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Minimizing Environmental Impacts of Industrial Growth:

Case study of petrochemical industry in Kazakhstan

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Abbreviations

ASIL	Approximately safe impact levels
BAT	Best available technique
BREF	Best available techniques reference documents
CO2	Carbon dioxide
COD	Chemical oxygen demand
EAP	Environmental Action Program
EC	European Commission
EEC	European Economic Community
EIA	Environmental impact assessment
ELV	Emission limit value
EMAS	Eco-Management and Audit Scheme
EU	European Union
GDP	Gross domestic product
GPP	Gas processing plant
HDPE	High density polyethylene
IPPC	Integrated Pollution Prevention and Control
ISO	International Organization for Standardization
MAC	Maximum allowable concentration
MoE	Ministry of Environment
MPD	Maximum permissible discharges
MPE	Maximum permissible emission
NGO	Non-governmental organization
NO	Nitric oxide
NOx	Nitrogen oxide
NO_2	Nitrogen dioxide
OECD	Organization for Economic Cooperation and Development
ORP	Oil refining plant
PE	Polyethylene
PM	Particulate matter
PP	Polypropylene
PRTR	Pollutant Release and Transfer Registers
PS	Polystyrene
RK	Republic of Kazakhstan
SanR&N	Sanitary regulations and norms
SEIA	Strategic Environmental Impact Assessment
SMEs	Small and medium enterprises
SO_2	Sulphur dioxide
TA	Technical assistance
UNDP	United Nations Development Program
US	United States
VOC	Volatile organic compounds
WHO	World Health Organization

Executive summary

Objectives and use of this report

This study was initiated as a response to the request of the Ministry of Economy and Budget Planning to develop methodologies to analyze and mitigate key environmental and natural resource aspects of industrial growth and to propose ways to integrate these methodologies into policy tools. The emerging petrochemical industry was selected as an example to demonstrate how methodology can be applied. In order to meet the Government's expectations, this report was structured as two interrelated tools:

- **Technical guidelines** (chapter two and three) focus on (i) an analysis of availability of environmental resources in different oblasts; and (ii) references to internationally best available techniques (BATs) in the production of polymers. These techniques avoid and minimize impact on the environment as a whole. The Government can use these technical guidelines to consider and decide on the adequate benchmarks for environmental performance of the petrochemical industry. Eventually, this can serve as a reference book when evaluating proposals submitted by plant developers.
- **Policy guidelines** (chapter four and five) focus on policy instruments which would encourage plant developers to apply the best available techniques when developing potentially hazardous industrial production in Kazakhstan. The Government can use these policy guidelines to establish a modern regulatory incentive framework that protects the environment and is attractive to reputable and responsible investors.

It is NOT the goal of this study to evaluate the Government's plan on petrochemical sector development. The authors did not also intend to conduct an environmental impact assessment of the Program or of any of its elements.

Synopsis

Revival and development of the petrochemical industry in Kazakhstan is possible without serious damage to the environment, so long as measures by investors in plant revival include best available techniques (BATs) that avoid and minimize impact on the environment as a whole. References to environmental performance of these techniques are included for example in the technical guidelines published by the European Commission. The Government should consider and decide on the adequate benchmarks for environmental performance prior to inviting investors to reactivate existing installations or build new ones. Best available techniques may not be applied by developers without modernization of the regulatory incentives for industry in Kazakhstan. In particular (i) environmental permitting will need to move from an approach based on Maximum Allowable Concentrations (MAC) to an approach based on best available techniques (BAT); (ii) monitoring including self-monitoring will need to be improved; (iii) a modern environmental liability regime will need to be introduced; (iv) financial sanctions need to be streamlined and fair, but deterrent and inevitable; and (v) a number of environmental fees need to be drastically reduced. For a small number of them the incentive function may be strengthened. Other economic instruments (e.g., tradable water use rights) may be introduced to manage environmental conflicts when new industries enter excessively polluted areas.

The devil is hidden in incentives: post-Soviet environmental regulations need to be modernized further to encourage developers to apply best available techniques.

The fundamental question is whether the existing policy incentives in Kazakhstan would actually encourage developers of newly growing industries to apply the best available techniques. This study evaluates the existing environmental policy framework in Kazakhstan in terms of incentives that it generates to prevent and mitigate the environmental impact of rapidly growing industries. The practical steps to reform and strengthen the current incentive framework are identified.

This study shows that while Kazakhstan has made commendable progress in modernizing its post-Soviet regulatory and institutional framework for environmental management, the present policy incentives are not adequate to manage effectively the environmental impact of rapidly growing new industries, such as petrochemicals. Present environmental policy instruments do not effectively protect the environment against industrial pollution. They also do not improve the domestic climate for new investments, in particular, they may deter reputable high profile investors who are serious about socially and environmentally responsible business.

Environmental quality standards are often stricter than comparable OECD standards but are established for short term concentrations only, while significant risk of chronic health hazards are associated with long term exposure to pollutants. In the OECD countries ambient quality standards are derived from assessment of risk to human health and ecosystems, while in Kazakhstan they are inherited from old soviet norms. Kazakh environmental quality standards are established for an excessive number of substances, beyond any reasonable capacity to monitor. Regulations cover more than 2,500 air and water pollutants, compared to 30-50 most dangerous and widespread pollutants regulated usually in OECD countries. Moreover, in OECD tradition ambient quality standards are treated as policy objectives, for which policy makers are accountable, rather then legally binding norms, from which emission caps for individual sources are derived.

Environmental permitting is a key: European regulatory system can serve as a reference for permits that are integrated and derived from environmental performance benchmarks.

The key problem seems to be an environmental permitting system inherited from the Soviet regulatory framework (State Environmental Review). Environmental permit conditions are derived from excessively strict ambient quality standards through a non-transparent technocratic process. The permitting process is cumbersome, not transparent and difficult to enforce. It triggers improvised ad hoc solutions, such as rolling temporary emission limits, or environmental fee waivers and offsets, which undermine incentive impact and open room for corruption. This situation adversely affects the investment climate and introduces uncertainty to investment decisions. As a result, environmental permits are perceived by enterprises and by most policy makers as one more bureaucratic burden on economic activities. In OECD countries, environmental permits have evolved to become tools that help industrial operators identify better technology and management approaches to improve overall plant efficiency while preventing adverse environmental impact. The current environmental permit process in Kazakhstan is designed to allow certain levels of emissions and discharges by enterprises, instead of encouraging continuous improvement of environmental performance by enterprises and preventing or minimizing pollution.

The European Directive on Integrated Pollution Prevention and Control (IPPC) may be a useful reference model for modern environmental permitting for large enterprises. Permit conditions are integrated in order to protect the environment as a whole, avoiding the transfer of pollutants from one medium to another. Permit conditions are also based on the concept of Best Available Technique (BAT), which is the cornerstone of environmental permitting philosophy in the European Union. Instead of deriving permit conditions from ambient quality standards (as in Kazakhstan), European (and most other OECD) legislators derive permit conditions from the best environmental performers in industry. The most advanced enterprises using the best environmental practices are used as benchmarks. Their environmental performance standards and their environmental management practices are defined as best available technique (BAT). The BATs are described and published by Governments in technical guidelines (BREFs) for individual industrial sectors. Specific technical guidelines, numerical performance indicators and references included in BREFs aim to curtail the discretion of permitting agencies and minimize the room for corruption. An example of such guidelines for the production of polymers, relevant to the plants in Atyrau and Aktau, is presented in this study. Environmental impact assessment (EIA) and the environmental permitting process provide the framework for these considerations. During the EIA and permit negotiations, the European BREFs can be used by the Government authorities, plant developers and the public as a reference for the identification of the best available techniques (BATs) that can be applied to reactivated plants.

The IPPC Directive defines what "best" and "available" means, and also proposes a concept of technique – not technology! Technique includes technology and the way in which the installation is designed, built, maintained, operated and decommissioned. Such an approach stresses behavioral aspects of permit requirements and a comprehensive approach to the environmental management of the enterprise. It is also meant to prevent the governments from prescribing specific technologies and brand names as BAT, as this could distort competition and trade. The process of determining BAT and periodic updates of BREFs in the European Union creates incentives to innovate with environmental management, to introduce new technologies and to continuously improve environmental performance.

A mix of environmental policy instruments can create a consistent incentive structure that would protect the environment and attract reputable strategic investors.

Modern environmental permits are necessary, but not sufficient conditions of an effective incentive structure to encourage best available techniques in industry. Present sanctions in Kazakhstan do not deter non-compliance. They also do not encourage enterprises to prevent pollution and take precautionary approaches. The main compliance assurance instrument - non-compliance fines - provides perverse incentives because fines are used to "purchase" the right to violate the law and circumvent liability for damages. Therefore, accidental pollution spills in industry – also due to negligence – are relatively frequent causing damages several times higher than fines paid for non-compliance. The preventive function of financial sanctions can be taken by an adequate environmental liability regime. This would protect the country much better against large scale risks associated with growth of potentially hazardous industrial activities. The Law on environmental insurance has been submitted to Parliament, but it seems to focus too much on a particular financial security instrument (mandatory insurance) rather than on the establishment of a predictable regime of civil liability for environmental damage supported by enforceable sanctions. The mandatory character of insurance envisaged in the new Bill also raises the question of availability at reasonable costs and on conditions of insurance in Kazakhstan. All in all, what is needed now is the introduction of a strict liability regime for environmental damages with credible sanctions proportional to the value of damages. If in the short-term this cannot be achieved through the courts, the fines system may be improved by shifting to daily or weekly assessments which would mount to significant levels, and it could be clarified in law and practice that payment of fines removes no legal liability for damages.

