Examples of such measures presumably include: switching to cleaner production technologies, installing end-of-pipe treatment, or modifying production processes so that there is more recycling of materials. Enterprises adopting such measures are allowed to waive a portion of their emissions tax liability during the period in which the measure is being implemented. During this period, a qualifying enterprise can reduce its emissions tax payments by an amount up to the savings it would realize on its base rate tax burden once the measure is fully implemented. Savings are calculated using total emissions for the previous four quarters as the baseline. In essence, the tax waiver enables an enterprise to enjoy the benefits (in terms of reduced emissions tax payments) that will eventually be generated by the pollution-reducing measure while the measure is still being implemented. The workings of the scheme are most easily understood with the aid of an example.

Consider a hypothetical enterprise that emits SO_2 and faces an annual limit of 100 tons for this pollutant. The base rate tax of 10 lats per ton is levied on annual emissions up to the 100 ton limit, and the corresponding penalty rate of 40 lats per ton is levied on annual emissions exceeding the 100 ton limit. Suppose the enterprise emitted a total of 120 tons of SO_2 in the previous four quarters. The enterprise is about to install scrubbers that would reduce its emissions of SO_2 by 90 percent. It will take one year to complete installation of the scrubbers. During this one-year period, the maximum tax waiver this enterprise is eligible for is: 0.9 x (100 tons x 10 lats/ton) = 900 lats; the 20 tons emitted above the 100 ton limit do not enter the calculation. During this period, the enterprise would still be required to pay 100 lats in taxes on its within-limit emissions [0.1 x (100 tons x 10 lats/ton)], and 800 lats in "penalties" on its above limit emissions [20 tons x 40 lats/ton].

An enterprise must satisfy a number of requirements to successfully obtain a tax waiver. First, eligibility is restricted to enterprises that do not have any outstanding tax debts. Any tax payments owed to state or district revenue authorities, including emissions tax payments, are considered to be tax debts. Second, when applying for a waiver, an enterprise must provide documentation of the effectiveness of the proposed measure. Third, to maintain eligibility for the waiver during the time in which the pollution-reduction measure is being installed, the enterprise must remain free of tax debt, and it must ensure that its emissions do not violate annual environmental quality standards specified by the Ministry of Environmental Protection and Regional Development (VARAM is the Latvian acronym for this ministry). If either of these conditions is not met, the tax waiver can be partially or wholly revoked.

As currently written, the tax waiver regulations require enterprises to deal with a number of government

[2]The tax waiver is actually quite broad, it also covers measures that reduce natural resource use. Our focus, however, is its impact on the adoption of measures that reduce pollution.

agencies. Applications for the waiver must be filed with the Ministry of Finance and with each of the regional and local authorities that receives a share of emissions tax revenues. (These revenues are collected by the State Revenue Service, but a portion of the revenues is allocated to a district-level authority and to a municipal- or parish-level authority.) Furthermore, as part of the application process, enterprises must obtain certification by VARAM of the effectiveness of the proposed measures, and they must obtain certification from state and local tax authorities that they do not have any outstanding tax debt. For measures that take longer than a year to implement, enterprises must essentially repeat the application process each year.

At present, no tax waivers have been granted. However, a few enterprises have made inquiries about the exact procedures and requirements for obtaining waivers.

IV. SELECTIVE OVERVIEW OF ENVIRONMENTAL CONDITIONS

In this section we provide a partial overview of environmental conditions in Latvia. Given the scope of this study, we restrict our attention to stationary source and point source pollution, thus ignoring mobile source and nonpoint source pollution. It should be noted that mobiles sources, in the form of motor vehicles, are estimated to account for approximately two-thirds of all air pollution in Latvia (National Environmental Policy Plan, 1995). Their share of pollution is likely to increase over time, given the rising number of vehicles in operation. As for water pollution, estimates of nonpoint source pollution loads are not readily available, but for some water bodies, runoff and leaching from agricultural lands is considered to be an important contributor to eutrophication and to contamination of drinking water supplies.[3] Experience in other countries (e.g., the U.S. and U.K.) has shown that it is frequently easier and cheaper to control emissions from point/stationary sources. Hence the focus on point/stationary source pollution is readily justified.

We first examine patterns of point/stationary source pollutant emissions, and then turn to ambient quality standards and levels. We also present some information on aggregate expenditures on environmental protection. Given the constraints on this study, we restrict attention to the most commonly emitted air and water pollutants.

A. Pollutant Emissions

Table 3 shows stationary source emissions of the four major air pollutants selected for this study. They are: particulate matter, carbon monoxide, sulfur dioxide, and nitrogen oxides. These four pollutants accounted for 95 percent of all stationary source pollution in 1995 . As Table 3 reveals, emissions of the selected pollutants fell substantially from 1990 to 1993. This was followed by an upturn in 1994, but emissions once again fell in 1995--in the case of SO_2 and NO_x, to below their 1993 levels. The reductions in emissions between 1990 and 1995 range from 29 percent for CO to 61 percent for particulate matter.

Table 4 shows point source emissions of the four water pollutants selected for this study. The four pollutants, suspended solids, chemical oxygen demand, total nitrogen, and total phosphorous, are

[3]Pollution from agricultural sources is likely to have fallen in the past few years given reductions in agricultural activity.

generally considered to be the major contributors to water pollution.[4] Chemical oxygen demand (COD) was chosen over biological oxygen demand (BOD) because it is a more inclusive measure of oxygen demand, and because emissions taxes are levied on COD and not BOD. As was true for the air pollutants, the data in Table 4 on water pollutants show a marked downward trend in emissions over time. However, unlike the case for air pollutants, the trend is not broken by an upturn in 1994, except in the case of COD emissions. Comparing the 1995 emissions levels to the 1990 levels shows reductions ranging from 51 percent for total phosphorous to 75 percent for suspended solids.

The downward trend in emissions over the past few years broadly mirrors changes in economic activity over this period. Estimates of gross domestic product (GDP) per capita for the five-year period are presented in Table 5. As can be seen, there were sharp drops in GDP per capita in 1991, 1992, and 1993, followed by smaller drops in 1994 and 1995. Underlying these drops in GDP per capita was the closure of numerous enterprises, among them many manufacturing plants, including those producing military equipment, that were major emitters of pollutants. For water pollutants, some of the reduction in emissions can also be attributed to the construction of wastewater treatment plants, in particular one for Riga (VARAM, 1995). At present, approximately 65 percent of municipal wastewater is treated. This fraction will rise in the near future given the planned construction of more wastewater treatment plants in urban centers.

Tables 6 and 7 provide breakdowns of pollutant sources. As seen in Table 6, heating systems are a major source of air pollutants. These fossil-fuel burning plants provide heat and hot water to households and enterprises. With the exception of particulate matter, heating systems account for three-quarters, or more, of 1995 stationary source emissions of the selected pollutants; for particulate matter, they account for a still sizeable 51 percent of emissions. The main state district heating plant, which primarily serves the Riga region, alone accounts for approximately a third of all SO_2 emissions, and a half of all NO_x emissions.

Table 7 provides a breakdown of water pollutant emissions by source. Municipal plants are by far the largest source of emissions, accounting for 80 percent or more of all emissions. Industrial sources account for much of the remainder. The data in Table 7 need to be interpreted with some caution, however, because the data in the table do not reflect the *original* source of emissions. Many industrial facilities send their wastewater to municipal plants where it is either wholly or partially treated before being released into water bodies. For data gathering purposes, these emissions are classified as emissions from municipal, rather than industrial, sources. Available data for the municipal sewage treatment plants in the three major cities of Riga, Daugavpils, and Liepaja indicate that, by *volume*, roughly 17 to 30 percent of the wastewater handled by the plants comes from industrial sources.[5] To the extent that industrial wastes are more concentrated than domestic wastes, the fraction of pollutant *loads* from industrial sources will be even higher.

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[4]Both total nitrogen and total phosphorous represent the sum of different forms of nitrogen and phosphorous, respectively, that are found in wastewaters. Emissions taxes are levied on total nitrogen and total phosphorous rather on individual nitrogen- or phosphorous-containing compounds.

[5]The estimates are: 17 percent of wastewater volume for Riga, 30 percent for Daugavpils, and 24 percent for Liepaja (estimates derived by Valdis Seglins).

The above data reveal that government enterprises, either at the state or municipal level, are the primary stationary/point source emitters of pollutants in Latvia. This is not surprising given that virtually all enterprises in Latvia were government owned and operated until 1991. However, an examination of data of the type presented in Tables 6 and 7 for the years 1990-94 indicates that there has been no clear trend towards a larger proportion of pollution being emitted by the private sector, despite the fact that numerous enterprises were privatized during this period. This apparent discrepancy can be explained by the fact that the enterprises privatized were small ones. Only a few large enterprises have been privatized thus far. As efforts to privatize them bear fruit, the proportion of emissions emanating from the private sector will increase. However, to the extent that district heating plants and municipal wastewater treatment plants remain in government control, government-owned enterprises will be a primary source of both air and water pollutants in Latvia. Although proposals for privatizing these enterprises are being considered, it does not appear that this will occur in the near future.

The geographic distribution of pollutant emissions is also of some interest. Table 8 shows 1995 emissions of the selected air pollutants in the three major cities of Latvia. Not surprisingly, emissions are largest for Riga: for the pollutants selected, it accounts for 10 to 20 percent of the total stationary source emissions in Latvia. Daugavpils is also a major emitter of SO_2 (14 percent of total) and CO (10 percent of total). As for Liepaja, it is only a major emitter of NO_x (17 percent of total), the Liepaja metallurgical plant (Liepajas Metalurgs) being a major source of this pollutant. The magnitude of the contribution from Daugavpils and Liepaja is surprising to the extent that each has only one-seventh the population of Riga. Together, these three cities account for a substantial portion of stationary source emissions of air pollutants in Latvia, ranging from 18 percent for particulate matter to 44 percent for NO_x.

Table 9 shows water pollutant emissions in 1995 for the three major cities. An even larger share of point source emissions of water pollutants is accounted for by the three cities. Riga alone is responsible for over a third of all point source emissions of total nitrogen and total phosphorous, and nearly two-thirds of all emissions of suspended solids and COD. Together, the three cities account for approximately three-quarters of all point source emissions of suspended solids and COD, and one-half of all point source emissions of nitrogen and phosphorous.

B. Ambient Standards and Quality

As noted earlier, the pollutant limits prescribed by the REBs are intended to ensure the maintenance of ambient quality standards carried over from Soviet environmental regulations.[6] There are apparently several hundred air and water quality standards. This is much larger than the number of standards typically employed in the West. The criteria used in setting the standards are unclear. Table 10 shows air quality standards for the pollutants selected for this study. The standards are presumably based on human health risks, rather than plant or animal risks, since they are intended for population centers. Note that there are no standards for annual average concentrations.[7] For comparative purposes, Table 10 also

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[6]The Council of Ministers' Resolution No. 337 of August 14, 1992 states that all former Soviet standards remain in force until they are repealed or replaced.

[7]Given that the standards were for all population centers (villages, towns, cities) in the former Soviet Union, annual average standards were probably deemed infeasible given the frequent monitoring needed to estimate annual averages with any precision.

lists U.S. and western European air quality standards. The U.S. standards are set at levels that are supposed to eliminate risks to human health, although there is some controversy as to whether they in fact do so (Portney, 1990).

The table indicates that, in general, the Latvian standards are the strictest. A comparison of the 24-hour standards shows that for carbon monoxide, sulfur dioxide, and nitrogen dioxide, the Latvian standards are stricter by a factor of at least two. The 24-hour particulate matter standard is identical to that for the U.S., but it is possible that the definitions of particulate matter (i.e., maximum particle size) differ.

Table 11 presents air quality data for Riga. Annual averages are listed along with maximum concentrations observed in air quality samples; the percentage of samples with concentrations exceeding Latvian 20-minute or 24-hour standards is also noted. The data do not exhibit clear trends over time.[8] For the pollutants selected, air quality was worst in 1994, and improved somewhat in 1995. In terms of meeting the Latvian standards, the only notable problem is NO_2 concentrations. For all other pollutants, no more than three percent of observed concentrations exceed the corresponding standards. A comparison of the 1995 air quality levels with the U.S. and European standards in Table 10 yields, with one exception, favorable results. Carbon monoxide concentrations do not appear to be excessive: the maximum value observed is far below the U.S. one-hour standard and below the European 24-hour standard. The same is true for sulfur dioxide: the annual average concentration is an order of magnitude lower than both the U.S. and European standards; the maximum observed concentration is higher than the European 24-hour standard but not the U.S. one. As for nitrogen dioxide, the annual average concentration exceeds the European standard but not the U.S. standard. Maximum observed values of this pollutant appear high when compared to the 24-hour standards for the U.S. and Europe.[9] Particulate matter concentrations do appear to be a problem: the annual average concentration is roughly double the European and U.S. standards, and the maximum value is an order of magnitude higher than the 24-hour standards.

Table 12 presents 1995 air quality data for all Latvian cities.[10] Arguably, these data represent the worst air quality levels observed in Latvia, with the exception of possible "hot spots" in the vicinity of large emitters of pollution located outside urban areas. The table shows that Riga has the worst air quality. The only notable exception is the carbon monoxide concentration in Ventspils.[11] The maximum concentration observed there is still lower than the U.S. one-hour standard. Nitrogen dioxide concentrations are high in all the cities: annual average concentrations in Riga, Jurmala and Olaine exceed European, but not U.S., standards, while maximum observed concentrations in all the cities exceed the Latvian 20-minute standard. Annual average particulate matter concentrations are high in

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[8]Some of the data are suspect: for instance, the constant annual average concentration of particulate matter. Also see the particulate matter concentrations in Table 12.

[9] A detailed study of air quality over the main streets in Riga indicates that high concentrations of nitrogen oxide and dioxide are of some concern (Ubelis, 1995). The study found, however, that average concentrations of air pollutants in Riga were some of the lowest among the large cities of Europe.

[10]The city of Nigrande does not appear in the table because data for it are very incomplete.

[11]Discussions with staff of the Latvian Hydrometeorological Agency indicate that the high CO levels in Ventspils are due to the proximity of the monitoring station to the harbor railway terminal. A large number of locomotive engines use the terminal; in addition, during winter months, there is open air heating of the terminal.

most cities, exceeding both European and U.S. standards.

The annual air quality data for Riga in Table 11, as well as annual air quality and emissions data for other Latvian cities (Environmental Pollution Observation Centre, 1996), show no clear relationship between stationary source emissions and air quality levels. In many cases, marked reductions in stationary source emissions over the past few years are accompanied by unchanging or worsening air quality. This supports the contention that air quality in urban centers is largely determined by emissions from mobile sources.

Turning to water quality, Table 13 lists Latvian and European Union (EU) ambient standards for the pollutants selected for this study.[12] Dissolved oxygen standards are listed because the primary concern associated with emissions of COD (and BOD) is depletion of oxygen in water bodies. The criteria underlying the Latvian standards, which once again were retained from the Soviet era, are unclear. The EU standards are intended to protect salmonid and cyprinid fresh water fish populations. The table indicates that the Latvian standards are, in general, within the range of EU standards. Thus, for the pollutants examined, Latvian water quality standards do not seem to be unusually strict.

Data on compliance with the ambient water quality standards in major water bodies is presented in Table 14. The first column shows the percentage of measured concentrations that exceeded any water quality standard. The remaining columns show exceedance percentages for water quality standards associated with the pollutants selected for this study.[13] The data in the first column indicate that, on the whole, water quality levels were better in 1995 than in the preceding two years. Percentage exceedances for 1995 are quite low, ranging from 3% to 15%. The data in the second and third columns show, however, that this trend does not necessarily hold for individual standards: percentage exceedances for nitrate/nitrite standards (third column) were substantially higher for some water bodies in 1995.

Restricting attention to the data for 1995, it can be seen that the dissolved oxygen standard is very infrequently exceeded in any of the water bodies: the largest exceedance in 1995 was 4%. In contrast, exceedance percentages for nitrate/nitrite standards (third column) are in double digits for approximately half the water bodies listed, namely, the Salaca, Gauja, Daugava and Lielupe river basins. Thus, nitrogen pollution appears to be a significant problem. This is not surprising, to the extent that existing sewage treatment plants are primarily intended to remove COD (and BOD) and suspended solids, rather than nitrogen (or phosphorous).

C. Expenditures on Environmental Protection

Data on expenditures on environmental protection for 1995 are presented in Table 15. These data should be viewed with some caution. They are based solely on self reports by enterprises and government agencies of their expenditures on natural resource protection. As a result, it is quite possible that these estimates are biased upwards. It is also possible that the estimates reflect some double counting because they include payments from one organization to another. For example, sewage tariffs paid by enterprises

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[12]U.S. standards are not listed because it does not have a uniform set of ambient water quality standards. Standards vary across states, and they vary from one water body to the next, depending on the uses the water body is designated to support (e.g., fishing vs. swimming).

[13] Data on compliance with standards for phosphates were not available.

to municipalities could show up as expenditures on water resource protection by the enterprises as well as by the municipalities that use these revenues to cover their expenses.

As can be seen from the table, expenditures on protection of water resources dwarf expenditures on other resources. The bulk of these expenditures can likely be attributed to the operation of municipal water and wastewater treatment plants. Most of the expenditures are made in the major cities. Ventspils incurred unusually large expenditures in 1995 because of the construction of a new wastewater treatment plant by the state-run Ventspils Nafta oil company and the reconstruction of the municipal water supply network.

V. IMPLEMENTATION OF THE LAW ON NATURAL RESOURCES TAX

We now turn to characterizing the implementation of the pollutant limits and taxes mandated by the Natural Resources Tax Law. The descriptive material presented here is based on interviews of staff members of the Riga and Daugavpils Regional Environmental Boards (REBs). These are the two largest of the nine land-based REBs in Latvia. The Riga REB interview was conducted first. We followed up with an interview of the Daugavpils REB in case there were substantive differences in the procedures used by different REBs. We found procedures to be essentially the same for the two REBs.[14] Information from the REBs was supplemented with information from staff of VARAM.

A. Permitting and Limit Setting

The permitting procedure starts with an application by an enterprise to the local Regional Environmental Board. The application contains a variety of information, including data on the characteristics of the enterprise's activities and waste streams. The REB reviews the application and specifies a set of limits that, in principle, ensures that ambient quality standards are not violated. The procedures used for setting limits for public and private enterprises are the same. An enterprise can always appeal for a change in limit values by filing a new application with the local REB.

Enterprise limits are calculated using manuals prepared by a variety of technical committees of the former Soviet Union. The manuals provide formulas for relating ambient concentration levels to pollutant loads. These formulas appear to be based on simple models of pollutant fate and transport. The level of detail and sophistication of the techniques specified in the manuals varies across pollutants. In practice, ambient quality goals are not the only determinants of an enterprise's limits. Other factors also play a role, and these factors may result in ambient quality goals not always being met.[15] Currently, it is not uncommon for limits to be determined through negotiations between enterprises and REBs. During the Soviet era, and shortly thereafter, REBs were fairly inflexible when setting limit values. They have become more flexible because of the quickly changing, and difficult, economic conditions facing enterprises. For instance, because of recent increases in the price of natural gas, district heating plants have been making greater use of fuel oil. Because burning of fuel oil generates more pollution (especially, sulfur dioxide emissions), limit values for some district heating plants have been raised.

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[14]Our findings about permitting procedures are consistent with those broadly described in Brunenieks, *et al.* (1996).

[15]This is not at all unusual--it is commonplace in the U.S. and Western Europe.

Both air and water permits contain limits on annual loads of pollutants (tons per year). Taxes are levied on the annual loads of common pollutants. Permits also contain limits on concentrations of pollutants in waste streams (for water pollutants) and emissions rates of pollutants, e.g., grams emitted per minute, (primarily for air pollutants, but also in the case of water pollutants). In some cases, there are seasonal, and even monthly, variations in the limits specified. The permits thus restrict the "time profile" of pollutant releases into the environment. This is common practice in other countries as well: it reflects the fact that damages from emissions do not depend solely on how much pollution is emitted, but also on when, and at what rate, it is emitted.

Permits currently being issued are typically valid for a period of one year, and must be renewed thereafter. In the past it was quite common for permits to be valid for periods of up to five years. Many of these permits are still in force. In at least some cases, permits are still in force, de facto, even though they have expired.

B. Monitoring Compliance

The enforcement problem faced by the REBs appears to be a difficult one. The Riga REB is responsible for approximately 500 point sources of water pollution and 440 stationary sources of air pollution. For these 940 sources, the Riga REB has 27 full-time inspectors. Although many of the sources of water pollution are also sources of air pollution, monitoring of compliance with air and water limits is carried out by different inspectors. The Daugavpils REB is responsible for approximately the same number of sources (1000), and it has a similar number of inspectors (32).

An enterprise is inspected from once a year to a maximum of four times a year. Larger enterprises are those inspected more frequently. The norm, however, is one inspection per year.[16] Enterprises are generally informed of upcoming inspections a few days before they are carried out. There appear to be no real legal obstacles to inspecting private enterprises.[17]

Inspections take the form of visual checks, together with collection of samples from waste streams for subsequent analysis at the REB's labs. Each year, the Riga REB carries out approximately 10,000 analyses (i.e., measurements of pollutant concentrations in waste stream samples). A similar number of analyses is carried out by the Daugavpils REB (9,545 in 1995). Measurements are used to determine not only compliance with annual loads (on which tax payments are based), but also to determine compliance with limits on pollutant concentration in waste streams and limits on emissions rates. In some cases, especially for air pollutants, emissions are estimated using formulas prescribed in manuals prepared, once again, by technical committees of the former Soviet Union. For example, emissions from furnaces, such as those used by district heating plants, are estimated using formulas that make use of information on the type of furnace, its operating characteristics, and characteristics of the fuel burned. Efforts are made to ensure the accuracy of the information used in the estimation procedures. In some cases this can be difficult to do on an ongoing basis. For example, continuously verifying characteristics of the fuel used by heating plants is both difficult and costly.

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[16]These inspection frequencies are similar to that in the U.S. (Russell, *et al.*, 1986, Chapter 2).

[17]In the U.S., there is some legal ambiguity about EPA's rights to inspect private enterprises (Russell, 1990).

In addition to the monitoring by REBs, enterprises are supposed to periodically measure their own emissions and self-report this data to REBs. Larger enterprises are required to do this quarterly.[18]

In addition to monitoring compliance with the limits contained in permits, government agencies must ensure that enterprises pay the correct amount in taxes. This monitoring is also done in large part by the REBs. The new tax law makes VARAM, or its agents, responsible for certifying an enterprises proposed tax payments. This appears to be consistent with current practices. The REBs do pass on data on enterprise emissions and limits to the State Revenue Service. Concern was voiced that for many enterprises the amounts paid in taxes were smaller than the monitoring costs incurred by the enterprises and REBs.

C. Sanctions for Noncompliance

Noncompliance with permit provisions can take a variety of forms, including: not obtaining a permit (reportedly a rare occurrence), not renewing a permit in time, not submitting self-reports, or under-stating emissions and associated tax payments. The initial response by REBs to detected noncompliance is to informally, or formally, reprimand the enterprise. If this does not result in the enterprise taking the steps necessary to achieve compliance, penalties can be levied administratively (i.e., without judicial proceedings). However, if the penalties are challenged by the enterprise, it has the right to judicial review.[19] If penalties are small, enterprises generally do not contest them. Data presented below suggest that the typical penalty is very small (less than 50 lats).

The most severe sanction is shutting down an enterprise. This typically requires lengthy legal proceedings, unless an immediate and severe danger is posed to human health. An enterprise was shut down by the Daugavpils REB last year, so the threat of closure may well be a credible one.

We were able to obtain detailed data on sanctions imposed by the Daugavpils REB in 1995. The data are shown in Table 16. Although the number of sanctions imposed (268) was quite large, the average penalty collected was less than 20 lats, a trivial sum for any enterprise. For the Riga REB we were only able to obtain aggregate data: it collected 120,000 lats in "fines" in 1995. Ninety percent of this sum came from payments of the penalty tax rate, and the remaining 10 percent (12,000 lats) from administrative penalties. If the number of sanctions imposed by the Riga REB is of the same magnitude as for the Daugavpils REB (they are responsible for nearly the same number of sources), the average administrative penalty assessed by the Riga REB was 45 lats, which is also a trivial sum.[20] It appears that the practice, common during the Soviet era, of linking administrative penalties to the average monthly wage is still quite common.

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[18]A similar self-reporting frequency is employed in the U.S.

[19]This is similar to enforcement procedures in the U.S. and Britain. Formal penalties are imposed only after repeated attempts at cajoling a firm into compliance fail.

[20] The 12,000 lats in administrative penalties collected by the Riga REB is likely to include penalties imposed on motor vehicles. (These were subtracted from the data for the Daugavpils REB presented in Table 16; they were equal to 40 percent of stationary/point source penalties.) Thus, the average penalty for stationary/ point sources is likely to be even smaller than 45 lats.

Aggregate data for all REBs on penalties assessed for violations of limits for water pollution *and* water use are presented in Table 17. The data represent penalties *assessed* and not penalties *collected.* This might explain why the estimates discussed in the previous paragraph, which were obtained directly from the Riga and Daugavpils REBs, are smaller than those reported in Table 17, which were obtained indirectly. Nevertheless, the data in Table 17 indicate that very modest sums are imposed in penalties. The maximum sum of penalties imposed is the 190,020 lats in 1994. At least some of these penalties would have been imposed on motor vehicles, enterprises exceeding their water use limits, and entities responsible for accidental spills of hazardous materials. Thus, the penalties imposed on stationary/point sources for violation of emissions limits could well be substantially smaller. The data in Table 17 also suggest that there is considerable variation in enforcement activity across REBs. Some REBs have assessed virtually no penalties in recent years.

D. Survey of Major Emitters

As part of this study, we identified the largest emitters of the selected air and water pollutants. Summary data on the top 30 emitters of air pollutants are presented in Table 18, and data on the top 20 emitters of water pollutants are presented in Table 19. Enterprises are classified as state, municipal, or private based on their *current* legal status. A smaller number of water pollutant emitters was chosen because, as shown below, emissions of water pollutants are highly concentrated.

The last row of Table 18 indicates that in 1995 the top 30 air pollutant emitters accounted for a substantial portion of total stationary source emissions in Latvia, ranging from 33% for carbon monoxide to 68% for sulfur dioxide. A strikingly large fraction of total emissions is accounted for by state and municipal enterprises. Together, they are responsible for nearly one-half to three-quarters of total emissions by the top 30 emitters.

The last row of Table 19 shows that emissions of the selected water pollutants are even more concentrated: in 1995, the top 20 emitters accounted for two-thirds or more of all point source emissions in Latvia. Unlike the case for air pollutants, municipal enterprises (typically, water and wastewater treatment plants), are the primary sources of water pollutants. They are responsible for roughly 85% of all emissions by the top 20 emitters. The remaining emissions are primarily from state enterprises, with a minimal contribution from private enterprises.

For each of the top 30 air pollutant emitters, Tables 20a-d show 1995 emissions levels and limit values for the four air pollutants. Limit values for particulate matter were not included in the database from which the tables were prepared. For the other three pollutants, the last column in each table shows the ratio of emissions to limit value. As can be seen, emissions are generally well below limits. For sulfur dioxide and nitrogen dioxide, the average ratio of emissions to limits are 51% and 66%, respectively, with only one enterprise exceeding its limits. The average ratio is somewhat higher for carbon monoxide, at 72%, with two enterprises exceeding their limits. Comparing the summary data at the bottom of the tables reveals no consistent relationship between the type of enterprise and the magnitude of the emissions-to-limit ratio.

A comparison of the limit values for 1995 and those for earlier years (see Tables A-1 in the Appendix) indicates that, in each year, limit values for roughly 20 percent of the enterprises are changed. In nearly all cases, these changes are not meaningful, in that emissions are well below both old and new limits.

Tables 21a-d show 1995 emissions levels and limit values for the top 20 emitters of water pollutants. Enterprises frequently have separate permits for different outfalls (discharge pipes). The limit values presented in the table represent the sum of the load limits for the pollutant in question.[21] The tables reveal that compliance[22]rates with limits are generally lower for water pollutants. This is especially true for suspended solids and total phosphorous. In the case of suspended solids, over half of the enterprises with load limits exceed these limits, in some cases by more than an order of magnitude. The average ratio of emissions to limit values, even after removing outliers, is 1.72. The situation is somewhat better for total phosphorous. Although nine of the twenty enterprises exceed their load limits, the average ratio of emissions to limit values is 0.99. For chemical oxygen demand, only four of the seventeen enterprises with load limits exceed the limits, and the average ratio of emissions to limit values, after removing an outlier, is 0.84. The pollutant with the highest compliance rate is total nitrogen: only two enterprises exceed their limits, and the average ratio of emissions to limit values, after removing an outlier, is just 0.52.