Environmental fees are not fulfilling their functions properly. There are too many fee titles (e.g., 1,217 air, and 1,345 water pollutants) to be managed efficiently and calculated properly. Notwithstanding relatively high rates, the fees do not provide incentives to reduce pollution. Calculation of payments due is non-transparent and discretionary. These features turn environmental fees primarily into a tool for government officials to extract some rent from the industry. Enterprises perceive them as such and as an opportunity for corruption. They are designed as an inefficient fiscal instrument to raise insignificant revenues to local budgets. They need to be drastically streamlined. Most of several thousand emissions fees could be abolished without any serious damage to the environment or to public revenue.

Monitoring (including self-monitoring) needs to be made more focused on priority problems, especially those which are associated with significant health risks or irreversible damages to environment. Monitoring also needs to be made more transparent and data meaningfully accessible to the public. At present, the authorities and the public do not have adequate access to relevant environmental information for decision making.

As a result of inadequate design of policy instruments, the environmental regulations are poorly enforced. Violations of permit conditions and serious industrial accidents are common. Enforcement agencies are not effective. Inspections are done once a year and have to be announced in advance. In fact, according to local Kazakh experts, not only are environmental inspectors' rights modest by international standards, but they are often rebuffed by powerful enterprises, in particular, the oil and gas extraction sectors. In addition, local and republican Governments exert pressure on the environmental inspection authorities to relax enforcement of permit conditions. This negative attitude is likely to be a part of a larger structural problem described earlier. Inspectors are sent to enterprises often with an impossible task - to enforce conditions of environmental permits which cannot be met in any other way than closing the plant, for example if background pollution exceeds ambient quality standards. No wonder that inspectors are perceived as a nuisance, obstacles to growth and rent-seekers. With the technique-based environmental permits, the tasks of inspectors would be more reasonable, transparent and conducive to economic development.

The Ministry of Environment has recognized several shortcomings in the post-Soviet regulatory system and has already undertaken commendable steps towards reforms (e.g., self-environmental monitoring by enterprises, voluntary integrated permits, financing of enforcement agencies, environmental insurance). Most of these reforms, however, have an experimental, pilot character, although generally they go towards the direction of good international practice. Strategic investors usually expect that experiments are converted into a predictable regulatory framework for environmental requirements and clear incentives that influence strategic decisions.

The paper recommends the Government of Kazakhstan to continue the reforms initiated by the Ministry of Environmental Protection by focusing on the key measures which are most relevant to manage environmental impact of potentially hazardous industrial activities. Permitting and enforcement seem to be the primary candidates for reform, which, for large enterprises, could focus on a gradual, but consistent replacing of the current State Environmental Review with an integrated environmental permitting system, flexibly modeled after the EU IPPC approach. Reform of the permitting system should be combined with harmonizing Maximum Allowable Concentration standards with internationally accepted ambient quality standards based on risk assessment. This study proposes a sequence of priority reforms. It also provides the detailed roadmap and schedule for the gradual and evolutionary reform of environmental permitting.

The analysis presented in this study may serve as a model for methodology of identification and mitigation of potential environmental conflicts associated with rapidly growing industries. It also gives easy references to technical and policy measures to avoid these conflicts according to the best international practices. This model can be tailored and applied by the Government of Kazakhstan to other petrochemical products and to other industries. Application of this model can more effectively protect the environment while improving the overall business climate in Kazakhstan.

The petrochemical sector has shrunk but Government revival plans are ambitious

At the moment, the petrochemical industry contributes very little to Kazakhstan's economy. Two strictly petrochemical enterprises – the plastic plant in Aktau and the polypropylene plant in Atyrau ceased operation several years ago. Upstream activities – three refineries and three gas processing plants – are working at a fraction of capacity and are not producing feedstock to petrochemical processes. There are also two plants with related products - synthetic rubber – which are in operation.

Yet, the long and medium term sector growth objectives laid down in the "Program of Development of the Petrochemical Industry in Kazakhstan for 2004 – 2010" are ambitious. In the near term, the reactivation of production at the "Plastic Plant" in Aktau City and the polypropylene plant in Atyrau seem to be priorities for the Government. A few options for reactivation, product mixes and output growth are being considered and discussed with potential developers of these two and other plants.

The present contribution to pollution and water consumption of petrochemical plants is negligible and can remain small if best available techniques are applied by developers.

The present contribution of the petrochemical sector to environmental pollution in Kazakhstan is negligible, because the key plants are either not operational or operate at low capacity. However, new plants are envisaged in some areas where the environment is already polluted and water is already scarce. This study contains an overview of the environmental situation and water stress in the oblasts where petrochemical plants are likely to be located according to the government's program.

The future incremental environmental impact of reactivated or new petrochemical plants may be very different, depending on how these plants will be designed, at what capacity they will operate and what will be their environmental performance.

After recommencing operations, the contribution of the Atyrau and Aktau plants to oblast air emissions would be negligible. These conclusions may not hold for different product mixes or much larger capacities than assumed in this case study.

The summary data on water stress indicators by oblast show that for rivers, the most severe water stress is present in the oblasts of West Kazakhstan, Karaganda and South Kazakhstan. Groundwater resources are significantly or severely stressed in the oblasts of Atyrau and Mangystau (where the city of Aktau is located). Overall, Kazakhstan experiences significant water scarcity, particularly, during droughts and low river periods. Water scarcity may trigger competition for access between emerging industrial activities, existing enterprises and agriculture in certain regions. Both industrial developers and permitting authorities will need to take water stress into account when considering location of industrial facilities, sources of water used and above all – water intensity of industrial processes. In certain cities, it is particularly important to ensure that industrial developers apply the most modern technologies that minimize water consumption and apply closed loop systems for most technological water uses.

The production of hazardous waste is not likely to be the critical factor when determining the location of the majority of petrochemical production processes. However, this is true only so far as modern technologies are applied, which can produce limited amounts of waste. Atyrau and Mangystau oblasts have comparatively less accumulated hazardous wastes improperly stored than other oblasts. However, in general, the hazardous waste storage is highly inadequate due to the absence of appropriate landfills as well as incentives to reduce waste generation. Also, in some oblasts (for instance in Karaganda and East Kazakhstan oblasts), current inappropriately stored hazardous waste at factory sites are already causing contamination of ground and surface waters that may lead to significant health hazards.

Environmental performance and resource efficiency of best available techniques are demonstrated in the example of reactivation of petrochemical plants in Atyrau and Aktau.

Since the detailed pre-feasibility studies have not been done, a few alternative technical options have been assumed as plausible hypothetical targets of reactivation of plastic and polypropylene production in Aktau and Atyrau. Three broad technical options and associated environmental performance indicators have been considered: (i) simple reactivation of existing processes with old design environmental performance parameters (ii) reactivation of existing processes with additional environmental control measures, and (iii) reconstruction of the sites with new technologies and processes. The two latter scenarios were considered plausible. Benchmarks for international best available techniques in the production of polymers have been provided. The study also gives references to the costs of certain best available techniques in this sector. Eventually, this case study provides technical guidelines on the environmentally responsible course of action under different possible scenarios of reactivation of petrochemical production in Atyrau and Aktau.

If old production plants are reactivated with additional control measures added, efforts should be made towards environmental controls that are reasonably achievable. Due distinction should be made between requirements with respect to existing and to new plants. It is suggested that during the environmental impact assessment and the permitting procedure, the developers who will reactivate plants should inform the permitting authorities about the actions and investments that will be made to eliminate or minimize environmental impacts and waste generation. They should also demonstrate how remaining emissions and waste volumes relate to international benchmarks of best available techniques (BAT). If a project developer cannot meet certain emissions levels below the BAT standards, s/he should elucidate why by demonstrating the practical impossibility and/or the excessive cost it would take to comply. The benchmarks included in this study can help all the parties involved to have a constructive dialogue on what the words ‘reasonable’, ‘practical’, possible’ or ‘excessive’, actually mean.

If new production facilities are built with new technologies, it should be reasonable to require from developers to meet the European benchmarks of the best available techniques (BAT) or even do better. Petrochemical products are international commodities, subject to internationally established product market prices and a limited variation in investment and operating costs due to geographical factors. If Kazakhstan is moving forward towards constructing new facilities, these plants will need to be capable to compete internationally with the same environmental performance standards as leading foreign companies in this sector. International experience shows that compromising on environmental standards does not make an industry more competitive internationally. Therefore, there is no ground to apply different (lower) environmental standards in Kazakhstan than what is internationally accepted as best available technique (BAT). Scenario analysis in this study shows that using best available techniques by developers of petrochemical plants can prevent health damages to local populations and avoid conflicts with existing industrial and agricultural activities over access to scarce environmental resources, such as water and clean air.

Best available techniques are usually associated with higher production efficiency but initial capital investments may be slightly larger.

The report includes indicative comparison of costs of traditional and more modern technologies for polypropylene production. Investment costs vary widely depending on the availability of infrastructure and utilities and process choices. For example, polypropylene can be produced from ethylene and butane or from methanol in a natural gas to monomer integrated process. Investments of US$200 to 250 million are not uncommon for plants with a capacity of 300-350 kt/y. In general, modern polypropylene plants yield lower production cost and lower pollution than the traditional slurry processes. Investments in reactivation of facilities that have been out of operation for many years will normally cost a substantial percentage (30-60 percent) of the alternative green-field projects. Additional investments in existing production units to collect and treat volatile organic compounds (VOCs) emissions will cost up to US$100,000 per ton of VOCs per year. Other environmental controls may also add to the costs of the reactivation option. The cost of additional, end-of-pipe, environmental control measures to meet modern international standards will need to be taken into account in the decision process. However, most likely the production and product quality parameters will be the most important factors in making decisions whether to reactivate old facilities or build new ones.