It should be noted that the quality of the emissions data in Tables 20 and 21, which were obtained from VARAM databases, is open to question. As part of our survey of major emitters, we obtained emissions data directly from some enterprises. In some cases, these reported emissions levels were substantially higher than the levels in the VARAM database.

To get some sense of the degree to which pollutant emissions are correlated, in other words, the degree to which major emitters of one pollutant are also major emitters of other pollutants, Tables 22 and 23 present the emissions rankings of the top emitters of air and water pollutants, respectively. Blank entries in the tables indicate that the enterprise was not among the top 30 (air pollutants) or top 20 (water pollutants) emitters for the pollutant in question. As can be seen from Table 22, emissions of air pollutants are quite correlated: 66 enterprises comprise the top 30 emitters of all four air pollutants. The degree of correlation is highest for state and municipal enterprises; correlation is limited for private enterprises, as evidenced by the numerous empty cells in that portion of the table.

Table 23 indicates that emissions of water pollutants are even more correlated than those for air pollutants: 37 enterprises comprise the top 20 emitters of all four water pollutants. The correlation is again highest among municipal enterprises. The Riga and Daugavpils water and wastewater treatment plants are the top two emitters of all four water pollutants.

A comparison of the enterprises in Tables 22 and 23 reveals, surprisingly, that there is very little correlation across environmental media. Only three enterprises (Bolderaja, Ogre, Valsts Slokas Celulozes un Papira Rupnica) are major emitters of *both* air and water pollutants.

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[21]Unfortunately, we were not able to obtain emissions data by outfall. Aggregating an enterprise's load limits for a given pollutant across outfalls could mask situations in which the enterprise's emissions exceed load limits for some outfalls but not others. This implies that the estimates of an enterprise's emissions tax payments derived in Section VII could be biased downwards.

[22]The term compliance is used loosely here: exceeding load limits does not imply an enterprise is violating regulations, unless it fails to make the appropriate tax payments.

VI. ASSESSMENT OF THE SYSTEM OF TAXES AND LIMITS

A. Ambient Quality Standards

An assessment of the current systems of taxes and limits must take into account the goals of these policy instruments. In principle, the primary goal is ensuring the maintenance of the exhaustive set of Soviet-era ambient quality standards. The reasonableness of these standards and their relevance to Latvian conditions can be questioned on at least two grounds. First, the standards were intended for the entire Soviet Union, as such, they were presumably chosen to cover an extremely broad range of polluting activities, pollutants, and environmental conditions. At least some of these will not be relevant to Latvia. Second, the criteria underlying the standards are unclear: Were the standards intended to *eliminate* risks to human health (as in the U.S.), or risks to all animal and plant populations? Or were they intended to strike a reasonable *balance* between risks and control costs? For the pollutants considered in this study, Latvian water quality standards are in the range recommended by the EU, but Latvian air quality standards are, in general, considerably stricter than those in Europe or the U.S.

VARAM is currently reviewing water quality standards for a larger set of pollutants than those considered here. This review is motivated, in large part, by Latvia's efforts to pave the way for integration into the EU. Based on our findings, the air quality standards should also be reviewed. (There appear to be no immediate plans to revise air quality standards.) Particular attention should be given to the 20-minute standards; standards for such a short averaging time are not commonly used outside the former Soviet Union, and these standards are likely to be the among the most costly to achieve. Attention should also be given to the desirability of instituting annual average standards. Such standards are common in the U.S. and western Europe, but are not employed in Latvia (at least for the pollutants examined).

Given the time-consuming and controversial nature of the standard-setting process, it would be appropriate to focus initial efforts on reviewing standards for common pollutants, and pollutants that are of particular concern in Latvia. A complete review of the full set of Soviet standards is unlikely to be a good use of VARAM's limited resources.

An issue that VARAM will face (it has probably done so already) when reviewing standards is deciding which criteria to use when setting standards. What types of risks should be considered? Just those experienced by humans, or also those experienced by plants and animals? Should the costs of achieving the standards be taken into account when setting them? Or should the costs be ignored? Experience in the U.S. and Europe shows that, at least implicitly, tradeoffs are invariably made between risks and costs even when the stated policy goal is eliminating risks to humans, animals, or plants. From an economic standpoint, it would be desirable to make these risk-cost tradeoffs explicitly and in a consistent manner, to the extent possible. Doing so would reduce the aggregate social costs of reducing risks.[23]

In the near term, maintaining Soviet standards for less common pollutants is arguably desirable, provided the standards are judiciously enforced. Having these standards on the books gives REBs a basis for

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[23]Economists have criticized the lack of consistency in the implicit tradeoffs commonly made when setting environmental and safety standards. For example, the costs of achieving the same reduction in risk of death can vary by more than an order of magnitude for different standards. This inconsistency implies that the reductions in risk are not being achieved at the lowest possible cost to society.

controlling emissions of these pollutants in the event that they become more common and troublesome. In the longer term, standards for these pollutants should be reviewed as well. In addition, attention should be given to standards for synthetic, toxic chemicals that were not in use in the former Soviet Union, and were therefore not explicitly regulated.

B. Ambient Quality Levels

Our data on ambient quality levels for the air pollutants examined in this study indicate that, with a few exceptions, ambient air quality levels are quite good. The potential problem pollutants are nitrogen dioxide and particulate matter. Annual average concentrations of nitrogen dioxide in Riga and, to a lesser extent, Jurmala and Olaine, exceed European standards, but not the U.S. standard. In all cities, maximum observed concentrations of nitrogen dioxide exceed the Latvian 20-minute standard (in the case of Riga and Jurmala, by a factor five), and they exceed the 24-hour U.S. and western European standards. Again, the reasonableness of the Latvian 20-minute standard needs to be assessed before violations of it are deemed a problem.

Particulate matter concentrations are also high in most cities. Annual average concentrations exceed U.S. and western European standards. Maximum observed concentrations exceed the 24-hour standards, and in the case of Riga, Olaine, and Ventspils, the 20-minute Latvian standard. A worthwhile first step would be to assess the quality of the data on annual average concentrations. It seems implausible for annual average concentrations of particulate matter to be the same (100 $\mu g/m^3$) for most Latvian cities.

It should be emphasized, once again, that the data do not indicate that these high concentration levels are due to stationary sources. Emissions from these sources have, in general, declined substantially in recent years, whereas ambient quality levels have generally stayed the same or even worsened. Thus, mobile sources appear to be responsible. In the case of particulate matter, it is possible that increased construction and renovation activities in cities, especially Riga, are also responsible for high concentration levels. Estimates of the costs of controlling emissions from these sources, which are largely unregulated at present, need to be developed and compared with estimates of the costs of imposing more stringent controls on stationary sources before policy choices are made. Turning to water quality, the paucity of suitable data on water quality makes it difficult to draw firm conclusions. However, the available data do indicate that levels of nitrogen compounds are high in many water bodies, exceeding both Latvian and European standards. This is true despite the fact that rates of compliance with nitrogen load limits are very high among the top 20 emitters. This suggests that either other sources of nitrogen are important or that the load limits prescribed are not sufficiently stringent.

C. Emissions Taxes

Combining emissions taxes and limits to regulate pollutants departs from the usual textbook prescription of using these instruments singly rather than jointly. However, this combined approach is also used in some western European countries (Hahn, 1989). From an economic standpoint, there are theoretical advantages to using instruments jointly (Roberts and Spence, 1976), however, it is unclear, if not unlikely, that these advantages are realized with the system currently in place[24]. Among the key issues is

[24]Roberts and Spence show that if the regulator is uncertain of firms' abatement costs, it can get closer to the first-best optimum by using a *carefully chosen* combination of taxes, tradeable permits, and subsidies.

setting the taxes, and limits, appropriately. As discussed below, the system of taxes currently in place can be evaluated from a number of perspectives.

1. Cost-Effectiveness in Achieving Policy Goals

Without detailed data on enterprises' costs of controlling emissions and data on the effects of their emissions on ambient quality, it is difficult to draw firm conclusions about the degree of cost-effectiveness of the current system of emissions taxes. However, some important qualitative observations can be made.

The usual economic argument made in favor of emissions taxes is that they are cost effective. Specifically, an emissions tax minimizes the social costs of achieving *reductions in emissions* by ensuring that marginal costs of reducing emissions are equal for all sources.[25] This does not automatically mean, however, that an emissions tax will minimize the social costs of achieving an *ambient quality standard.* The latter is true only if, on a per unit basis (e.g., per ton), emissions are equally damaging for all sources. If, however, the effect of emissions on ambient quality depends on the location of emissions, an emissions tax will not be cost-effective.[26] Location of emissions is typically of importance for the major water pollutants (those considered here) and for some air pollutants. Hence, some caution should be exercised in advocating the use of emissions taxes on cost-effectiveness grounds when the policy goal is achieving ambient quality standards (as in Latvia). The extent of the deviation from cost-effectiveness of an emissions tax will depend on the extent to which location is important: if the effects of location are modest, the departure from cost-effectiveness will be small.

There is further reason for exercising caution in advocating the use of emissions taxes on cost-effectiveness grounds. The cost-effectiveness argument assumes sources are cost-minimizers. For private enterprises, this is a reasonable assumption: if an enterprise is not minimizing its costs it is not maximizing its profits. However, government enterprises are major emitters of pollutants in Latvia. It is open to question whether the incentive structure in these enterprises results in cost minimizing behavior.

In our discussions with REB staff, concern was voiced that many enterprises seemed to make little or no effort to reduce their emissions, they simply paid the necessary taxes.[27] If we are willing to assume that these enterprises are cost-minimizers, then this behavior is not inconsistent with cost effectiveness. These enterprises presumably find it cheaper to pay the tax than to reduce emissions. From the standpoint of cost-effectiveness, this is not a bad outcome if the enterprises' emissions are below limits. If these limits ensure the maintenance of ambient quality standards, and these standards are considered to be appropriate policy goals, it can be argued that any abatement expenditures by these enterprises would be

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[25]To be precise, the argument is that a *uniform* emissions tax minimizes the aggregate *abatement* costs associated with achieving a reduction in emissions. The tax may not minimize the enforcement and information costs associated with achieving the emissions reduction.

[26]For example, the effect of a ton of COD on dissolved oxygen concentrations in a river will depend on the characteristics of the river (e.g., its flow rate) at the point where the COD is introduced. In such settings, a uniform tax on *concentration*, rather than *emissions*, contributions is cost effective.

[27]In the textbook world of smooth, continuous marginal abatement cost curves, a positive tax always induces some reduction in emissions. In practice, control options are often lumpy, resulting in discontinuous responses to a tax.

socially wasteful. Raising the emission tax just to induce these enterprises to cut their emissions would not be economically justifiable. On the other hand, if the enterprises' emissions are above limits, and this results in the violation of ambient quality standards, it can be argued, on economic grounds, that the tax should be raised. The obvious question is: by how much? Without detailed information on how costly it is for enterprises to reduce their emissions, this question is difficult to answer. At present, there appears to be little information of this type. However, the substantial increase in tax rates that will take effect on July 1, 1996 will create a "natural experiment" that should generate useful information on enterprises' costs of reducing their emissions.

2. Source of Revenue

Although the standard economic argument in favor of emissions taxes focuses on their role as an incentive for reducing emissions, this is not the only role for such taxes. Another role is as a source of revenue for the government. This role appears to be an important one for the system of emissions taxes currently in place (i.e., the 1995 taxes). Indeed, it can be argued that it is the primary role given that for many enterprises the taxes provide little incentive for emissions reductions and that many enterprises are emitting below their limits. A question that should therefore be asked is whether these taxes are a cost-effective source of revenues for the government. This question has already been asked within VARAM given the decision to eliminate taxes on chlorides and sulfates because the revenues they were likely to generate would not justify the costs of administering and enforcing them.

This question was also implicitly asked by REB staff when they expressed concern that emissions tax payments for many enterprises were substantially smaller than the costs to the REB, and to enterprises, of routinely measuring emissions.[28] On the surface, this may seem blatantly uncost-effective. But this is not necessarily true. If the emissions measurements are also needed to verify an enterprise's compliance with limits, then the measurements can be justified in the same way that measurements of pollutants that are not taxed are justified. But what if routine measurements are *not* needed to verify an enterprise's compliance with its limits? For example, it may be possible, in many cases, to inexpensively verify an enterprise's compliance with its limits without routinely measuring its emissions (e.g., by checking that its output level, or use of polluting inputs, is not higher than usual). In such cases, measuring emissions for the sole purpose of collecting emissions taxes may well be uncost-effective. Determining whether it is, requires a comparison of the costs of measuring emissions and the costs of raising revenues through other means (such as income taxes, for example).[29] Comparing measurement costs to tax payments is not appropriate because the measurement costs are real resource costs, whereas the tax payments are simply transfers from the enterprise to the government (albeit costly transfers). Estimates of the (marginal social) cost of government revenues in western countries are in the range of 20-40%, this means that for each dollar, say, raised in revenues, 20-40 cents of real costs are incurred. The cost of government revenues in Latvia may well be higher than this, but it is certainly less than 100%, that is, each lat raised in revenues through income taxes, say, would not impose real costs of one lat or more.

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[28]Measuring emissions of even common pollutants, especially in water, can be quite expensive. Estimates presented by Russell, *et al.* (1986) for the U.S. show that analysis of a single waste stream sample typically costs hundreds of dollars.

[29]This again assumes that limits and ambient quality goals are appropriately set. Any incentive effect the tax has in keeping emissions below limits would then be inconsequential. It also assumes that there are no deadweight losses associated with the emissions tax.

This implies that measuring emissions for the sole purpose of collecting emissions taxes may be uncost-effective even if tax payments are *somewhat larger* than measurement costs; if the tax payments are *smaller* than measurement costs it is certainly uncost-effective.

It is quite likely that the second case described above holds for enterprises whose emissions levels are inherently low, and who therefore pay small amounts in taxes. One means of reducing uncost-effective expenditures on measurements (and more generally on tax administration and enforcement) for such enterprises would be to exempt them from paying emissions taxes. The enterprises would only be required to comply with the limits in their permits. This sort of "regulatory tiering", where different levels, or stringencies, of regulation are applied to different "sizes" of enterprises, has been used with some success in the U.S. in a number of regulatory settings, not just environmental ones. This regulatory tiering is also recommended below in the context of the permitting process.