Regarding the costs of polystyrene production, technologies have developed in a different manner than those for polypropylene production. It will therefore be more likely that the existing plants will be rehabilitated provided there is a good market basis and a reliable and cost-effective supply of raw materials and utilities. Also, for polystyrene production the main challenge is the reduction of VOC emissions to the atmosphere and in particular styrene monomer emissions. Investments in control measures range from US$20,000 to over US$100,000 per ton of reduced VOC per year.

It will be important for the Government to consider and decide on adequate benchmarks for environmental performance, prior to inviting investors to reactivate existing installations or build new ones. For individual control measures and technology choices, a balance will always need to be found between the need to avoid excessive risk to the people and the environment on the one hand, and practical feasibility, costs and economic impacts on the other. The most environmentally friendly scenarios would also be associated with lower production costs, but initial capital investments may be slightly higher under some circumstances. The Kazakh government now faces a typical policy dilemma in the industrialized world – how to influence short-term decisions of individual and free economic agents to serve the long term interests of the industry and of the society as a whole.

1. Present state and development plans of petrochemical and related sectors

1.1. Introduction

Kazakhstan is fortunate to be well endowed with oil and gas resources, land and a wide range of minerals. These resources contribute significantly to Kazakhstan's GDP[1]. The challenge Kazakhstan is facing is to ensure that they deliver the maximum sustainable benefits to the country's economy now and in the future. The government of Kazakhstan is aiming to pursue policies to increase the added value of the economy by diversification, broadening the base for non-oil growth, increasing the linkages between oil- and gas sectors and their related industries, including petrochemical industry. These objectives are embodied in the *Indicative Plan of Social and Economic Development for 2004-2006 (IPSED)*, *2003-2015 Industrial Innovation Program* and in several sector development programs. One of such sector programs – *The Program of Development of the Petrochemical Industry of the Republic of Kazakhstan for 2004-2010* – marks a strategic decision to promote development of petrochemical industry as one of the downstream sectors adding value to oil and gas extraction and primary processing. Individual assessments of economic viability for petrochemical plants and products have not been undertaken yet, and specific investment decisions will be dependent on a number of criteria, which are not analyzed within the scope of this study.

At the same time, Kazakhstan has inherited a legacy of significant environmental problems related to pollution and natural resource use by industry. Large parts of the country, including several urban zones, suffer severe water scarcity. Environmental impact of extraction and manufacturing industries that Kazakhstan inherited from the Soviet Union is sometimes associated with significant health damages to population and excessive pressures on scarce water and other environmental resources. In some regions, this may threaten development of rural sectors, such as agriculture, fisheries, tourism, the productivity of which depends on fragile ecosystems. New emerging, high tech economic activities may also face unfair competition for access to environmental resources (e.g., clean water and air). Highly skilled labor, especially educated youth is already escaping from heavily polluted cities, undermining the competitive edge of export oriented sectors.

In order to achieve sustained long term growth of the economy, environmental and natural resource considerations play an increasing role in formulation of the industrial development objectives for the next 10-15 years. The government programs recognize the importance of international state-of-art environmental standards in industry for the long-term sustainability of economic development of the country. This was also reflected in the address of President Nazarbayev to the nation on March 29, 2004 when he recognized that competitiveness of Kazakhstan in the world community needs the strategy of reaching European standards both in economic and social sectors.

[1] The oil sector is estimated to account for 15 percent of GDP on average over the past 5 years.

1.2. Study objective and outcomes and methodology

This study was initiated as a response to the request of the Ministry of Economy and Budget Planning (MEBP) to develop methodologies to analyze and manage key environmental and natural resource aspects of industrial growth and to propose possible methods of integration of these considerations into the policy process. This study was conducted within the framework of the Joint Economic Research Program (JERP). The report is not the only output of the JERP program. During the years 2004 and 2005 a number of workshops were organized to facilitate the transfer of international know-how on technical and environmental aspects of petrochemical industry. These activities have been reported regularly to the Government of Kazakhstan and to the Bank.

Based on the discussions and outcomes of the workshop with the government in Astana held on July 27, 2004 and on the concept meeting held on September 15, 2004, the objective of this study is to assist the Kazakh authorities with developing regulatory and institutional frameworks to mitigate environmental and natural resource impacts of industrial development. The petrochemical industry was proposed by the Government as a pilot sector to demonstrate the proposed approaches. The outcomes of the analytical work may serve as a model for development of environmental management strategies for this and other growing industrial sectors in the country.

Expert-to expert dialogue, reviews of practical experience, as well as policy and institutional analysis were used to share OECD and other country good practices in mitigating environmental impacts on industrial growth.

Several technical and policy workshops as well as videoconferences via satellite were organized to facilitate expert-to-expert dialogue and know-how transfer. Local consultants and scientific institutions have contributed to the study with information on environmental and natural resource conditions in the country, while the Bank ensured a transfer of practical knowledge on environmental technologies and management practices from private industry with regard to regulatory and policy framework for environmental management in the OECD countries.

Only a portion of the know-how transferred to Kazakhstan within the scope of this project could have been reflected in the final report. According to the main objective of this project, the final report focuses on:

- Technical guidelines on how to recognize internationally best available techniques in the production of polymers that avoid or minimize adverse environmental impact and maximize overall production efficiency
- Policy guidelines on how to implement priority regulatory and policy reforms to create incentives for investors to apply best available techniques in developing new and potentially hazardous industrial production in Kazakhstan.

The next two chapters (1.3 and 1.4) will discuss the present state of, and the government's plans for the petrochemical sector in a context of related upstream industries (oil refining and gas processing), as well as other related products, such as rubber.

1.3. Present state of petrochemical and related sectors

Oil extraction

The Republic of Kazakhstan is one of the largest oil production regions in the world with large potential hydrocarbon raw reserves. Oil and gas condensate production was more than 59 million tons in 2004 and is constantly growing. With the development of oil fields at the Caspian Sea, oil extraction is expected to exceed 150-170 million tons by 2015.

Oil refining

Kazakhstan has three oil refining plants (ORP) and three gas processing plants (GPP). At present, the raw processing of hydrocarbons is limited by oil and gas separation without further delivery of feedstock to petrochemical processes.

At the beginning of the chain, there are 3 oil refineries in Kazakhstan: (1) OJSC “Atyrau Oil Refining Plant” (AORP); (2) CJSC “Pavlodar Petrochemical Plant” (PPCP); and (3) OJSC “PetroKazakhstan Oil Products” in Shymkent (PKOP). All three are in operation, however, for fuel production only. None of them produces anything that is used for the production of petrochemicals, therefore they cannot be regarded at present as part of the petrochemical sector in Kazakhstan. Only 20 percent of crude oil is refined in the country. The designed production capacities are 18.6 million tons/year with the average capacity utilization of about 40-50 percent in recent years, with negative consequences for plant efficiency and process performance. Light fraction extraction is much less complete than in Western plants.

Gas processing

Three gas processing plants – Tengiz GPP in Atyrau, Kazakh GPP in Zhanaozen (200 km from Aktau), and Zhanazhol GPP (ZhGPP) in Zhem city have a general design processing capacity of 6.25 billion m^3 of gas per year. Zhanazhol Gas Processing Plant (ZGPP) is part of OJSC “CNPC-Aktobemunaigas”. It has a processing capacity of 0.7 billion m^3 of gas per year. After reconstruction, the plant capacity has been increased up to 0.8 billion m^3 per year. The second Zhanazhol GPP was put into operation in September 2003 with the production capacity for the natural gas processing of 1.4 billion m^3 per year. The third plant was due for commissioning in 2005. The Tengiz Gas Processing Plant (TGPP) is located in Atyrau Oblast at the Tengiz field developed by JV “Tengizchevroil”. After reconstruction and expansion, the plant can process up to 6.0 billion m^3 of gas and 1 million tons of condensed gas per year. The Kazakh Gas Processing Plant (KGPP) is located in the Mangystau Oblast (Zhanaozen City). It was constructed for the associated gas utilization from the Mangyshlak fields and provision of the Aktau City plastic plant with raw materials, but has never delivered these inputs. The first part of the plant was constructed in 1973. The plant construction with the capacity of 1.5 billion m^3 per year of gas processing and 600 thousand tons per year of liquid oil products was completed in 1979. Putting this plant into operation made possible a utilization level of the associated gas in this region of up to 60 percent.

Existing petrochemical plants

At present, there are two enterprises for plastic production in the territory of Kazakhstan and none of them is in operation. “Polypropylene Plant” Ltd. Atyrau City was stopped in 1996. The “Plastic Plant” Ltd. Aktau City is out of operation since 2004. In May 2004, Sat&Company purchased the property of “Plastic Plant” Ltd. At the same time, the Kazakhstan investor purchased “Polypropylene Plant” Ltd. In December 2004, the Company “KazMunaiGas Exploration, Extraction” (the subsidiary of the national oil and gas holding “KazMunaiGas”) purchased 50 percent of shares of these two plants from Sat&Company.

"Polypropylene Plant" Ltd. (Atyrau City) was established on the basis of the Chemical Plant which was put into operation in 1966. Production of the granular polypropylene of molding and fiber types based on the method of continuous polymerization within the medium of the heavy solution was purchased in 1976 from Montedison Company (Italy) and put into operation in 1977. Lines for production of the sack tare and hay-binding cord were put into operation in 1993. The Italian technological line for processing, filling and packing of the tail part of the propylene processing was assembled in 1995. The main production technological plant workshops are: polypropylene polymerization based on the technology of the Company "Monte Katini Edison" (Italy); polypropylene and polyethylene granulation; catalyst production used for output of own products; nitrogen-oxygen production satisfying the need of the Atyrau Oblast in technical and medical oxygen and nitrogen; production of consumer goods; and cord and sack tare production based on the technology of the "Linde" Company, Germany. The design capacity per year was: propylene production – 30 thousand tons; polyethylene compositions from the imported powder – 3.5 thousand tons; hay-binding cord - 23 thousand tons; and sacks made of polypropylene - 6 million units. The plant operated on imported raw materials – propylene, heptane, butanol. It stopped operations in 1996 and has stayed idle since then.

"Plastic Plant" Ltd. (Aktau City) was arranged on the basis of a full technological cycle: from the monomer synthesis (styrene) up to production of finished types of polystyrene in the form of beads and granules. Developers of the production technologies of the polystyrene brands: the blowproof (BPB) and of the general destination (GDB) are the Company "Emikota" (USA); foaming polystyrene (FP) – the developer of the production technology is Company "Rhone Poulenc" (France). The plant was put into operation at the time of high deficit in basic raw materials, ethane, which was delivered from the Kazakh Gas Processing Plant (Zhanaozen City) in the volume of 60 tons per year with the demand of 160 thousand tons. Another raw material, i.e., petroleum benzene, in the volume of up to 260 thousand tons per year was imported from petrochemical enterprises in Russia, Ukraine and Byelorussia. The plant operated until 1993 with the full technological cycle including the following products: a) ethylene production; b) facility for the ethylbenzene-styrene production; c) facility for the polystyrene plastic production. A fire in 1995 caused a complete shutdown of the ethyl-benzol facility and subsequent shut-down of the production of styrene. Production of polystyrene on the basis of the styrene imported from Russia turned to be rather problematic. The plant shortly resumed operations in 2001-2003 with a pilot level of production of some 5 kt polystyrene (PS) per year but has been idle ever since.

New petrochemical plants under development

In 1997, Kaznephtekhim Ltd. (Almaty City) was established with branches in Atyrau City, Aktau City, Aktobe City, Astana City and Uralsk City. This is a developing plant on exploration/exploring of hydrocarbon fields and transportation, storage and processing of hydrocarbon raw material. This enterprise is one of the owners of "Polypropylene Plant Ltd." in Atyrau City and "Plastic Plant Ltd." in Aktau City discussed above.

ChevronMunaigaz Polyethylene Pipes Plant Inc., (Atyrau City) manufactured the first batch of pipes, which is about 600 tons, in April 2003. Three modern processing science intensive lines were installed for manufacturing of high-density pipes that are almost pollutant-free because the plant produces plastic pipes out of plastic granulates imported from Russia and other countries, therefore there are no chemical processes on site.

Rubber Products

Synthetic rubber products are not always considered to be part of the petrochemical industry. There are three **rubber products** plants in Kazakhstan, out of which only two are in operation. The first, OJSC Saranrezinotekhnika in Saran City, Karaganda Oblast produces conveyor belts and similar products. The second, Karagandaresinotekhnika Ltd., also in Saran City, ceased production in 1997. The third, OJSC InterComShina in Shymkent City, produces tyres. OJSC Saranrezinotekhnika and Karagandaresinotekhnika Ltd. were established in 2000 on the basis of the separated assets of the giant plant OJSC Karagandaresinotekhnika. This plant was equipped with modern production equipment of domestic and foreign origin. Construction of the OJSC Karagandaresinotekhnika plant was started in 1968 and commissioned in 1975. But this plant has been at a long standstill since 1997. Problems with raw materials supply (90 percent supplied from Russia) and funds caused, at first, a decrease in production and subsequently a complete stop of production. OJSC InterComShina (Shymkent City) is the only plant is Kazakhstan and Central Asia producing tires for trucks, cars and agricultural machinery. Subject to technique, this plant is the state-of-the-art equipped plant in comparison with 17 similar plants in the CIS. The construction of this plant was started in 1975. The first tire production output was in 1980. The equipment was supplied by such companies as: “Krupp”, “Pirelli”, “Repike”, “Fata”, “Byuler-Miag”.

1.4. Sector development plans and scenarios

The objective of this study is to identify the policy options for mitigating the negative environmental impact of the industry that is envisaged to grow according to Government plans. It is NOT the goal of this study to evaluate Government’s plans. Therefore, this chapter will merely give the overview of the objectives and scenarios included in the Government’s program and related documents of local experts.

The rationale for the *“Program of Development of the Petrochemical Industry in Kazakhstan for 2004 – 2010”* stated by the Government and local experts include to:

- Add value to domestic oil production;
- Increase capacity utilization of oil and gas processing capacities in Kazakhstan ;
- Enhance efficiency of oil and gas refining business; and
- Reduce import dependence of production of petrochemical products.

The implementation of the Program is expected to yield the following results:

- Develop domestic raw material base for petrochemical enterprises, based on modernization and rehabilitation of existing oil and gas processing facilities and create new petrochemical complexes through targeted investment construction projects; and
- Create comprehensive infrastructure for Kazakhstan petrochemical industry, based on modernization and rehabilitation of operating petrochemical enterprises and creation of new facilities, technologies, equipment and materials.

According to the Program document, its implementation in these areas will allow to:

- secure further development of vertical integrated structures from extracting and shipment of hydrocarbon material to fine and comprehensive processing of this material, producing finished petrochemical products; and
- process significant amounts of associated gas that are currently flared, causing excessive emissions of harmful substances in free air;

By 2010 the following outputs of petrochemical and related products are expected:

- ***polystyrene***: up to 300,000 tons a year,
- ***polypropylene***: up to 100,000 tons a year,
- ***polyethylene***: between 50,000 and 300,000 tons a year;
- ***Synthetic rubber***: 60,000 to 120,000 tons a year, which is a volume required for manufacture of general mechanical rubber goods and tire products (3 million to 5 million inner tubes and tires a year);
- ***Sulfur products*** (commercial granular and flake sulfur, sulfur concrete, sulfur cement, modifiers, etc.) based on utilization of associated products of gas and oil cleaning and processing; and
- ***Import substituting products for oil and gas complex of Kazakhstan*** (catalysts, reagents, demulsifiers, etc.

Plans to reactivate production of polystyrene plastics

The reactivation of production at the "Plastic Plant" in Aktau City seems to be a high priority for the Government. Two types of polystyrene products are envisaged: high impact and expandable polystyrene. Future plans are to increase polystyrene production gradually to 60, 150, 300 and ultimately 450 kt/y, and subsequently add styrene (STY), ABS, Ethylene (Eth), ethyl benzene (EB), benzene (BEN), polyethylene (PE).

Two options for future expansion of polystyrene are listed in the Government program:

Option 1 may include the following measures:

- Establish styrene monomer production of 300 thousand tons per year (2008) through reconstruction of the styrene facility of the reactor block for ethyl-benzol dehydrogenation (expenses for the project implementation are US$5 million);
- Increase the production volumes of the polystyrene plastics in compliance with the existing capacities of the technological lines to reduce costs of product (2004-2010);
- Technical modernization of the operating capacities of the "Plastic Plant" in Aktau to increase capacity to 150 thousand tons per year up to 2006, and 300 thousand tons per year up to 2010 as well as to improve the quality in compliance with the international standards;
- Rehabilitate the facility for ethylene production on the basis of standby, remaining usable mothballed equipment of the rectification unit;
- Increase the variety of the polystyrene of common destination and high impact polystyrene; increase the production volumes of the expandable polystyrene;
- Open up the production of new brands including the polystyrene ABC-plastics, ion-exchange resin and membranes in compliance with the international standards ISO; and

- Implement the construction of new up-to-date facilities and workshops for polyethylene and other petrochemical products output within the production infrastructure of the Aktau “Plastic Plant”.

Option 2 is based on the assumption that an ethane pipeline with the capacity of 500 thousand tons/year will connect the Aktau plant with the Tengiz deposit at a cost of US$70 million, and the product pipeline (ShFLU from Tengiz to Kazakh Gas Refining Plant (GRP)) will be built with the capacity of 900 thousand tons/year (at a cost of US$80 million.). These cost estimates were conducted by the government experts. This option may also include the following measures:

- Rehabilitation of the ethylene facility, increase of the capacity from 70 to 110 thousand tons/year;
- Rehabilitation of the ethylbenzene facility, increase of the capacity from 346 thousand up to 392 thousand tons/year;
- Reconstruction and modernization of the styrene facility, increase of the capacity up to 370 thousand tons/year;
- Construction of the facility for the high impact polystyrene production with the unit capacity 60-80 thousand tons/year (cost is US$1.5 million), expansion of the high impact polystyrene production, increase of the capacity up to 150 thousand tons/year;
- Expansion of the expandable polystyrene production, increase of the capacity from 60 to 100 thousand tons/year; and
- The proposed ethane resources will allow a new ethane pyrolysis (EP) facility with a capacity to produce ethylene at a level of 250-300 thousand tons/year. Construction of two new facilities for production of the high and low pressure EP may be made on the basis of own ethylene.

Given the past difficulties with importing styrene from Russia, the Government is trying to solve this problem by supplying Aktau plastic plant with domestic raw resources. Therefore the Government program envisages that ethylene (up to 160,000 tons per year) is expected to be transported from KGPP in Zhanaozen by pipeline. The Government also considers a possibility for relocation of the plant close to the raw materials base and location of new ethylene production next to the raw materials base as well. This would significantly shorten the length of the ethane pipeline.