A final point on the use of emissions taxes as a source of revenue is the relationship between the magnitude of the tax and the revenue collected. Specifically, raising emissions taxes will not always increase the amount of revenue collected. There invariably will be a "Laffer curve" effect. As emissions taxes are raised, enterprises will (eventually) find it cheaper to reduce emissions than pay taxes on those emissions. There will be some point, determined by enterprises' costs of reducing emissions, beyond which further tax increases will result in less revenue being collected.[30] This effect is most easily appreciated with the following extreme-case example.[31] Suppose an enterprise emits 1,000 tons of a pollutant. The enterprise can reduce emissions of this pollutant at a constant cost of 100 lats per ton. The current tax on the pollutant is 50 lats per ton. Because the tax per ton is smaller than the cost per ton of reducing emissions, it is cheaper for the enterprise to not reduce its emissions at all and simply make the tax payment of 50,000 lats (1,000 tons x 50 lats/ton). Suppose now that the tax is raised to 200 lats per ton. It is now cheaper for the enterprise to control its emissions than to pay the tax. Therefore, the enterprise will reduce its emissions to zero, at a cost of a 100,000 lats (1,000 tons x 100 lats/ton), and pay nothing in taxes. Thus, the tax increase results in revenues falling from 50,000 lats to zero.

3. Choice of Pollutants

Determining which pollutants should be subject to taxation is also an issue of some importance. As we have seen, only a subset of regulated pollutants are taxed. Moreover, the set of pollutants taxed has changed somewhat with the new tax law. These changes appear to have been motivated in part by concerns about the costs of administering and enforcing taxes. The effectiveness of taxes in controlling pollutants also should be considered (if this is not already true). A common economic argument is that if the regulator is uncertain about sources' costs of reducing emissions, taxes are preferable to emissions limits (alone) only if there is limited concern about the exact quantity of pollutant emitted.[32] This may

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[30]A Laffer-like effect could also arise if higher tax rates are viewed as unreasonable, leading to more widespread tax evasion. Anecdotal evidences suggests this occurred recently in the context of heating charges for households: large increases in the charges resulted in a fall in revenues because a large fraction of households ceased paying their heating bills.

[31]The example is an extreme one only because the marginal cost of reducing emissions is assumed to be constant (100 lats per ton). Typically, marginal costs of reducing emissions increase as emissions fall.

[32]More formally, taxes are preferable only if the marginal damage curve is less steeply sloped than the marginal abatement cost curve (e.g., see Baumol and Oates, 1988, Chapter 5).

not be true of highly toxic chemicals: environmental damages may increase sharply if concentrations of these pollutants rise above some threshold level. In this case, it would be desirable to control the amounts of these pollutants with a set of effectively enforced limits.

Examining the list of pollutants taxed under the new law (Tables 1 and 2), possible pollutants that are highly toxic and that exhibit threshold effects are cadmium, chromium and lead. The taxes on these pollutants are, comparatively, very high. If they are high enough to keep enterprises' emissions within appropriate limits, there is little reason for concern. However, if with these taxes, enterprises find it cheaper to exceed appropriate limits and pay the penalty tax rate, the issue of how best to regulate these pollutants needs to be re-examined. Raising tax rates is one option. However, determining by how much to raise rates will require good estimates of enterprises' costs of controlling emissions of these pollutants. Setting tax rates that are perceived to be unreasonably high may simply result in enterprises concealing their emissions, or not paying taxes. Eliminating the taxes and just having emissions limits would correct the problem only if the emissions limits can be effectively enforced with stiff, credible penalties for exceeding them. Another alternative would be to employ technology standards for such pollutants; i.e., requiring all firms emitting these pollutant to install specific abatement technologies. This option may well be the least costly to enforce, once enterprises have installed the abatement technologies.

4. Inflation

Among the reasons emissions taxes did not prove effective during the early '90s is that the real levels of the taxes were eroded by high inflation rates. Although efforts were made to adjust the taxes periodically, they did not keep pace with inflation. The new taxes represent a substantial increase in real rates. Although inflation is currently low, it would be desirable to explicitly index the tax rates to some measure of inflation (e.g., a producer price index, if one is available). This would ensure that the taxes are not eroded over time. Also, compared to sporadic and difficult-to-anticipate adjustments of tax rates, it would give enterprises a better ability to predict how tax rates will vary over time. This diminished uncertainty will improve their ability to make cost-effective decisions about investments in pollution control measures.

5. Relationship to Municipal Tariffs for Industrial Wastewater

A final issue related to emissions taxes is one that is outside the scope of this study, but which deserves mention because it is likely to have important implications for the effectiveness of the taxes on water pollutants. As discussed in Section IV, a substantial fraction of the wastewater discharged by municipal plants comes from industry. Municipalities impose tariffs on the enterprises whose wastes they process. These tariffs vary from one municipality to the next, and it is unclear how they are set. There is some evidence that the tariffs bear little resemblance to the tax rates for water pollutants (they appear to be based on volume of wastewater alone), and that the tariffs differ substantially for private and public enterprises and for residential users. Attention needs to be given to the interaction between municipal tariffs and emissions taxes, and to rationalizing the two sets of charges. In the current situation, enterprises may be able to effectively bypass emissions taxes on water pollutants by choosing to send their wastewater to municipal plants.

D. Permitting and Limits

Our survey of major emitters shows that, with a few exceptions in the case of air pollutants, emissions levels for most of these enterprises are well below their permit limits. This was also observed by Brunenieks, *et al.* (1996) in a survey of enterprises in Riga and Daugavpils. From an "environmentalist" standpoint this finding may be interpreted as indicating that permits limits are too lenient. However, from an economic standpoint, this conclusion is not necessarily valid, given that fairly stringent ambient quality standards are generally being met under the current system. The key question is whether ambient quality standards would be met if enterprises were emitting at their limit levels. This question is an important one to the extent that emissions levels increase as Latvia's economic recovery progresses. Attempts to answer this question by looking at pre-1990 data on emissions levels are likely to be misleading given the drastic changes that have occurred in the composition of economic activities. The emissions and ambient quality data we have examined indicate that, for the pollutants considered in this study, there is considerable "slack" in the system: more than modest increases in emissions by existing enterprises or new ones could be accommodated without exceeding ambient quality standards. The only exception to this finding is nitrogen levels in water bodies. As noted earlier, it is unclear whether this problem is due to emissions from point sources.

1. Cost-Effectiveness of Permitting Practices

Another question that needs to be addressed is whether the system of limits is being implemented in a cost-effective manner. Our survey of major emitters indicates that in some cases limits are changed from one year to the next even though emissions are consistently well below limits. To the extent that revising limits is (administratively) costly for REBs, as well as for enterprises, it may be advisable for REBs to engage in less "fine tuning" of limits.

In a similar vein, questions can be raised about the current practice of issuing permits that are valid for only a year. Previously, they were typically valid for a few years. Issuing short-lived permits does give REBs greater flexibility in revising the limits contained in permits. However, it is unclear whether this flexibility is needed, again because emissions are typically below limits. REBs could reduce administrative costs, while retaining flexibility where needed, by tailoring the life of a permit to the characteristics of the enterprise. Permits valid for more than a year could be granted to enterprises whose emissions are inherently low (and therefore do not have much of an effect on ambient quality), and to enterprises whose emissions have remained below limits and are likely to continue to do so. For safety, a clause could be added to permits explicitly allowing the REB to revise permit conditions, before a permit has expired, if significant changes occur in an enterprise's activities (e.g., large increases in product output levels would signal potential increases in emissions levels). This type of approach is another example of the regulatory tiering suggested earlier in the context of emissions tax payments. Another benefit of this approach, beyond reducing administrative costs, is that it would reduce the regulatory uncertainty faced by some enterprises, making it easier for them to make cost-effective decisions about investments in pollution reduction measures.

2. Potential for "Bubbling"

Our survey of the largest emitters of water pollutants revealed that for some pollutants their permits virtually always contained more than one load limit (e.g., multiple limits for tons of COD emitted). The explanation provided was that separate limits were specified for different outfalls (discharge pipes) or for

different discharge conditions. Much of this differentiation of limits may be justified. However, it is likely that in some cases enterprises could be given more flexibility, without jeopardizing ambient quality levels, by combining some of the limits and letting the enterprise determine the allocation of emissions across different outfalls. For example, suppose an enterprise has two outfalls, one currently has a limit of 1000 tons of COD per year while the other has a limit of 500 tons of COD per year. The suggestion is to add the two limits and specify an aggregate limit of 1,500 tons for both outfalls. Doing so would allow the enterprise to exploit any cost differences in reducing emissions from the two outfalls. For example, it might be cheapest for the enterprise to reduce its emissions from just one outfall. This sort of "bubble policy" is a simple form of emissions trading within an enterprise. It has been widely used in the U.S., and has generated large savings in abatement costs. Our discussions with REBs indicate that there is some discomfort (largely on ethical grounds) with the idea of emissions trading, but this discomfort is likely to be lower for trading within an enterprise, as is being recommended here.

3. Limits for Emissions of Nitrogen Compounds in Water

The water quality data presented in Section IV indicate that observed concentrations of nitrogen compounds frequently exceed Latvian standards, which are similar in magnitude to EU standards. Data for the top emitters indicate, however, that emissions of nitrogen compounds are well within prescribed limits. These two findings could imply that nitrogen limits are not sufficiently stringent. Reducing these limits would make enterprises face the penalty tax rate for a larger portion of their emissions. This would induce them to reduce their emissions of nitrogen compounds, assuming the penalty tax rate is high enough to have such an incentive effect. It is possible, however, that the high concentrations of nitrogen compounds observed in water bodies are due to other sources of nitrogen, specifically, other point sources(the top 20 emitters account for only 66% of total point sources emissions) or nonpoint sources, such as agricultural activity. Further study of this issue is needed.

E. Monitoring and Enforcement

The large increases in emissions taxes that go into effect on July 1, 1996 will test the monitoring and enforcement capabilities of the REBs. The higher taxes will increase the incentives for tax evasion among enterprises. The REB staff we interviewed recognized that their task was going to become more difficult, and were apprehensive of the reception the new law would get from enterprises. It is therefore important to enhance the incentives and resources for enforcement within the REBs, and to ensure that the resources are used effectively.

1. Incentives and Resources within REBs

As currently written, the new tax law does not explicitly allocate a share of tax revenues and penalties collected to REBs. The revenues are divided between local, regional, and state governments. Some portion of the revenues allocated to regional governments do indirectly make their way to the REBs. Serious consideration should be given to explicitly allocating a share of the tax revenues and penalties collected in a region to the local REB. This would increases incentives within each REB to enforce the system of limits and taxes. It may be especially effective to give each REB a reasonably large share of the penalties it collects. Giving too large a share of penalties collected to an REB could create an incentive for it to engage in over-enforcement, i.e., detecting and punishing noncompliance in cases where the social benefits of doing so are negative.

An alternative means of increasing the funds available to REBs would be to charge a fee for processing permit applications. This fee could be indexed to the size of the firm, either in terms of its revenues or the magnitude of its emissions. This would also enhance the incentives for REBs to ensure emitters of pollutants have valid permits.

2. Standardizing and Updating Enforcement Capabilities

The limited data we have indicate that there is considerable variation in enforcement activity across REBs. Attention should be given to developing a basic set of monitoring and enforcement guidelines that are applicable to all REBs. The monitoring technologies currently being used by REBs should also be assessed to determine whether cheaper and more accurate technologies for measuring emissions are available. (For example, within the past few years, a relatively inexpensive technology for continuously measuring sulfur dioxide emissions has been developed in the U.S.) This does not imply that sophisticated and accurate measuring technologies are always appropriate. As for any activity, the benefits of more accurate and more frequent monitoring should be weighed against the associated costs. In many cases, current techniques for estimating emissions based on formulas that make use of information on enterprise activities, input use, etc., may be sufficient. Efforts should be made, however, to validate the formulas periodically by comparing the estimates they generate to measured levels of emissions. Attention should also be given to the accuracy of the enterprise emissions data contained in VARAM databases.

3. Cost-Effective Enforcement

As noted in Section V, REBs currently inspect large emitters more frequently than small ones. This practice is easily justified (in fact, it can be viewed as an example of regulatory tiering), and it is one step towards making cost-effective use of enforcement resources. Another step would be to *explicitly and formally* link enterprises' self-reporting requirements and the frequency of REB inspections to an enterprise's compliance history. For example, enterprises could be classified into two groups depending on their compliance histories. Enterprises with a history of many violations would be assigned to a "poor" group, while enterprises with a history of few violations would be assigned to a "good group". Enterprises in the poor group would be required to self-report emissions data, say, twice as often as enterprises in the good group, and would be inspected twice as often. Upon compiling good compliance records, enterprises in the poor group would be moved to the good group. Similarly, if enterprises initially placed in the good group did not sustain their compliance records, they would be moved to the poor group. This form of enforcement scheme can significantly increase the compliance rates achieved with a given level of resources even when penalties assessed for violations are not very large (Harrington, 1988).

Additional improvements in cost-effectiveness could be obtained by further tailoring self-reporting requirements and inspection frequencies. In practice, an enterprise's ability and incentive to engage in noncompliance will depend on the technique it uses to reduce its emissions. For example, if an enterprise reduces its emissions by using a more expensive input that is less polluting (e.g., heating plants using natural gas instead of fuel oil), it has greater ability and incentive to violate its emissions limits on an ongoing basis than if it reduced its emission by installing a new technology that is inherently less polluting. In the first case, the firm can reduce its costs by surreptitiously using more fuel oil; in the second case, it has already sunk its costs of compliance. Therefore, self-reporting requirements and inspection frequencies should take into account the technique used by an enterprise to comply with its

limits. Enterprises that can save large sums by engaging in noncompliance should face more stringent self-reporting requirements and inspection frequencies than those that would only save small sums.[33]

4. Nature of Inspections

As noted earlier, REBs currently inform enterprises of inspections a few days ahead of time. The drawback to this approach is that observations taken during inspection visits may not be representative of an enterprise's usual characteristics. Enterprises are likely to try to put "their best foot forward" during inspection visits and reduce levels of polluting activities. Because of this possibility, it is often suggested that inspections be carried out randomly (e.g., not always on the same day of the week) and by surprise (e.g., Russell, 1990). Although this approach may, in principle, be preferable, it is likely to create a very adversarial relationship between REBs and enterprises. Studies carried out in the U.S. and Britain (Bardach and Kagan, 1982, and Hawkins and Thomas, 1984) suggest that this can be detrimental to the regulatory process: if enterprises perceive regulators to be unreasonable, they are inclined to be uncooperative and to take steps to hamper the regulator (such as routinely contesting penalties in court).