Plans to reactivate production of polyethylene and polypropylene

Reconstruction of the Polypropylene (PP) Plant Ltd. in Atyrau is planned to reach the capacity of 50 kt of polypropylene (PP) per year and 3.5 kt of polyethylene (PE) per year. Ultimately, the future output should increase to 100 kt/y PP and 200 kt/y PE.

In the short run, the feedstock of propylene will most likely be imported from Russia by train (2 days). The Government program stipulates, however, that in the long run the "Polypropylene Plant" in Atyrau will rely on the domestic raw resources base, i.e., the products of GRP in case of the complex processing of the gas condensates, natural and associated gas.

The activities aimed at the expansion of existing and establishment of new productions may include construction of the facility for the propylene production with the technology of propane dehydrogenation with the capacity of 150 thousand tons per year, as input to further production of polypropylene, acrylonitrile and ethylene-propylene kauchuk. The cost of the propane dehydrogenation facility was estimated by the government experts at US$170 million. Moreover, the Government plans to establish a new polyethylene production with the capacity of 200 thousand tons per year. The Program envisaged that this could reactivate the production of pipes made of polyethylene of high density oriented at the first stage with raw materials from Europe and Russia with domestic polymers produced from domestic raw materials.

Table 1 provides an overview of various alternative assumptions included in the *"Program of Development of the Petrochemical Industry in Kazakhstan for 2004 – 2010"*.

Table 1: Government alternative assumptions regarding planned outputs of petrochemical products: Low *; Medium **; High ***

Petrochemical	Petrochemical Type	Reactivation of existing plant or new plant	Plant's Capacity as metric tons/year (MTY)	Plant Location	Produced Consumer Goods	Raw Materials Used and Method of Transportation to the Pipeline Terminal Station	Source of raw material inputs	Method Used	Licensing Company mentioned in the program
1	2	3	4	5	6	7	8	9	10
Polypropylene	Granular, Molded and Fiber optic	Reactiv.	actually – 0 30 000 MTA* 50 000 MTA** by 2006 year	Atyrau City	Molded binder, bags, bonding agents	Propylene Heptane Butanol	Russia Ukraine	Suspension method: with the use of balloon mixing apparatus	Montedison-Polimeri
		New	40000-60000 MTA *** by 2010 year	Atyrau City		Propylene	Atyrau City ORP (AORP)	Polymerization	
Polystyrene	Beads and Stabilized Granules	Reactiv.	actually -0 60000 MTY * 150000 MTA ** by 2006 year	Aktau City		Styrene Benzene Peroxide Caoutchouc Tribasic calcium phosphate	Russia Russia Germany Belgium	Uninterrupted polymerization in mass (UPM)	
	General Purpose	Reactiv.	55000 MTY*	Aktau City		Styrene	Russia	UPM	Emicota
	High impact	Reactiv.	54000 MTY* 150000 MTY***	Aktau City		Styrene	Russia	UPM	Emicota
	Expandable	Reactiv.	60000 MTY** 100000 MTY***	Aktau City		Styrene Tribasic calcium phosphate	Russia Belgium	UPM	Rhone-Poulenc
		New	Will be added 150000 MTA *** by 2010 year	Aktau City		Styrene Benzene Peroxide Caoutchouc	Kazakhstan Kazakhstan Kazakhstan	Polymerization	
Styrene		Reactiv.	300000 MTA ** by 2008 year 370000 MTA *** by 2010 year	Aktau City		Benzene Ethylene Ethylbenzene	Aktau	Catalytic Alkylation Dehydrogenation	
ABS-Plastic			40000-45000 MTA***	Aktau City		Butadiene-styrene rubber	Russia		Dow Chemical
	Ethylene	New	70000 MTA** 110000 MTA***	Aktau City		Ethane-500000 MTY Ethane pipeline -new	Kazakh Gas Plant Zhanaozen	Pyrolysis	
Ethylbenzene	Ethylbenzene	New	346000 MTA** 392000 MTA***			Ethylene Benzene	Aktau City	Catalytic Alkylation	
	Ethylene	New	250000 MTA***	Zhem City		Ethan Ethane pipeline -new		Pyrolysis	
	Ethylbenzene	New	130000 MTA**	AOPP		Benzene	AORP	Catalytic Alkylation	
	Benzene	New	260000 MTA***	AOPP				Dehydrogenation	
	Benzene	New	300000 MTA***	Aktau City				Dehydrogenation	
Polyethylene	LLDPE HDPE	New	55000-65000 MTA*** 65000-75000 MTA***	Aktau City		Ethylene	Aktau City Zhem	Polymerization	
	LLDPE	New	200000 MTA***	Atyrau City	Pipes			Polymerization	
Propylene		New	150000 MTA***	Atyrau City		Propane		Dehydrogenation	

Legends: LLDPE – Linear low density polypropylene; HDPE – high density polypropylene; ORP - Oil Refining Plant
Source: Sergey Inuytin and Madi Kireyev on the basis of government program and Kazakh expert estimates

2. Environmental conditions and water availability in the areas where petrochemical industry may be located

This chapter does not aim at analyzing the environmental situation in Kazakhstan. It focuses on the regions and the environmental issues that are associated with the petrochemical industry. The objective is to identify the potential environmental problems which may lead to conflict with other uses of environmental resources over access to adequate water, clean air and waste treatment facilities.

2.1. Air

2.1.1. Air emissions

The air emissions from stationary sources decreased in Kazakhstan in the 90s, due to the general recession and a decrease in output of industry. However since 1999-2000, air emissions from the major pollutants have stabilized or have been increasing again. The highest emissions of air pollutants in recent years have been in Karaganda (SO_2, NO_x, dust and VOC) and, Pavlodar (NOx and dust). Mangystau (with Aktau) had the highest emissions of hydrocarbons in Kazakhstan but scored low on other pollutants (see figures 1-4).

Figure 1: NOx emissions trends from stationary sources by oblast (ton/year)

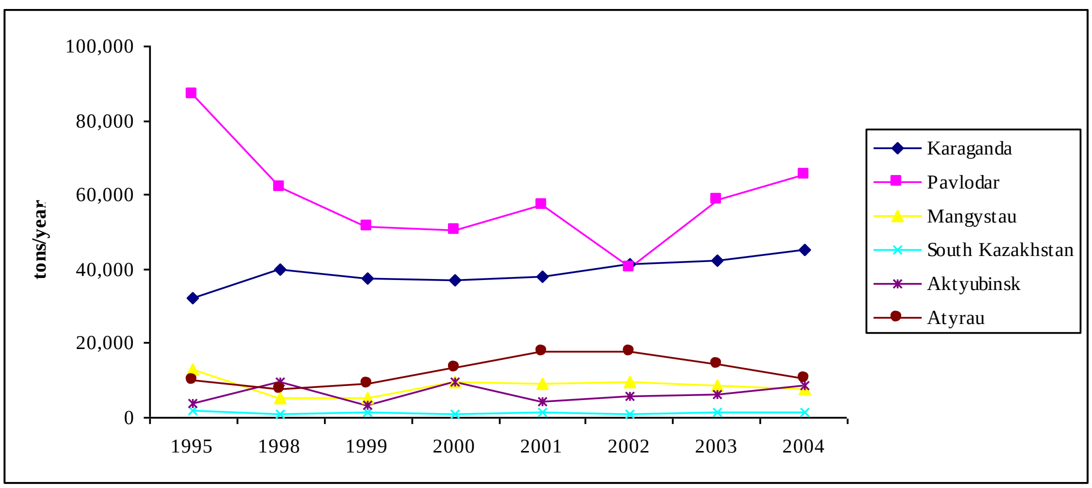


Figure 2: Hydrocarbon emissions trends from stationary sources by oblast (ton/year)

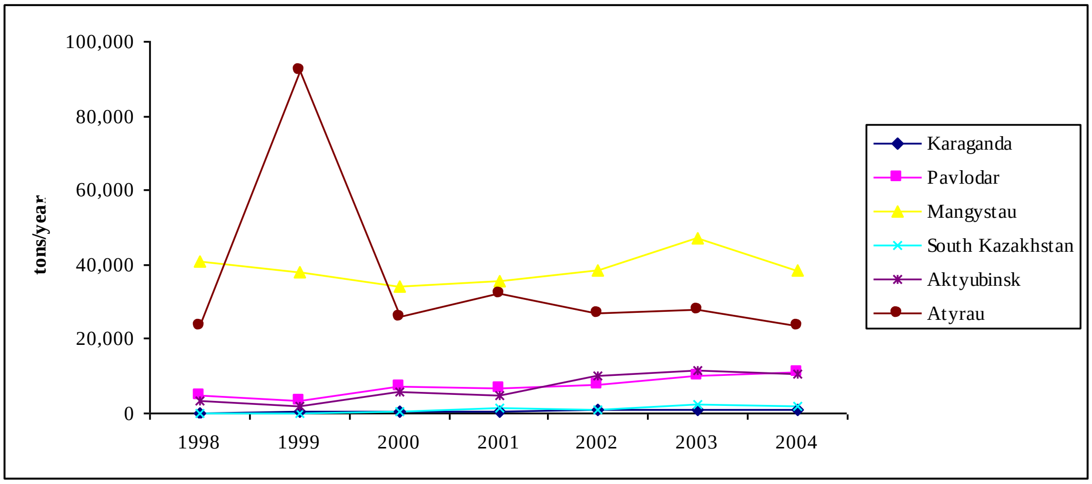


Figure 3: SO_2 emissions trends from stationary sources by oblast (ton/year)

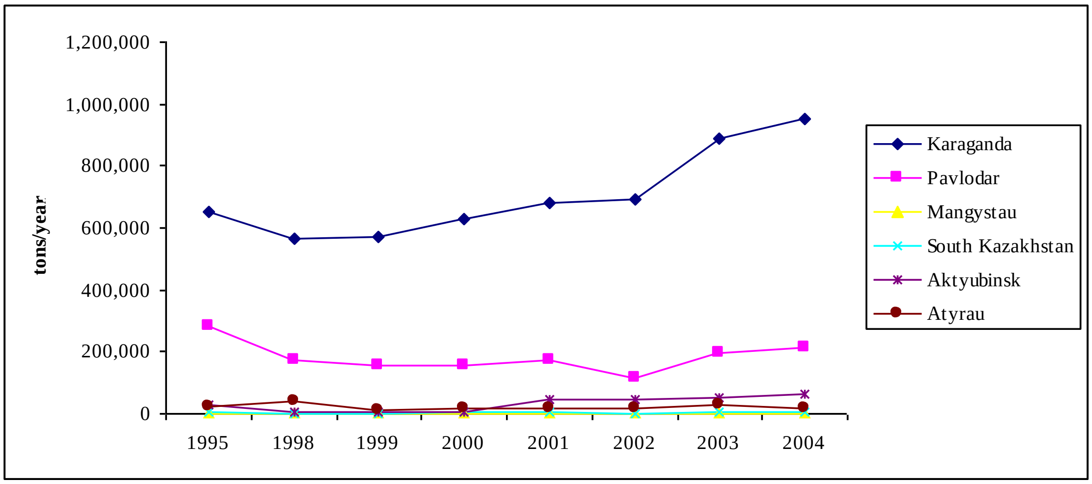
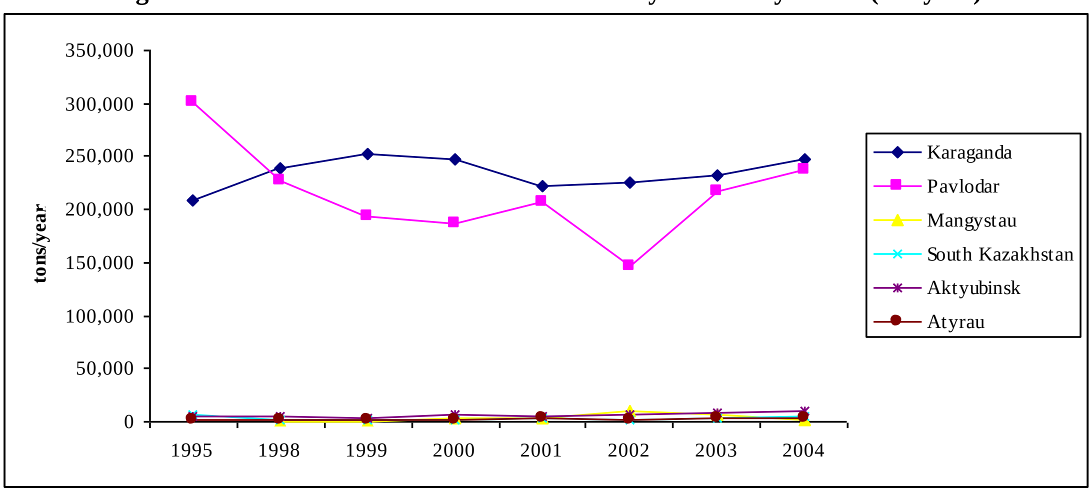


Figure 4: Dust emissions trends from stationary sources by oblast (ton/year)



Source : Local consultants after State Statistical Committee

According to local consultants, air emissions data cannot be broken down by sector. Therefore, it is difficult to estimate historical emissions from upstream activities such as oil, gas and refineries or related products, e.g., rubber.

Contribution of the current petrochemical sector to air emissions is negligible since strictly speaking petrochemical plants have not been in operation for several years. In 2003 when the Aktau plant operated in a pilot mode at low capacity, it contributed to 0.1 percent of emissions of NOx and 0.2 percent of emissions of hydrocarbons (see table 2) from stationary sources. Only SO_2 emissions from the plant accounted for a significant share (64 percent) of emissions from stationary sources in the oblast. However, it is mainly due to the fact that the SO_2 emissions from other sources in Mangystau were very small (compare with figure 3 above). These relative contributions would be even smaller if mobile sources (traffic) were included in total emissions data.

As rough simulations presented in table 2 show, even after commencing operations with old production processes and emission intensity (though with larger output), the contribution of both plants to oblast emissions of SO_2, NOx and hydrocarbons to the air would be negligible (1.7-1.8 percent) except SO_2 emissions from the plastic plant in Aktau. After resuming operations the Aktau plant can emit 3-4 times more SO_2 than all other sources in the oblast. Yet, as stated earlier, this is due to the fact that forecasted SO_2 emissions from other sources are negligible. These conclusions may not hold for different product mix or much larger capacities in Atyrau and Aktau plants than assumed for scenario analysis in this study.

Table 2: Forecasted emissions of selected pollutants from Aktau and Atyrau petrochemical plants (with old emission intensities) as percentage of total forecasted emissions from other stationary sources in oblasts (tons/year)

	Aktau/Mangystau		Atyrau 2006[1] (capacity: 100,000 polypropylene)
	2003 (capacity: 5K polystyrene)	2006[1] (capacity: 50K polystyrene)	
SO2	64.0%	362.0% [2]	0.0%
NOx	0.1%	1.8%	0.9%
Hydrocarbons	0.2%	1.7%	0.6%

Source: Own simulations on the basis of data provided by consultants
Notes:
[1] Total 2006 emissions from the oblast were forecasted using linear extrapolation of 2001-2004 emission trends.
[2] The expected figure of SO_2 for 2006 are larger than 100 percent because with linear extrapolation, Aktau plant would emit 3-4 times more SO_2 than all other sources together.

2.1.2. Urban air quality

Available data suggest that ambient air quality in major cities in those oblasts that could be of interest for the location of the petrochemical industry has deteriorated, especially since 2003 (figures 5-7). This could have been associated with the recovery of industrial production and increased car traffic. Population exposure to pollution may be even worse than data suggests because of the chaotic Soviet patterns of urban development in Kazakh cities, where residential areas are mixed with industrial sites[2].

Figure 5: SO_2 ambient air concentrations compared to regulations

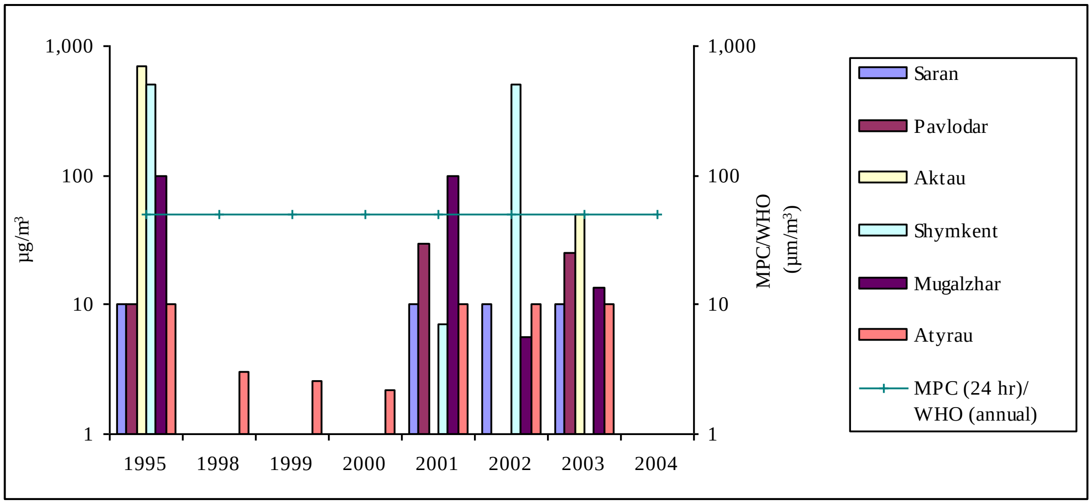
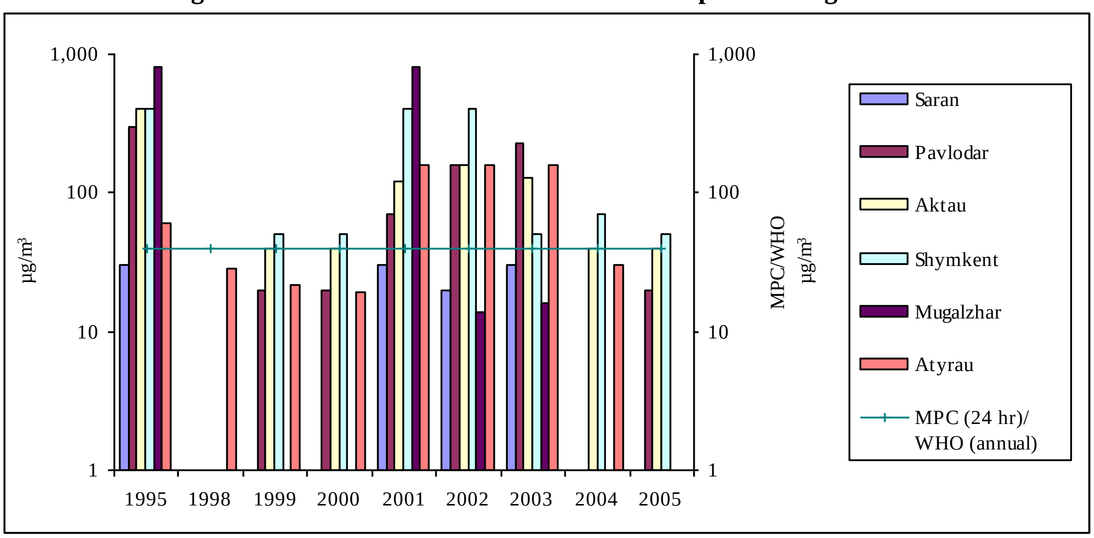
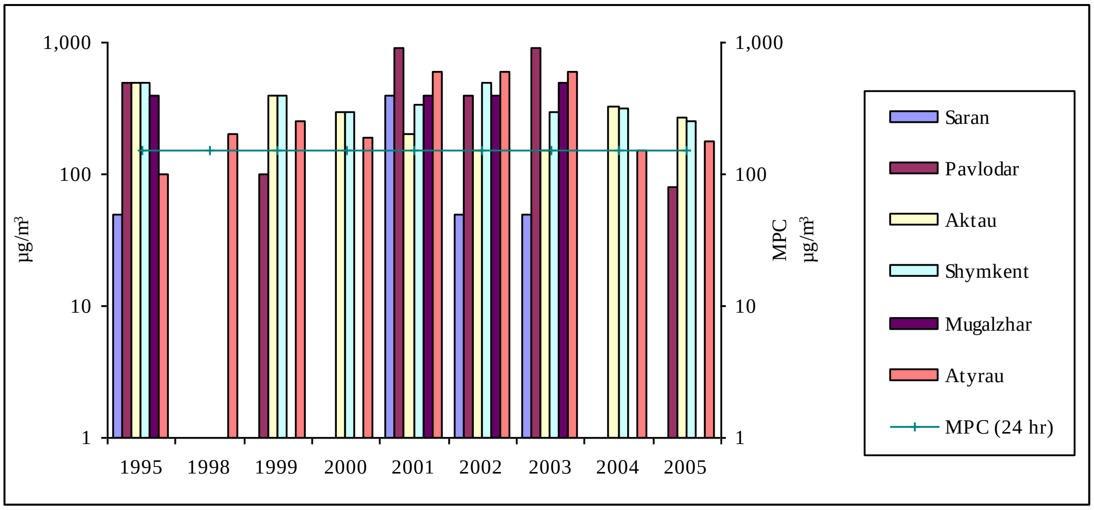