Given the difficult economic environment currently facing enterprises in Latvia, it is especially important that a markedly adversarial relationship between REBs and enterprises not be established. Accordingly, surprise inspections visits are likely to be counterproductive. It would be worthwhile, however, to explore the middle ground: for instance, carrying out inspection visits randomly, but giving enterprises a day's notice. This may allow REBs to reduce the bias in observations made during inspection visits, without creating a perception among enterprises of regulatory unreasonableness.

VII. ASSESSMENT OF TAX WAIVER PROVISION

The intent of the newly introduced tax waiver is to encourage investment in structural measures that reduce emissions. We have some concerns about how well the current waiver provision will achieve this goal. These concerns are described below.

1. Tax Debt Status and Eligibility

Eligibility for waivers is restricted to enterprises that do not have tax debts. We understand that this requirement will be strictly enforced. Unfortunately, we have been unable to obtain data on the tax debt status of major emitters. However, anecdotal evidence indicates that many of them are likely to have outstanding debts.

2. Transactions Costs and Savings

Enterprises that are eligible for waivers may be deterred from applying for them by the transactions costs involved: as discussed in Section III.B, enterprises must file applications with, or seek the approval of, multiple government agencies in order to obtain a waiver. These transactions costs could be high relative to the tax savings that are generated by the waiver. These savings are likely to be modest, as

[33] In the long run, this would influence enterprises' choice of technique in a beneficial manner, in that they would be (indirectly) induced to take into account the enforcement costs associated with alternative techniques.

explained below.

Table 24 presents economic data we are able to collect for a subset of major emitters. The figures for tax payments need to be interpreted with some caution. Numbers that are not preceded by a less than sign are reported payments of *all* natural resources taxes, including taxes for water use; numbers preceded by a greater than sign are estimates of tax payments that were calculated using only the data in Tables 20 and 21. As such, the first set of numbers are upper bounds on total air and water pollution tax payments, while the second set of numbers are lower bounds.

With the exception of the state enterprise Dauteks and the Riga municipal treatment plant, both the reported and estimated tax payments are quite small in absolute terms -- typically on the order of a few thousand lats. If tax payments triple in response to the tripling of tax rates in the second half of 1996 (this would occur only if firms do not find it cheaper to reduce their emissions), tax payments would be on the order of a few tens of thousands of lats. This is a modest sum, and it represents tax payments for the largest emitters of pollutants.

The potential savings from emissions-reduction measures will depend on the extent to which the measures reduce emissions. This will depend on the particulars of each case. If we assume, for the sake of argument, that the measures cut emissions of *all* pollutants by a third, the annual savings in tax payments would be on the order of a few thousand lats for all the enterprises in Table 24, except Dauteks and the Riga municipal plant. This implies that if the enterprises were able to take full advantage of the tax waiver, their tax payments would be reduced by a few thousand lats during the period of implementation. This period is likely to last no more than a year for all but very capital-intensive measures. These savings are quite modest, especially when compared to the budgets of the enterprises. Table 24 shows that as a fraction of revenues, tax payments are very small, with a maximum ratio of less than two percent. As a fraction of profits, tax payments vary considerably for the few enterprises for which we were able to obtain profit data.

As part of our survey of major emitters, questionnaires were sent out to emitters of air pollutants. Of the eight enterprises that responded, only one enterprise indicated an interest in exploiting the tax allowance provision. The remaining enterprises implicitly or explicitly did not consider it worthwhile to take advantage of it.[34]

Although some caution needs to be exercised in drawing general conclusions from the limited data we were able to obtain, our findings suggest that the effect of the tax waiver will be modest. With a few exceptions, for even the largest emitters of pollutants the tax savings associated with the waiver are small, even in absolute terms. The savings will be even smaller for enterprises with lower emissions. Moreover, even if the savings do make it worthwhile for enterprises to incur the transactions cost associated with obtaining a waiver, it is questionable whether they will be eligible for the waiver.

It would be worthwhile to explore options for simplifying the application process and increasing the savings that can be enjoyed by enterprises. A rather extreme alternative for increasing savings is one employed in Germany: emissions taxes can be waived for a period of three years prior to installation of a measure that reduces emissions by at least 20 percent. A more moderate alternative is one that has

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[34]Our telephone follow-ups to the questionnaires sent out to major emitters of air pollutants suggested that enterprises had given little thought to the potential for cost savings through emissions reductions. The emissions tax payments were not seen as one of the pressing problems currently facing enterprises. However, our questionnaire did induce some enterprises to consider the potential for cost savings through emissions reductions.

been employed in the U.S.: investment in pollution control technologies is encouraged by allowing enterprises to rapidly depreciate investment in pollution control technologies when calculating corporate taxes.

3. Disseminating Information on Technologies

One respondent to our survey noted that a major obstacle faced by enterprises was a lack of knowledge regarding available measures for reducing pollution emissions. Enterprises lack the resources and the expertise to identify relevant measures and to assess their relative merits; technical literature from western Europe and the U.S. is of limited use if enterprises do not have in-house translation capabilities, or the funds to pay for translations.

This problem of information dissemination is likely to be a serious impediment to the success of any tax provision for encouraging investment in pollution-reducing measures. Attention needs to be given to possible mechanisms for making information easily accessible to enterprises. One option is to create a unit within VARAM that acts as a clearinghouse for information on measures/technologies for reducing emissions.[35] The social benefits from making such information accessible to enterprises will, in some cases, extend beyond the environment. Among the options for reducing emissions is switching to new less-polluting production technologies; in at least some cases, these technologies are not only cleaner, but also more efficient, yielding direct benefits to the enterprise.

VIII. SUMMARY OF RECOMMENDATIONS

Our main recommendations are summarized below, organized by target area:

Ambient Quality Standards

- Review air quality standards in addition to the review of water quality standards currently underway. Consider the merits of dropping the 20-minute averaging time standards, which are not commonly used outside the former Soviet Union, and adding annual average concentration standards, which are.

Ambient Quality Levels

- Identify emissions sources responsible for high atmospheric concentrations of nitrogen dioxide and particulate matter in Riga, Jurmala, and Olaine. Assess the quality of monitoring data on annual average concentrations of particulate matter — existing data imply identical concentrations for nearly all cities.

- Identify emissions sources responsible for high concentrations of nitrogen compounds in major water bodies. Consider tightening emissions limits for point sources if these are found to be the most cost-effective sources to control.

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[35]The U.S. Environmental Protection Agency has provided such a service to U.S. firms in the case of measures for reducing the use of chlorofluorocarbons.

Emissions Levels

- Assess the accuracy of enterprise emissions data in VARAM databases. Emissions estimates obtained directly from enterprises were in some cases substantially larger than those contained in VARAM databases.

System of Taxes and Limits

- Exempt small emitters from paying taxes, only require them to comply with limits. This is likely to improve the system's cost-effectiveness, and to reduce the regulatory burden on both Regional Environmental Boards and small emitters.

- Issue multi-year permits to small emitters, or to enterprises whose emissions are likely to be stable over time. This is also likely to improve the system's cost-effectiveness, and it would reduce the regulatory uncertainty facing some firms. This reduced uncertainty will make it easier for them to make cost-effective decisions about investments in emissions reduction measures.

- Index emissions tax rates explicitly to inflation. This would maintain the taxes' incentives over time, without requiring periodic legislative or regulatory intervention. It would also allow enterprises to better anticipate the manner in which tax rates will change, reducing the uncertainly they face. Again, this would make it easier for them to make cost-effective decisions about investments in emissions reduction measures.

- Examine the potential for bubbling, that is, specifying a single limit for all of an enterprise's emissions of a given pollutant. Currently, for some water pollutants, separate limits are specified for each of an enterprise's outfalls. In at least some cases, this may unnecessarily restrict an enterprise's flexibility in choosing the least-cost means of reducing its aggregate emissions of the pollutant.

- Take advantage of the natural experiment created by the large increase in tax rates that goes into effect on July 1, 1996 to develop estimates of enterprise abatement costs. At present, there is very little information on enterprise abatement costs. Estimates of abatement costs are essential for conducting benefit-cost analyses of pollution control policies. By collecting accurate data on enterprise emissions levels over time, VARAM can at least develop upper bound estimates of enterprise abatement costs in both the short run and long run..

Monitoring and Enforcement

- Explicitly allocate a share of tax, and especially penalty, revenues to Regional Environmental Boards. This would not only increase the resources available to the Boards, but also enhance incentives to enforce limits and taxes. Similarly, consider levying a fee, payable to REBs, for issuing permits to enterprises. This would also increase the resources available to REBs and increase their incentive to ensure emitters have valid permits.

- Explicitly and formally link enterprises' self reporting requirements and inspection

frequencies to their compliance histories. This will improve compliance rates even without increases in resources devoted to enforcement.

Tax Waiver

- Increase the potential tax savings to enterprises that invest in pollution-reducing measures. It is uncertain whether the current provision provides a strong enough incentive.

- Establish a government clearinghouse for information on pollution-reducing measures. Without such a facility, enterprises are unlikely to have enough access to information on possible measures they could adopt.

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Table 1: Base Tax Rates for Air Pollutants (in lats per ton)

Pollutant	1995 Tax Rate	1996 Tax Rate
Particulate matter (Dust)	1.00	3.00
Carbon monoxide (CO)	1.00	4.50
Sulphur dioxide (SO_2)	3.25	10.00
Nitrogen Oxides (NO_x)	3.25	10.00
Volatile Organic Compounds	3.25	10.00
Hydrocarbons (CnHn)	3.25	10.00
Heavy Metals and Compounds	3,250.00	800.00
Ammonia (NH_3)	not taxed	10.00
Other Inorganic Compounds	not taxed	10.00

Table 2: Base Tax Rates for Water Pollutants (in lats per ton)

Pollutant	1995 Tax Rate	1996 Tax Rate
Suspended Solids	not taxed	10.00
Chemical Oxygen Demand (COD)	10.00	30.00
Total Nitrogen	10.00	30.00
Total Phosphorous	10.00	30.00
Oil Products	2,500.00	8,000.00
Chromium	15,000.00	50,000.00
Cadmium	15,000.00	50,000.00
Lead	15,000.00	50,000.00
Chlorides	1.00	not taxed
Sulfates	1.00	not taxed

Table 3: Stationary Source Emissions of Major Air Pollutants (in tons)

Year	Particulate Matter	Carbon Monoxide (CO)	Sulfur Dioxide (SO_2)	Nitrogen Oxides (NO_x)
1990	31,700	33,020	56,860	14,190
1991	27,660	32,090	58,480	14,580
1992	13,880	23,120	38,260	10,350
1993	9,500	20,900	43,710	8,730
1994	13,180	24,720	51,600	10,280
1995	12,465	23,425	38,075	7,913

Source: *Environment Pollution in Latvia, Annual Survey 1994*, Environmental Pollution Observation Centre, State Hydrometeorological Agency, Riga, 1995.

Table 4: Point Source Emissions of Major Water Pollutants (in tons)

Year	Suspended Solids	Chemical Oxygen Demand (COD)	Total Nitrogen	Total Phosphorous
1990	37,400	no data	8,152	1,042
1991	35,159	69,628	7,053	816
1992	16,608	61,229	3,912	704
1993	10,084	34,564	3,288	597
1994	10,469	28,853	3,256	554
1995	9,310	26,515	3,085	504

Sources: Data for 1993 and 1994 are from *Annual Report on Water Statistics*, Latvian Environmental Data Center. Data for 1995 are *from State Statistics Report on Water Use in 1995, Statistical Form - 2, Aggregate Data*, Latvian Environmental Data Center, 1996. Data for 1990 are from *Environmental Protection in Latvia, 1990, Overview*, LR VAK, 1991, 75. Data for 1991 and 1992 are from *Report on Environmental Conditions in Latvia*, Latvian Environmental Protection Committee, 1992.

Table 5: Gross Domestic Product (GDP) Per Capita (in lats)

Year	GDP Per Capita
1990	1106
1991	994
1992	655
1993	568
1994	559
1995	553

Sources: 1990-94 data are from *Latvia: Human Development Report, 1995*, United Nations Development Program, Riga, 1995. 1995 estimate is based on data from the Business Information Center of the Latvian Development Agency, as reported in *Riga in Your Pocket, May/June '96.*

Table 6: Stationary Sources of Air Pollutants, 1994 (in tons; percentage of total in parentheses)

Pollutant	Latvenergo Heating Plant[a]	All Other Heating Systems[b]	Industry	Total
Particulate matter (Dust)	773 (6 %)	6,038 (45 %)	6,522 (49 %)	13,333
Carbon monoxide (CO)	87[c] (< 1 %)	21,775 (88 %)	2,862 (12 %)	24,724
Sulphur dioxide (SO_2)	20,234 (39 %)	30,318 (59 %)	1,046 (2 %)	51,598
Nitrogen Oxides (NO_x)	3,295 (32 %)	4,746 (46 %)	2,240 (22 %)	10,281

Source: *Environmental Pollution in Latvia, Annual Review, 1994.* State Hydrometeorological Agency, Riga, 1995.

[a] Main state district heating plant that primarily serves Riga.

[b] District heating plants and heating systems in enterprises.

[c] These emissions of carbon monoxide are unusually low; this may perhaps be due to the efficiency of the furnaces employed.

Table 7: Point Sources of Water Pollutants, 1995 (in tons; percentage of total in parentheses)

Pollutant	Municipalities[a]	Industry	Agriculture & Fisheries	Other	Total
Suspended Solids	8,237 (88%)	810 (9%)	147 (2%)	116 (1%)	9,310
Chemical Oxygen Demand (COD)	22,316 (84 %)	3,592 (14 %)	383 (1 %)	224 (< 1 %)	26,515
Total Nitrogen	2,455 (80 %)	480 (15 %)	111 (4 %)	39 (1 %)	3,085
Total Phosphorous	403 (80 %)	77 (15 %)	16 (3 %)	8 (2 %)	504

Source: From *State Statistics Report on Water Use in 1995, Statistical Form - 2, Aggregate Data,* Latvian Environmental Data Center, 1996.

[a] Includes wastewater from industrial sources that is sent to municipal plants.