Figure 6: NOx ambient air concentrations compared to regulations



[2] The sanitary zones are formally established for each industrial site and population is supposed to live outside. Ambient quality is checked at the edges of these zones and concentrations outside should not exceed maximum allowable concentration standards (MAC). In reality however many people live within these zones. In Pavlodar for instance, apartment blocks are 1,000 meters from the Pavlodar Refinery.

Figure 7: Suspended particles ambient air concentrations compared to regulations



Although ambient air concentrations data have been missing for many years, it seems that ambient air concentrations often violate legal standards (so called Maximum Allowable Concentrations – MACs). Aktau has problems attaining suspended dust concentration standards, and Atyrau has difficulties attaining standards for NOx and suspended dust. Higher violations seem to have occurred in the years 2001-2003. By the Integrated Pollution Index used in Kazakhstan, the most polluted cities were Shymkent (13.5), and Aktau (5.4). On the other hand, Pavlodar (1.3), Atyrau (1.2) and Saran (0.4) have relatively cleaner air.[3]

It is difficult to draw robust and policy relevant conclusions from these data. A post-Soviet approach to ambient air quality monitoring is not fully compatible with international standards. Short term exposure standards in Kazakhstan are stricter than equivalent standards recommended by the World Health Organization. But Kazakh MAC standards are defined for short term exposures only. They are averaged over 24 hours (such as data on figures) or less, although international epidemiological studies show that the significant health risk – such as chronic respiratory diseases – comes from long term exposures to even lower concentrations of pollutants. From the data provided, it is not possible to determine how often these 24-hour standards are violated, in which seasons of the year and what were the annual average concentrations. The standards for particulate matter (suspended dust) for short term exposures are also stricter than in the EU, but they are determined for all particles suspended in the air, irrespective of size. Fine particles, PM_{10} and $PM_{2.5}$, which are most hazardous to health and for which international standards are set, are not monitored because there is no standard for them in the law (epidemiological studies for PM_{10} and $PM_{2.5}$ were not known in Soviet times). More discussion on ambient quality standards in Kazakhstan will be found in chapter 4 on policy instruments.

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[3] These indices are calculated by Kazhydromet using data of daily air quality monitoring. Usually Index (I) is calculated for five main pollutants – dust (suspended substances), SO_2, CO, NO_2 and formaldehyde:

I<5 (low level of air contamination)
I=5-6 (slightly high)
I=7-13 (high)
I>14 (very high)

The tentative conclusion can be drawn however, that although air quality in the cities, where petrochemical plants may be located is generally poor, the incremental contribution of petrochemical plants to air pollution is not likely to be significant, especially if plant operators apply the best available production techniques. These techniques will be elaborated further in the chapter 3. These conclusions may not hold for all product mixes and very large plant capacities.

2.2. Water resources and water quality

2.2.1. Water resources

By the amount of river runoff on its land, Kazakhstan belongs with the countries very poorly endowed with water. Fresh water supply is 37,000 m^3 per km^2 of territory or 6,000 m^3 per person per year. Annual run-off is as low as 37 mm per year.

The intensity of the freshwater use is high in Kazakhstan. The total average consumption per person in 2002 amounted to 1,040 m^3 per person per year in 2002. This is lower than North America (1,480 m^3), but higher than OECD-Europe (560 m^3), the EU-15 (600 m^3) OECD average (920 m^3) and the World average (664 m^3 per capita per year)[4]. Most water intense oblasts where total water consumption per capita is the highest are Karaganda (industry), Mangystau (industry), Pavlodar (industry/agriculture) and South Kazakhstan (agriculture).

Water consumption by oblasts and by major users group is shown in table 3.[5] Overall, in the country, the largest pressure on water resources comes from irrigation in agriculture (70 percent of total water withdrawal). Industry is the largest water user in Karaganda (92 percent) and Mangystau Oblasts (97 percent) and also in Pavlodar (65 percent) and Atyrau (59 percent of total water use). Agriculture is by far the largest water use in South Kazakhstan, West Kazakhstan and Aktobe Oblasts.

Table 3: Consolidated data for water consumption by oblast and by users group

	Domestic use	Industrial consumption	Agriculture
Republic of Kazakhstan	**4%**	**26%**	**70%**
Aktobe Oblast	15%	11%	73%
Atyrau Oblast	10%	59%	31%
West Kazakhstan Oblast	6%	3%	91%
Karaganda Oblast	6%	92%	2%
Mangystau Oblast	2%	97%	0%
Pavlodar Oblast	2%	65%	33%
South Kazakhstan Oblast	2%	1%	97%

Source: UNDP 2002 National Report on Human Development

[4] OECD Environmental Data, Compendium 2004

[5] The total water available for water consumption takes into account the high level of water losses during transmission. (up to 50 percent in several regions), in agricultural water supply (above 40 percent), in the systems of centralized and industrial water supply due to their deteriorated situation (20-30 percent).

Table 3 shows where the main pressure on water resources comes from in each oblast. It does not tell us, however, if there is enough water in these oblasts for all the users. Therefore, for the purpose of this study, local consultants have compiled water stress indicators for these oblasts, which measure annual water consumption as a proportion of the total renewable water resources.[6] This indicator is recommended by the European Environment Agency[7] as a good measure of water scarcity. Its scales are presented in box 1.

Box 1: Water stress indicator values

When annual water consumption as a percentage of total renewable water resources is:

- Less than 10% = no water stress
- Between 10% and 20% = low water stress;
- Between 20% and 40% = stress
- 40% or more = severe water stress

For the determination of water stress, all water uses are taken into account, since all uses determine the water availability compared to the available renewable fresh resources.

The summary data on water stress indicators by oblast are presented in table 4. For rivers, the most severe water stress is present in the oblasts of West Kazakhstan, Karaganda and South Kazakhstan. Groundwater sources are significantly or severely stressed in the oblasts of Atyrau and Mangystau. Overall, Kazakhstan experiences significant water scarcity particularly during droughts and low river periods.[8] More detailed information and tables about water stress and pressures by oblast can be found in annex 5.

Table 4: Water stress indicators by oblast in Kazakhstan

Oblast	Surface waters stress		Groundwater	
Aktobe	9.8%	No stress	2.7%	No stress
Atyrau	19.9% (Ural); 5% (small rivers)	Low stress	50%	Severely stressed
West Kazakhstan	62,2%	Severely stressed	3.5%	No stress
Karaganda	44.6% (Nura); 59.1% (Irtysh-Karag. canal)	Severely stressed	15.3%	Low stress
Mangystau	25.5%	stressed	31.5%	stressed
Pavlodar	16.2%	Low stress	19.4%	Low stress
South Kazakhstan	30.0%	stressed	18.0%	Low stress

Water scarcity may trigger competition between emerging water intensive industrial activities and existing industrial and agricultural enterprises for access to scarce water resources in certain regions of Kazakhstan. Both industrial developers and permitting authorities will need to take water stress into account when considering location of industrial facilities and sources of water use. Above all, water intensity of industrial

[6] Based on data of the Committee for Water Resources under the Ministry of Agriculture of RK
[7] European Environmental Agency, Europe's Environment: the Third Assessment, 2003
[8] For comparison, the whole region of Western, Central and Eastern Europe, the Caucasus and Central Asia on average abstracts only 7 percent of freshwater resources. 33 countries in this region abstract less than 20 percent, while 14 countries abstract more than 20 percent of their freshwater resources.

processes will need to be examined in advance of issuing a construction permit. In certain cities and water sources, it will be particularly important to ensure that industrial developers apply modern technologies that minimize water consumption and apply closed loop systems for most water uses, including cooling.