Table 8: Stationary Source Emissions of Air Pollutants in Main Cities, 1995 (in tons; percentage of Latvia total in parentheses)

City	Particulate Matter	Carbon Monoxide (CO)	Sulfur Dioxide (SO_2)	Nitrogen Oxides (NO_x)
Riga	1,280 (10 %)	3,673 (16 %)	5,611 (15 %)	1,582 (20 %)
Daugavpils	377 (3 %)	2,342 (10 %)	5,297 (14 %)	549 (7 %)
Liepaja	658 (5 %)	1,224 (5 %)	1,867 (3 %)	1,325 (17 %)
Sum	2,315 (18 %)	7,239 (31 %)	12,775 (32 %)	3,456 (44 %)

Source: *Environmental Pollution in Latvia, Annual Report 1995*, Environmental Pollution Observation Centre, State Hydrometerological Agency, Riga, 1996.

Table 9: Point Source Emissions of Water Pollutants in Main Cities, 1995 (in tons; percentage of Latvia total in parentheses)

City	Suspended Solids	Chemical Oxygen Demand (COD)	Total Nitrogen	Total Phosphorous
Riga	5,995 (64 %)	15,795 (60 %)	1,112 (36 %)	183 (36 %)
Daugavpils	556 (6 %)	2,112 (8 %)	184 (6 %)	36 (7 %)
Liepaja	272 (3 %)	1,606 (6 %)	241 (8 %)	26 (5 %)
Sum	6,823 (73 %)	19,513 (74 %)	1,537 (48 %)	245 (48 %)

Source: From *State Statistics Report on Water Use in 1995, Statistical Form - 2, Aggregate Data*, Latvian Environmental Data Center, 1996.

Table 10: Comparison of air quality standards. (Numbers represent maximum permissible concentrations in $\mu g/m^3$, averaged over the time period specified. Latvian standards are in bold, U.S. standards[a] are in standard font, and Western European standards are in italics).

Pollutant	1 hour	8 hours	24 hours	1 year	20 minutes
Particulate matter			**150**, 150	50, *40-60*	**500**
Carbon monoxide (CO)	40 000	10 000	**3000**, *8000*		**5000**
Sulphur dioxide (SO_2)			**50**, 365, *100*	80, *40-60*	**500**
Nitrogen dioxide (NO_2)			**40**, *150*	100, *30*	**85**
Nitrogen oxide (NO)			**60**		**400**

Sources: Latvian standards are from *Environmental Pollution in Latvia, Annual Report 1995*, Environmental Pollution Observation Centre, State Hydrometeorological Agency, Riga, 1995. U.S. standards are the primary National Ambient Air Quality Standards as reported in T. Tietenberg, *Environmental and Natural Resource Economics*, p. 355, Harper Collins, 1995. Western European standards are from a variety of sources.

[a] The U.S. 24-hour standards can be exceeded on (no more than) one day of each year.

Table 11: Air Quality in Riga. (Measurements are based on samples from 5 monitoring stations).

Pollutant	Measured Parameter in µg/m3	Year					
		1990	1991	1992	1993	1994	1995
Particulate Matter	annual average	100	100	100	100	100	100
	maximum value	1800	1800	1300	800	1300	600
	% above standard	3	2	1	1	1	0.3
Carbon Monoxide (CO)	annual average	1000	1000	1100	1000	1200	900
	maximum value	21000	24000	9000	21000	7000	7000
	% above standard	0.3	0.1	0.1	0.3	0.3	0.2
Sulfur Dioxide (SO_2)	annual average	10	7	6	4	10	3
	maximum value	14	89	150	100	150	81
	% above standard	0	0	0	0	0	0
Nitrogen Dioxide (NO_2)	annual average	60	70	50	60	80	70
	maximum value	740	620	480	620	530	490
	% above standard	17	31	8	19	28	30

Sources: Arnolds Ubelis, *Preliminary Status Report on Air Pollution and Transport Problems of Riga*, Institute of Atomic Physics and Spectroscopy, University of Latvia, 1995; and *Environmental Pollution in Latvia, Annual Report 1995*, Environmental Pollution Observation Centre, State Hydrometerological Agency, Riga, 1996.

Table 12: Air Quality in Latvian Cities, 1995 (annual average / maximum value in µg/m³)

City	Particulate Matter	Carbon Monoxide (CO)	Sulfur Dioxide (SO_2)	Nitrogen Dioxide (NO_2)
Riga	100 / 600	900 / 7000	3 / 81	70 / 490
Daugavpils	100 / 400	200 / 3000	4 / 400	20 / 90
Liepâja	100 / 500	400 / 3000	4 /64	30 / 170
Jûrmala	100 / 400	500 / 3000	4 / 50	70 / 400
Olaine	no data	no data	no data	40 / 270
Rèzekne	0 / 200	200 / 1000	3 / 10	30 / 80
Jèkabpils	100 / 400	500 / 2000	3 / 26	20 / 120
Valmiera	100 / 400	600 / 4000	1 / 19	20 / 40
Ventspils	100 / 1700	2300 / 25000	5 / 434	30 / 690

Source: *Environmental Pollution in Latvia, Annual Report 1995*, Environmental Pollution Observation Centre, State Hydrometerological Agency, Riga, 1996.

Table 13: Comparison of Ambient Water Quality Standards. With the exception of dissolved oxygen, numbers represent maximum permissible concentrations in water bodies, measured in mg/liter. For dissolved oxygen, numbers represent minimum permissible concentrations in mg/liter.

Entity	Suspended Solids	Dissolved Oxygen (O_2)	Nitrates (NO_3)	Nitrites (NO_2)	Ammonium (NH_4)	Phosphates (PO_4)
Latvia	none	6	9.1	0.02	0.39	0.25
European Union	25	5 - 9	none	0.01 - 0.03	0.04 - 1	0.2 - 0.4

Sources: Latvian standards are from *Environmental Pollution in Latvia, Annual Report 1995*, Environmental Pollution Observation Centre, State Hydrometeorological Agency, Riga, 1996, and from Brunenieks, et al. (1996), Table 3.1.2. European Union standards are from Directive 78/659/EEC (freshwater for fish).

Table 14: Water Quality in Major Water Bodies. (Entries give percentage of measured concentrations that exceeded relevant water quality standards).

Water Body	Year	% Exceedance of Any Standard	% Exceedance of Dissolved Oxygen Standard	% Exceedance of Nitrogen Standards
Velikaja	1993	13	0	36
	1994	29	13	13
	1995	15	0	0
Salaca	1993	6	0	7
	1994	9	2	16
	1995	11	1	36
Gauja	1993	6	0	4
	1994	11	1	2
	1995	9	1	39
Daugava	1993	11	2	22
	1994	11	5	20
	1995	7	3	10
Lielupe	1993	19	5	51
	1994	16	5	42
	1995	10	4	43
Venta	1993	11	0	2
	1994	6	0	0
	1995	8	1	5
Irbes Straits	1993	7	0	0
	1994	16	0	0
	1995	10	0	0
Small Rivers into Baltic Sea	1993	15	0	10
	1994	13	3	5
	1995	6	2	2
Coastal Baltic Sea	1993	15	0	0
	1994	11	0	0
	1995	3	0	0

Source: Environmental Pollution Observation Centre, State Hydrometeorological Agency, Riga, 1996.

Table 15: Expenditures on Natural Resource Protection, 1995 (in thousands of lats)

Resource	Latvia	Riga	Daugavpils	Liepaja	Ventspils	Rezekne	Jurmala
Water	10,199	2,851	822	191	4,524	229	629
Air	1,790	496	76	232	877	25	0
Soil[a]	325	123	22	1	13	1	< 1
National Parks	59	< 1	0	0	0	0	0
Total	12,373	3470	920	423	5,414	255	629

Source: *Indicators for Environmental Protecton in the Republic of Latvia, 1995 Statistical Bulletin*, State Committee for Statistics of the Republic of Latvia.

[a] Sum of expenditures on prevention of soil contamination and soil recultivation.

Table 16: Administrative Sanctions Imposed by Daugavpils REB on Stationary Sources, 1995

Type of Violation	Number of Cases	Penalties Collected (lats)	Average Penalty (lats)
Air	66	561	8.5
Water	120	2,285	19.0
Soil	82	1,580	19.3
Total	268	4,426	16.5

Source: Daugavpils REB.

Table 17: Water Extraction and Pollution Penalties for Regional Environmental Boards (in lats)

Regional Environmental Board	1993	1994	1995
Riga	9,985	13,502	25, 980
Daugavpils	748	83,647	3,233
Liepaja	99	38,818	0
Ventspils	1,306	1,439	0
Ogres	454	1,294	2,413
Jelgavas	14,845	7,333	8,544
Valmiera	0	0	0
Madona	8,468	2667	8,721
Rçzekne	11	0	0
Marine	50, 902	41,320	58,554
Total	86,818	190,020	107,445

Source: From annual reports of Regional Environmental Boards.

Table 18: Characteristics of Top 30 Emitters of Air Pollutants, 1995. (Percentages in first three rows give proportion of total top 30 emissions. Percentages in last row give proportion of total stationary source emissions in Latvia accounted for by top 30 emitters. Number of enterprises in parentheses).

Enterprise Type	Particulate Matter	Carbon Monoxide (CO)	Sulfur Dioxide (SO_2)	Nitrogen Oxides (NO_x)
State[a]	44% (10)	47% (11)	65% (13)	79% (16)
Municipal	8% (17)	31% (10)	21% (10)	7% (6)
Private	48% (15)	22% (9)	14% (7)	14% (8)
Percentage of Total Emissions in Latvia	39%	33%	68%	62%

Source: Based on data in Table 3 and Tables 20a-d.
[a] Includes Russian Army radar facility.

Table 19: Characteristics of Top 20 Emitters of Water Pollutants, 1995. (Percentages in first three rows give proportion of total top 20 emissions. Percentages in last row give proportion of total point source emissions in Latvia accounted for by top 20 emitters. Number of enterprises in parentheses).

Enterprise Type	Suspended Solids	Chemical Oxygen Demand (COD)	Total Nitrogen	Total Phosphorous
State	12% (8)	17% (8)	9% (3)	8% (2)
Municipal	85% (9)	80% (11)	86% (16)	87% (16)
Private	3% (3)	3% (1)	5% (1)	5% (2)
Percentage of Total Emissions in Latvia	94%	96%	66%	73%

Source: Based on data in Table 4 and Tables 21a-d.

Table 20a: Top 30 Emitters of Particulate Matter, 1995

Enterprise	Type	Emissions (tons/year)	Limit (tons/year)
AS "Broceni" Broceni	private cement company	1273.3760	no data
Valsts kudras fabrika "Struzani"	state peat factory	540.1220	no data
VAS "Liepajas metalurgs"	state steel company	499.6320	no data
VAS "Latvenergo" Rigas TEC-1	state district heating company	250.5860	no data
k/d 18951 Skrundas RLS	Russian Army radar facility	238.3880	no data
Rigas TEC-2	state district heating power station	229.1300	no data
SIA "VSV" Alojas KPI ("Park International")	private company	122.2800	no data
SIA "Latvija Timber International Ltd"	private company	103.2320	no data
PU "Zilaiskalns"	municipal enterprise	97.5500	no data
AS "Broceni" Novadnieki	private company	96.4060	no data
PVAS "Jekabpils cukurfabrika"	state sugar factory	86.4990	no data
Valsts Valmieras stikla skiedras rupnica	state glass wool cloth factory	86.1644	no data
SIA "Jelgavas mezs"	private timber factory	85.1920	no data
PU "Balvu energija"	municipal district heating	80.1230	no data
SIA "Ventspils laukceltnieks"	private building company	79.1100	no data
VAS "Dauteks"	state glass wool factory	77.3600	no data
ZS "Upmali"	private farm	76.5540	no data
Uznemums "Labiekartosana"	municipal enterprise	76.4700	no data
VAS "Lokomotive"	state train repair facility	74.6320	no data
AS "Bolderâja"	private wood processing plant	71.3520	no data
AS CBF "Viator" Saulk. asf.bet.rupnica	private asphalt factory	64.3690	no data
VU "Aizkraukles celtnieks"	state building enterprise	63.5906	no data
SIA "AVESTA"	private company	63.1258	no data
SIA "Latlini"	private flax factory	63.0600	no data
Dobeles STU - k.m. Berzes 2	municipal district heating	61.9340	no data
SIA "Skabarga-2"	private company	58.6400	no data
SIA "Nicgales keramzits"	private building material factory	58.0090	no data
Limbazu RPB "Maizes kombinats"	private bread factory	58.0000	no data
SIA "Ventspils koks"	private timber company	57.3480	no data
Auru pag. Gardenes namu parvalde (Kulturas nams)	municipal enterprise	56.2800	no data
	Total State Enterprises[a]	2146.1040	
	Total Municipal Enterprises	372.3570	
	Total Private Enterprises	2330.0538	
	Total Top 30	4848.5148	

Source: Latvian Environmental Data Centre.

[a] Includes Russian Army radar facility

Table 20b: Top 30 Emitters of Carbon Monoxide (CO), 1995

Enterprise	Type	Emissions (tons/year)	Limit (tons/year)	Emissions/ Limit
VAS "Dauteks"	state glass wool factory	1008.712	1170.907	0.86
VAS "Liepajas metalurgs"	state steel company	670.232	2879.099	0.23
k/d 18951 Skrundas RLS	Russian Army Radar Facility	521.608	no limit	
PU STU SC-2	municipal district heating	422.018	765.000	0.55
VAS "Lokomotive"	state train repair facility	333.750	930.540	0.36
AS "Lignums"	private company	307.264	813.850	0.38
PU STU SC-1	municipal district heating	305.643	387.000	0.79
Jelgavas STU - k.m. Ganibu 61	municipal district heating	280.737	2180.554	0.13
SIA "Rigas finieru rupnica"	private company	271.013	361.267	0.75
Malpils pagasta padome	municipal enterprise	266.532	0.000	
PU "Balvu energija"	municipal district heating	247.617	439.331	0.56
Gulbenes Valsts STU, Blaumana 46	municipal district heating	227.371	0.000	
Valsts razosanas uznemums"Ogre"	state knitwear company	207.430	224.036	0.93
Valsts Slokas Celulozes Un Papira Rupnica	state pulp and paper mill	205.927	692.740	0.30
PU "Siltums" Brivibas 38	municipal district heating	191.340	275.058	0.70
AS "8CBR" Smiltenes razosanas baze	private company	190.230	240.000	0.79
AS "Latvijas finieris" rupnica "Latvijas berzs"	private company	184.156	226.967	0.81
PU "Zemgales siltums" k.m. Ritausmas 2	municipal district heating	171.760	195.500	0.88
PU "Siltums" Talsu 75	municipal district heating	159.657	65.058	2.45
AS "Latvijas finieris" rupnica "Furniers"	private company	156.421	550.702	0.28
AS "Pardaugavas siltums" Lepju iela	private company	153.922	190.187	0.81
Valsts kudras fabrika "Struzani"	state peat factory	153.495	200.920	0.76
SIA "Ventspils koks"	private company	151.865	240.075	0.63
Incukalna pazemes gazes kratuve	state enterprise	149.756	184.000	0.81
VAS "Misas kudra"	state peat factory	148.321	176.474	0.84
AS "Bolderaja"	private wood processing plant	143.283	202.581	0.71
Valsts Valmieras stikla skiedra rupnica	state glass wool (cloth material) factory	130.771	453.111	0.29
AS "Brivais vilnis" Salacgriva	private fishing company	129.696	107.300	1.21
PU "Jurmalas ST" Libiesu 9	municipal district heating	126.710	230.000	0.55
Ventspils tirdzniecibas osta	state enterprise	121.546	126.626	0.96
	Total State Enterprises[a]	3651.548	7038.453	0.63[b]
	Total Municipal Enterprises	2399.385	4537.501	0.83[b]
	Total Private Enterprises	1687.850	2932.929	0.71[b]
	Total Top 30	7738.783	14508.883	0.72[b]

Source: Latvian Environmental Data Centre.

[a] Includes Russian Army radar facility

[b] Unweighted average of ratios for the specified enterprises.

Table 20c: Top 30 Emitters of Sulfur Dioxide (SO_2), 1995

Enterprise	Type	Emissions (tons/year)	Limit (tons/year)	Emissions/ Limit
Rigas TEC-2	state district heating plant	7918.428	14500.000	0.55
VAS "Dauteks"	state glass wool factory	2446.491	3523.688	0.69
VAS "Latvenergo" Rigas TEC-1	state district heating plant	1655.800	2450.000	0.68
PU STU SC-2	municipal district heating plant	1322.828	2529.000	0.52
PU STU SC-1	municipal district heating plant	973.608	1281.000	0.76
AS Rezeknes piena konservu kombinats	private condensed milk company	846.000	1494.500	0.57
Valsts razosanas uznemums "Ogre"	state knitwear company	804.380	1062.180	0.76
VAS "Latvenergo" SC "Olaine"	state district heating plant	798.297	2400.000	0.33
AS "Bolderaja"	private wood processing plant	696.221	1638.770	0.42
VAS "Ventspils nafta"	state oil company	695.909	1502.664	0.46
PU "Siltums" N.Rancana iela	municipal district heating plant	669.214	1274.000	0.53
AS "Liepajas siltums" "TEC"	private company	636.697	1320.000	0.48
PU "Siltums" Talsu 75	municipal district heating plant	583.390	751.336	0.78
PU "Siltums" Brivibas 38	municipal district heating plant	517.979	617.400	0.84
AS "Pardaugavas siltums" Lepju iela	private company	465.927	549.662	0.85
VAS "Latvenergo" SC "Andrejsala"	state district heating plant	432.434	2314.000	0.19
VAS "Latvenergo" SC "Imanta" (termofik.parv.)	state district heating plant	428.373	1620.000	0.26
Jelgavas STU - k.m. Ganibu 61	municipal district heating plant	414.398	2560.799	0.16
AS "Liepajas cukurfabrika"	private sugar factory	403.010	1540.680	0.26
Ventspils tirdzniecibas osta	state enterprise	365.398	297.700	1.23
PVAS "Jekabpils cukurfabrika"	state sugar factory	320.024	1097.822	0.29
Tukuma pils. pasv. "Siltumtiklu uznemums"	municipal district heating plant	305.926	1071.000	0.29
Valsts Valmieras stikla skiedras rupnica	state glass wool factory	288.839	817.925	0.35
VAS "Latvenergo" SC "Zasulauks" (termofik.parv.)	state district heating plant	283.336	1300.000	0.22
AS "Jelgavas cukurfabrika"	private sugar factory	281.899	466.562	0.60
k/d 18951 Skrundas RLS	Russian Army radar facility	277.923	no limit	
Jekabpils PU "Jekabpils siltumtikli" Tvaika iela	municipal district heating plant	260.177	1926.000	0.14
AS "Ligija teks"	private company	224.295	448.230	0.50
Ludzas PU "Siltums"	municipal district heating plant	223.349	506.769	0.44
PU "Balvu energija"	municipal district heating plant	222.420	597.840	0.37
	Total State Enterprises[a]	16715.632	32885.979	0.50[b]
	Total Municipal Enterprises	5493.289	13115.144	0.50[b]
	Total Private Enterprises	3554.049	7458.404	0.53[b]
	Total Top 30	25762.97	53459.53	0.51[b]

Source: Latvian Environmental Data Centre.

[a] Includes Russian Army radar facility

[b] Unweighted average of ratios for the specified enterprises.

Table 20d: Top 30 Emitters of Nitrogen Dioxide (NO_X), 1995

Enterprise	Type	Emissions (tons/year)	Limit (tons/year)	Emissions/ Limit
Rigas TEC-2	state district heating plant	1178.369	3455.000	0.34
VAS "Liepajas metalurgs"	state steel company	1096.365	1863.897	0.59
VAS "Latvenergo" Rigas TEC-1	state district heating plant	453.800	1436.600	0.32
AS "Broceni" Broceni	private cement company	248.937	455.169	0.55
VAS "Dauteks"	state glass wool factory	201.957	248.096	0.81
VAS "Lokomotive"	state train repair facility	159.752	261.521	0.61
k/d 18951 Skrundas RLS	Russian Army radar facility	151.630	no limit	
AS "Jelgavas cukurfabrika"	private sugar factory	108.354	192.773	0.56
Valsts Valmieras stikla skiedras rupnica	state glass wool factory	91.249	168.083	0.54
VAS "Latvenergo" SC "Andrejsala"	state district heating plant	90.965	180.000	0.51
AS "Liepajas siltums" "TEC"	private company	80.973	223.000	0.36
VAS "Ventspils nafta"	state oil company	79.242	114.924	0.69
Valsts kudras fabrika "Struzani"	state peat factory	79.089	104.571	0.76
PU STU SC-2	municipal district heating	74.969	153.000	0.49
PU "Zemgales siltums" k.m. Ritausmas 2	municipal district heating	65.430	78.200	0.84
VAS "Latv. dzelzc." Rigas lok. depo	state enterprise	64.673	190.541	0.34
PU STU SC-1	municipal district heating	60.610	80.000	0.76
AS Rezeknes piena konservu kombinats	private condensed milk company	58.100	58.700	0.99
PU "Jurmalas ST" Libiesu 9	municipal district heating	57.950	85.000	0.68
AS "Bolderaja"	private wood processing plant	56.686	61.364	0.92
VAS "Latvenergo" SC "Imanta" (termofik.parv.)	state district heating plant	55.438	59.000	0.94
AS "Lignums"	private company	54.524	100.840	0.54
Ventspils tirdzniecibas osta	state enterprise	48.416	51.474	0.94
Incukalna pazemes gazes kratuve	state enterprise	42.547	73.665	0.58
AS "Pârdaugavas siltums" Lëpju ielâ	private company	39.796	49.420	0.81
RA "Lode"	state enterprise	39.390	40.000	0.98
PU "Siltums" Brivibas 38	municipal district heating	37.970	55.010	0.69
SIA "Ventspils koks"	private timber company	37.423	54.359	0.69
Valsts razosanas uznemums "Ogre"	state knitwear company	37.380	28.158	1.33
Jelgavas STU - k.m. Ganibu 61	municipal district heating	37.354	356.004	0.10
	Total State Enterprises[a]	3870.2624	8275.53	0.68[b]
	Total Municipal Enterprises	334.283	807.214	0.59[b]
	Total Private Enterprises	684.793	1195.625	0.68[b]
	Total Top 30	4889.3384	10278.369	0.66[b]

Source: Latvian Environmental Data Centre.

[a] Includes Russian Army radar facility

[b] Unweighted average of ratios for the specified enterprises.

Table 21a: Top 20 Emitters of Suspended Solids, 1995

Enterprise	Type	Emissions (tons/year)	Limit* (tons/year)	Emissions/ Limit
Riga Udensapgâde Un Kanalizâcija	municipal water & wastewater	5750.81	4999.12	1.15
Daugavpils Ûdensvads	municipal water & wastewater	539.90	1266.38	0.43
Rîgas Miesnieks' AS	state meat processing plant	463.20	no load limit[a,b]	
Kandavas Pilsetas Komunâlais Uznemums	municipal enterprise	337.37	0.72	468.57
Liepâjas Pilsetas Ûdensvada Un Kanalizâcijas	municipal water & wastewater	269.74	975.10	0.28
Riga Carriage Building	state railroad carriage factory	191.50	no permit[c]	
Vinda Cesu Pilsetas Pasvaldibas Uznemums	municipal water & wastewater	188.40	43.35	4.35
Cesvaines Piens	private milk plant	130.29	6.97	18.69
Aizkraukles Ûdensvada Un Kanalizâcijas	municipal water & wastewater	114.67	22.75	5.04
Ogre Valsts AS	state knitwear factory	109.00	172.21	0.63
Madonas Ûdens	municipal enterprise	102.68	231.00	0.44
Bolderâja AS	private wood processing plant	93.20	196.50	0.47
Kaija Valsts Zivju Konservu Kulinârijas	state fish processing plant	85.00	19.40	4.38
Gulbene Alba	municipal enterprise	74.01	30.00	2.47
Aldaris Alusdaritava	private brewery	55.18	no limits[b]	
Plavnieki Valsts Uznemums	state enterprise	52.00	no data	
Liepaja Valsts Adu Rûpnîca	state leather factory	51.54	0.10	515.40
Ventspils Ostas Rûpnîca' Valsts Uznemums	state harbor chemicals facility	45.00	140.59	0.32
Valmieras Ûdensvada Un Kanalizâcijas Pârvalde	municipal water & wastewater	44.72	78.61	0.57
Uzvara AS	state food factory	41.78	no limits[b]	
	Total State Enterprises	1039.02		130.18[d] (1.78)[e]
	Total Municipal Enterprises	7422.30		53.70[d] (1.86)[e]
	Total Private Enterprises	278.67		9.58[d]
	Total Top 20	8739.99		68.22[d] (1.72)[e]

Source: Emissions data from Latvian Environmental Data Centre; permit data from Regional Environmental Boards.

*Enterprises commonly have multiple permits; the sum of load limits across permits for a given pollutant is specified.

[a] Only concentration limits specified in permit.

[b] Enterprise uses Riga municipal sewerage.

[c] Factory under reconstruction.

[d] Unweighted average of the ratios for the specified enterprises.

[e] Unweighted average excluding the outlier ratio of 468.57 for Kandavas Pilsetas Komunâlais Uznemums and/or the outlier ratio of 515.40 for Liepaja Valsts Adu Rûpnîca.

Table 21b: Top 20 Emitters of Chemical Oxygen Demand (COD), 1995

Enterprise	Type	Emissions (tons/year)	Limit* (tons/year)	Emissions/ Limit
Riga Ûdensapgâde Un Kanalizâcija	municipal water & wastewater	14659.89	22278.91	0.66
Daugavpils 'Ûdensvads' Paðvaldîbas Uznemums	municipal water & wastewater	2053.80	7228.46	0.28
Liepâjas Pilsetas Ûdensvada Un Kanalizâcijas	municipal water & wastewater	1605.48	4837.80	0.33
Rîgas Miesnieks AS	state meat processing	1558.00	450.00	3.46
Bolderâja AS	private wood processing plant	792.20	1179.00	0.67
Valsts Slokas Celulozes Un Papîra Fabrika	state pulp and paper mill	670.30	4120.00	0.16
Jelgava Udensvada Un Kanalizâcijas	municipal water & wastewater	630.95	853.20	0.74
Ventspils Ostas Rûpnîca Valsts Uznemums	state harbor chemicals facility	476.00	843.57	0.56
Rîgas Raugs Valsts Uznemums	state yeast plant	473.00	no load limit[a,b]	
Vinda Cesu Pilsetas Paðvaldîbas Uznemums	municipal water & wastewater	393.60	260.10	1.51
Ogre Valsts AS	state knitwear factory	350.00	923.76	0.38
Olaines Kimiski-farmaceitiska Rupnica	state pharmaceuticals factory	278.40	630.00	0.44
Saldus Komunâlo Uzòçmumu Kombinâts	municipal enterprise	275.22	147.91	1.86
Kandavas Pilsetas Komunâlais Uznemums	municipal enterprise	272.57	4.32	63.09
Kaija' Valsts Zivju Konservu Kulinârijas	state fish processing plant	257.76	no load limit[a]	
Rçzeknes Ûdensvada Un Kanalizâcijas	municipal water & wastewater	183.62	388.80	0.47
Latvijas Balzâms Valsts Firma	state alcoholic beverages plant	179.60	no limits[b]	
Jûrmalas Ûdensvada Un Kanalizâcijas Uznemums	municipal water & wastewater	155.71	280.08	0.56
Tukuma KUK - Tukums	municipal services	149.60	153.00	0.98
Valmieras Ûdensvada Un Kanalizâcijas Pârvalde	municipal water & wastewater	145.77	471.69	0.31
	Total State Enterprises	4243.06		1.00[c]
	Total Municipal Enterprises	20,526.21		6.48[c] (0.77)[d]
	Total Private Enterprises	792.20		0.67[c]
	Total Top 20	25,561.47		4.5[c] (0.84)[d]

Source: Emissions data from Latvian Environmental Data Centre; permit data from Regional Environmental Boards.

* Enterprises commonly have multiple permits; the sum of load limits across permits for a given pollutant is specified.

[a] Only concentration limits specified in permit.

[b] Enterprise uses Riga municipal sewerage.

[c] Unweighted average of the ratios for the specified enterprises.

[d] Unweighted average excluding the outlier ratio of 63.09 for Kandavas Pilsetas Komunâlais Uznemums.

Table 21c: Top 20 Emitters of Total Nitrogen, 1995

Enterprise	Type	Emissions (tons/year)	Limit* (tons/year)	Emissions/ Limit
Riga Ûdensapgâde Un Kanalizâcija	municipal water & wastewater	986.34	4932.16	0.20
Daugavpils 'Ûdensvads' Paðvaldîbas Uznemums	municipal water & wastewater	180.07	462.62	0.39
Jelgava Udensvada Un Kanalizâcijas	municipal water & wastewater	126.19	314.26	0.40
Ventspils Ostas Rûpnîca' Valsts Uznemums	state harbor chemicals facility	109.00	310.71	0.35
Bolderâja AS	private wood processing plant	100.00	434.26	0.23
Olaines Kimiski-farmaceitiska Rupnica	state pharmaceuticals factory	69.92	139.23	0.50
Vinda Cesu Pilsetas Pasvaldibas Uznemums	municipal water & wastewater	69.25	95.80	0.72
Rçzeknes Ûdensvada Un Kanalizâcijas	municipal water & wastewater	57.28	36.08	1.59
Valmieras Ûdensvada Un Kanalizâcijas	municipal water & wastewater	46.73	173.74	0.27
Tukuma KUK - Tukums	municipal water & wastewater	39.30	56.35	0.70
Salaspils Ûdensvada Un Kanalizâcijas	municipal water & wastewater	38.59	76.11	0.51
Jûrmalas Ûdensvada Un Kanalizâcijas Uznemums	municipal water & wastewater	35.03	90.72	0.39
Aizkraukles Ûdensvada Un Kanalizâcijas	municipal water & wastewater	26.00	50.29	0.52
Madonas Ûdens	municipal water & wastewater	25.81	34.81	0.74
Jçkabpils Pilsetas Ûdensvadu Un Kanalizâcijas	municipal water & wastewater	25.57	101.77	0.25
Gulbene ALBA	municipal water & wastewater	23.46	33.15	0.71
Dobeles Ûdensvada Un Kanalizâcijas	municipal water & wastewater	21.02	44.79	0.47
Jaungulbenes Pagasta Valde	municipal enterprise	19.21	3.51	5.47
Kraslavas Pilsetas Pasvaldibas	municipal enterprise	18.91	no permit	
Kekavas Putnufabrika	state poultry processing plant	13.13	30.17	0.44
	Total State Enterprises	192.05		0.43[c]
	Total Municipal Enterprises	1738.76		0.89[c] (0.56)[d]
	Total Private Enterprises	100.00		0.23[c]
	Total Top 20	2030.81		0.78[c] (0.52)[d]

Source: Emissions data from Latvian Environmental Data Centre; permit data from Regional Environmental Boards.

*Enterprises commonly have multiple permits; the sum of load limits across permits for a given pollutant is specified.

[a] Only concentration limits specified in permit.

[b] Enterprise uses Riga municipal sewerage.

[c] Unweighted average of the ratios for the specified enterprises.

[d] Unweighted average excluding the outlier ratio of 5.47 for Jaungulbenes Pagasta Valde.

Table 21d: Top 20 Emitters of Total Phosphorous, 1995

Enterprise	Type	Emissions (tons/year)	Limit* (tons/year)	Emissions/ Limit
Riga Ûdensapgâde Un Kanalizâcija	municipal water & wastewater	165.92	268.35	0.62
Daugavpils 'Ûdensvads' Paðvaldîbas Uznemums	municipal water & wastewater	34.56	61.44	0.56
Liepâjas Pilsçtas Ûdensvada Un Kanalizâcijas	municipal water & wastewater	26.05	66.40	0.39
Ventspils Ostas Rûpnîca' Valsts Uznemums	state harbor chemicals facility	20.00	23.43	0.85
Bolderâja AS	private wood processing plant	15.10	32.75	0.46
Jelgava Udensvada Un Kanalizâcijas	municipal water & wastewater	15.01	23.50	0.64
Rçzeknes Ûdensvada Un Kanalizâcijas	municipal water & wastewater	11.48	11.28	1.02
Valsts Slokas Celulozes Un Papîra Fabrika	state pulp and paper mill	9.16	51.50	0.18
Saldus Komunâlo Uzòçmumu Kombinâts	municipal water & wastewater	9.00	6.60	1.36
Vinda Cesu Pilsetas Pasvaldibas Uznemums	municipal water & wastewater	8.01	7.23	1.11
Jûrmalas Ûdensvada Un Kanalizâcijas Uznemums	municipal water & wastewater	7.18	7.79	0.92
Jçkabpils Pilsçtas Ûdensvadu Un Kanalizâcijas	municipal water & wastewater	6.09	7.68	0.79
Gulbene ALBA	municipal services enterprise	5.77	2.50	2.31
Tukuma KUK - Tukums	municipal services enterprise	5.67	4.25	1.33
Valmieras Ûdensvada Un Kanalizâcijas Pârvalde	municipal water & wastewater	5.22	13.10	0.40
Aizkraukles Ûdensvada Un Kanalizâcijas	municipal water & wastewater	4.91	3.79	1.29
A/s Preiïu siers	private cheese factory	4.77	2.13	2.24
Madonas Ûdens	municipal services enterprise	4.41	2.63	1.68
Kuldîgas Ûdensvada Un Kanalizâcijas	municipal water & wastewater	3.91	6.38	0.61
Dobeles Ûdensvada Un Kanalizâcijas	municipal water & wastewater	3.70	3.38	1.10
	Total State Enterprises	29.16		0.32[a]
	Total Municipal Enterprises	316.89		1.01[a]
	Total Private Enterprises	19.87		1.35[a]
	Total Top 20	365.92		0.99[a]

Source: Emissions data from Latvian Environmental Data Centre; permit data from Regional Environmental Boards.

* Enterprises commonly have multiple permits; the sum of load limits across permits for a given pollutant is specified.

[a] Unweighted average of the ratios for the specified enterprises.

Table 22: Rankings of Major Emitters of Air Pollutants.

Enterprise Classification	Particulate Matter	Sulfur Dioxide	Nitrogen Oxides	Carbon Monoxide
State Enterprises				
VAS "Latvenergo" Rigas TEC-2	6	1	1	
VAS "Dauteks"	16	2	5	1
VAS "Latvenergo" Rigas TEC1	4	3	3	
VAS "Liepajas metalurgs"	3		2	2
VAS "Ventspils nafta"		10	12	
Incukalna pazemes gazes kratuve			24	24
k/d 18951 Skrundas RLS	5	26	7	3
Valsts razosanas uznemums "Ogre"		7	29	13
Valsts kudras fabrika "Struzani"	2		13	22
VAS "Latvenergo" SC "Olaine"		8		
Valsts Valmieras stikla skiedras rupnica	12	23	9	27
VAS "Lokomotive"	19		6	5
Ventspils tirdzniecibas osta		20	23	30
PVAS "Jekabpils cukurfabrika"	11	21		
VAS "Latvenergo" SC "Andrejsala"		16	10	
VAS"Latvenergo"SC "Imanta"(term.parv.)		17	21	
VU "Aizkraukles celtnieks"	22			
VAS"Latvenergo" SC "Zasulauks" (termof.p.)		24		
VAS "Latv. dzelzc." Rigas lok. depo			16	
RA "Lode"			26	
Valsts Slokas celulozes un papira rupnica				14
Municipal Enterprises				
PU STU SC2		4	14	4
PU STU SC1		5	17	7
PU "Siltums" N.Rancana iela, Rezekne		11		
PU "Siltums" Talsu 75, Ventspils		13		19
PU "Siltums" Brivibas 38, Ventspils		14	27	15
Jelgavas STU k.m. Ganibu 61		18	30	8
PU "Balvu energija"	14	30		11
PU "Zilaiskalns"	9			
Uznemums "Labiekartosana"	18			
Auru pag. Gardenes n. p. (Kulturas nams)	30			
Tukuma pils. pasv. "Siltumtiklu uznemums"		22		
Jekabpils PU "Jekabpils siltumtikli" Tvaika ie.		27		
Ludzas PU "Siltums"		29		
PU "Zemgales siltums" k.m. Ritausmas 2			15	18
PU "Jurmalas ST" Libiesu 9			20	29
Malpils pagasta padome				10
Gulbenes Valsts STU, Blaumana 46				12

Table 22 (cont.): Rankings of Major Emitters of Air Pollutants.

Private Enterprises	Particulate Matter	Sulfur Dioxide	Nitrogen Oxides	Carbon Monoxide
AS "Broceni" Broceni	1		4	
AS Rezeknes piena konservu kombinats		6	18	
AS "Bolderaja"	20	9	20	26
AS "Liepajas siltums" "TEC"		12	11	
AS "Pardaugavas siltums" Lepju iela		15	25	21
AS "Liepajas cukurfabrika"		19		
AS "Jelgavas cukurfabrika"		25	8	
SIA "VSV" Alojas KPI ("Park International")	7			
SIA "Latvija Timber International Ltd"	8			
AS "Broceni" Novadnieki	10			
SIA "Jelgavas mezs"	13			
SIA "Ventspils laukceltnieks"	15			
ZS "Upmali"	17			
AS CBF "Viator" Saulk. asf.bet.rupnica	21			
SIA "AVESTA"	23			
SIA "Latlini"	24			
Dobeles STU k.m. Berzes 2	25			
SIA "Skabarga2"	26			
SIA "Nicgales keramzits"	27			
Limbazu RPB "Maizes kombinats"	28			
SIA "Ventspils koks"	29		28	23
AS "Ligija teks"		28		
AS "Lignums"			22	6
SIA "Rigas finieru rupnica"				9
AS "8CBR" Smiltenes razosanas baze				16
AS "Latvijas finieris" rupnica "Latvijas berzs"				17
AS "Latvijas finieris" rupnica "Furniers"				20
AS "Brivais vilnis" Salacgriva				28

Source: Based on data in Tables 20a-d.

Table 23: Rankings of Major Emitters of Water Pollutants.

Enterprise Classification	Suspended Solids	Chemical Oxygen Demand	Total Nitrogen	Total Phosphorous
State Enterprises				
'Rîgas Miesnieks' AS	3	4	20	
Ventspils Ostas Rûpnîca' Valsts Uznemums	18	8	4	4
'Kaija' Valsts Zivju Konservu Kulinârijas	13	15		
Valsts Slokas Celulozes Un Papîra Fabrika'		6		8
'Rîgas Raugs' Valsts Uznemums		9		
'Olaines Kimiski-farmaceitiska Rupnica'		12	6	
Uzvara AS	20			
Pïavnieki Valsts Uznemums	16			
'OGRE' Valsts AS	10	11		
'Latvijas Balzâms' Valsts Firma		17		
Valsts Rigas Vagonbuves Rûpnîca	6			
Valsts Liepâjas Âdu Rûpnîca'	17			
Kekavas Putnufabrika			20	
Municipal Enterprises				
Riga Ûdensapgâde Un Kanalizâcija	1	1	1	1
Daugavpils 'Ûdensvads' Paðvaldîbas Uznemums	2	2	2	2
Liepâjas Pilsçtas Ûdensvada Un Kanalizâcijas	5	3		3
Vinda Cesu Pilsetas Pasvaldibas Uznemums	7	10	7	10
Gulbene Alba	14		16	13
Jelgava Udensvada Un Kanalizâcijas		7	3	6
Madonas Ûdens	11		14	18
Aizkraukles Ûdensvada Un Kanalizâcijas	9		13	16
'Kandavas Pilsetas Komunâlais Uznemums'	4	14		
Rçzeknes Ûdensvada Un Kanalizâcijas		16	8	7
'Saldus Komunâlo Uzòçmumu Kombinâts'		13		9
Tukuma KUK - Tukums		19	10	14
'Jûrmalas Ûdensvada Un Kanalizâcijas'		18	12	11
Kraslavas Pilsetas Pasvaldibas			19	
Jaungulbenes Pagasta Valde			18	
Valmieras Ûdensvada Un Kanalizâcijas Pârvalde	19	20	9	15
'Jçkabpils Pilsçtas Ûdensvadu Un Kanalizâcijas'			15	12
Salaspils Ûdensvada Un Kanalizâcijas'			11	
'Dobeles Ûdensvada Un Kanalizâcijas'			17	20
Kuldîgas Ûdensvada Un Kanalizâcijas				19
Private Enterprises				
Bolderâja AS	12	5	5	5
Cesvaines Piens	8			
Aldaris Alusdaritava	15			
A/s "Preiïu siers "				17

Source: Based on data in Tables 21a-d.

Table 24: Economic Data for Selected Enterprises (in thousands of lats)

Enterprise	Type	Natural Resource Tax Payments	Revenues	Profits (after tax)	Tax Payments/ Revenues	Tax Payments/ Profits
'Rîgas Miesnieks' AS	state meat processing	< 5	19,710		< 0.0254%	
'Latvenergo' VAS*	state district heating		135,000	66,200		
'Dauteks' VAS*	state glass wool	< 27	38,387	-2,036	< 0.0703%	-1.3261%
'Liepajas Metalurgs'*	state steel	> 4.732[a]	29,594	2,343	> 0.0160%	> 0.2100%
Valsts Kudras Fabrika 'Struzani'*	state peat	< 3.892	376	2.079	< 1.0351%	< 187.2054%
'Jekabpils Cukurfabrika'*	state sugar	< 1.431	2,712		< 0.0528%	
'Valsts Slokas Celulozes Un Papîra Fabrika'	state pulp and paper mill.	> 6.915[a]	2,290		> 0.3020%	
'Ventspils Ostas Rûpnîca'	state harbor chemicals	> 6.050[a]	6,060		> 0.0100%	
'Rîgas Raugs'	state yeast plant	< 0.8				
'Ogre' valsts AS	state knitwear factory	> 6.321[a]	16,510		> 0.0382%	
'Olaines Kimiski-farmaceitiska Rupnica'*	state pharmaceuticals	> 3.47[a]	5,980		> 0.0580%	
'Kaija' Valsts Zivju Konservu Kulinârijas	state fish processing	< 0.68	3,890		< 0.0175%	
'Latvijas Balzâms' Valsts Firma*	state alcoholic beverages	< 1.97	30,070	2422	< 0.0066%	< 0.0813%
Riga 'Ûdensapgâde Un Kanalizâcija'	municipal water & wastewater	< 235	12,610		< 1.8636%	
STU Siltums Rezekne	municipal district heating	< 7.273	1,688	non-profit	< 0.4309%	
Viator AS CBF*	private asphalt plant	< 0.214	1,739	7.129	< 0.0123%	
'Bolderâja' AS*	private wood processing	< 8.356	8,659	657	< 0.0965%	< 1.2718%
Cesvaines Piens*	private milk	< 6.342	2,500		< 0.2540%	

Sources: Data for enterprises marked with an asterisk are from responses to questionnaires sent to major emitters of air pollutants or from interviews with staff of major emitters of water pollutants. For the remaining enterprises, data on revenues are from the Latvian business daily, *Dienas Bizness*, June 19, 1996 issue; data on tax payments are from the Riga and Liepaja Regional Environmental Boards.

[a]Lower bound on tax payments calculated using data on emissions and limits in Tables 20 and 21, and tax rates in Tables 1 and 2.

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