In order to tentatively test to what extent new petrochemical plants can affect water stress in Atyrau and Aktau Oblasts, we have conducted a rough simulation of an incremental impact of reactivation of the petrochemical plant there on water stress under different scenarios. The water stress before and after the reactivation of these plants is illustrated in table 5 and table 6.

Table 5: Water stress before and after reactivating polypropylene production at Atyrau under three technical options (capacity of 100,000 tons polypropylene)

Item	Units	Option 1	Option 2	Options 3
Total water demand by plant per year	Mio m^3 / year	0.91	0.23	0.18
Fresh Surface water				
Total water available	Mio m^3/year	2090	2090	2090
Total water use	Mio m^3/year	332	331	331
Water stress before		Low	Low	Low
Incremental growth of water use by plant	%	0.3	0.1	0.1
Water stress indicator after	%	16	16	16
Water stress after		Low	Low	Low
Groundwater				
Total water available	Mio m^3/year	47.5	47.5	47.5
Total water use	Mio m^3/year	24.71	24.03	23.98
Water stress before		Severe	Severe	Severe
Incremental growth of water use by plant	%	3.7	1.0	0.8
Water stress indicator after	%	52	51	50
Water stress after		Severe	Severe	Severe

Note: **Option 1:** Projections for reactivated Polypropylene Plant Atyrau; **Option 2 :** Traditional suspension HDPE/ polypropylene technologies; **Option 3:** Modern HDPE/polypropylene technologies. These three options are further elaborated in chapter 3.3.

Table 6: Water stress before and after reactivating polystyrene production in Aktau for product and three technical options (output of 50K tons polystyrene/year)

Item	Units	General Purpose PS	High Impact PS	Expandable PS
Total water demand by plant per year	Mio m^3 / year	55,000	55,000	300,000
Fresh Surface water				
Total water available	Mio m^3/year	30	30	30
Total water use	Mio m^3/year	7.72	7.72	7.96
Water stress before		stressed	stressed	stressed
Incremental growth of water use by plant	%	0.7	0.7	3.8
Water stress indicator after	%	26	26	27
Water stress after		stressed	stressed	stressed
Groundwater				
Total water available	Mio m^3/year	100	100	100
Total water use	Mio m^3/year	31.56	31.56	31.80
Water stress before		stressed	stressed	stressed
Incremental growth of water use by plant	%	0.2	0.2	0.9
Water stress indicator after	%	32	32	32
Water stress after		stressed	stressed	stressed

Notes:
In both simulations, for the sake of illustration of the unlikely extreme scenario, it was assumed that, each time, the entire water demand by a plant is met with single water source (surface or groundwater).
We have taken an amount of wastewater discharge as the measure for water intake. However, it was assumed that storm water is discharged separately and if groundwater or river water is used for cooling, it is as make-up water for closed systems with air coolers.

The tentative conclusion drawn from these simulations is that the reactivation of these plants would not change the water stress category even if total water demand was satisfied by withdrawal from the most stressed resources. However, the groundwater in Atyrau and rivers in Aktau are already stressed. The choice of water source and water efficient technologies will be important in both locations. These conclusions may not hold for all product mixes and very large plant capacities.

2.2.2. Water quality

Water quality standards in Kazakhstan are under the responsibility of the Ministry of Health Care. The main document which stipulates MACs for surface water is "Sanitary Rules and Norms for the surface water pollution protection" (SanR&N #3.01.070.98). The Water Code or the Environmental Protection Code does not cover the standardization of water quality or the maximum admissible discharges of harmful substances into water or oil contamination of water bodies.[9] Hence, these laws do not focus on the reduction of water pollution.

[9] A new draft Law on Water Supply and Sanitation is scheduled to be considered by the Parliament in third quarter 2006, which shall be supplemented with proposed amendments in the Water Code.

Water quality monitoring is insufficient both in terms of the amount of sampling stations, frequency of monitoring and number of pollutants that are monitored. The State Environmental Monitoring System is under the responsibility of the KazHydroMet Service (a branch of the Ministry of Environmental Protection). KazHydromet monitoring system includes a net of sampling stations all around Kazakhstan, in all trans-boundary and large water bodies. These sampling stations were operated during Soviet time, but collapsed during the perestroika. Right now, the whole system is under rehabilitation. As for Atyrau, there is water quality monitoring for Ural river only. As for Aktau, there is no state monitoring of the Caspian Sea. Data presented by governmental bodies (regional departments the of Ministry of Environmental Protection) came from different sources, including surface water monitoring done by enterprises (self-monitoring system), scientific projects or ad hoc grant-funded research (UNDP, donors, etc.).

Within the European Union, the 1976/464/EEC Directive is the framework directive which aims at the elimination or reduction of pollution of inland, coastal and territorial waters by particularly dangerous substances and to take preventive action at source[10]. The Directive could, for petrochemical processes, be applicable for certain catalysts or solvents if they appear in wastewater discharges. The key provisions of this Directive are summarized in box 2.

Box 2: Key issues in industrial wastewater management stipulated by the EU Directive on discharges of certain dangerous substances to water

The main directive (1976/464/EEC) establishes two lists of dangerous substances:

- Pollution caused by discharges of substances on List I must be ended; and
- Pollution caused by products on List II must be reduced.

List I contains substances selected on the basis of their toxicity, persistence and bioaccumulation.

An authorization system that contains emission standards for the discharge of List I substances must be established. These emission standards must conform to limit values laid down by the directive based on the **best available technique** and inventories of discharges that may contain List I substances. Separate emission standards are only allowed, if it can be proven that the water quality objectives of the directive are met.

For List-II substances, pollution reduction programs must be established with deadlines for implementation and compliance with emission standards for all discharges. The emission standards must be based on the water quality objectives. The list of substances that may be associated with petrochemical production is included in annex 3.

Strict monitoring requirements exist for the monitoring of the aquatic environment affected by discharges from industrial enterprises and other important discharge points. The directives have references to methods of measurements and laboratory analysis.

One of the principles in the Directive is that industrial processes cannot be generalized, which implies that pre-treatment should always be applied prior to combining process effluent streams with the sanitary wastewater from the same enterprise.

[10] The Framework Directive has the following number of daughter Directives:

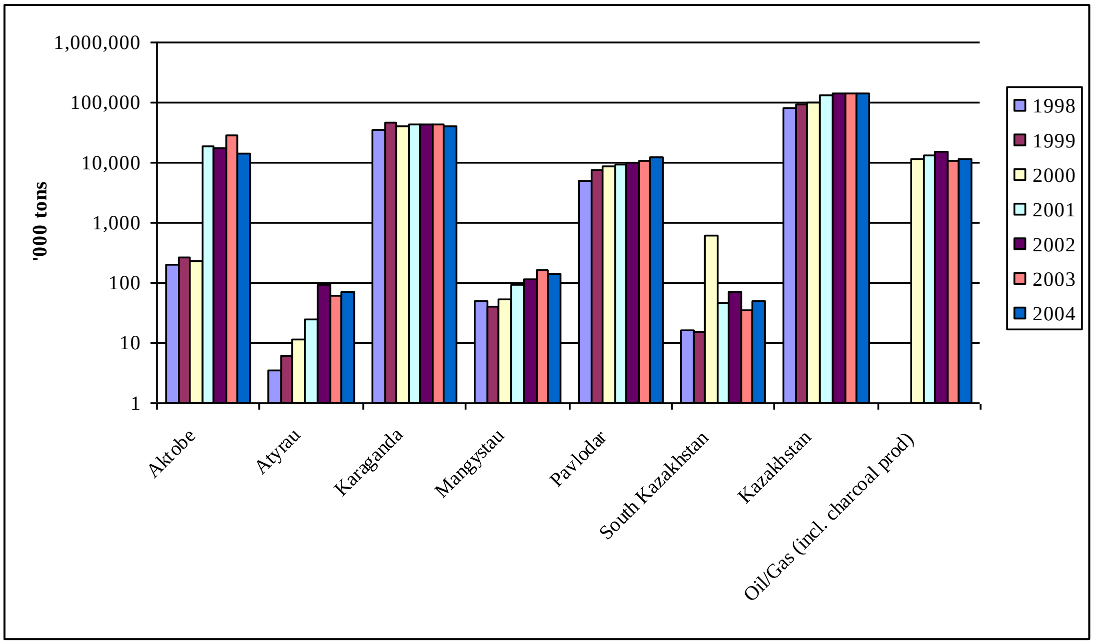
- Directive 1982/176 on certain mercury discharges;
- Directive 1983/513 on cadmium discharges;
- Directive 1984/156 on other mercury discharges;
- Directive 1984/491 on discharges of hexachlorocyclohexane; and
- Directive 1986/280 on discharges from certain industrial plants.

Wastewater coming from the current petrochemical industry does not create environmental problems because the facilities are idle. Forecasted wastewater loads from future production of the petrochemical industry should not be a severe environmental issue (see next chapter).

2.3. Waste

An overview of the amount of hazardous waste generated in Kazakhstan, in selected oblasts over the past seven years is presented by figure 8.

Figure 8: Hazardous waste generation in Kazakhstan by oblast



The statistical data include the hazardous waste generated by charcoal production, which is mainly in the Karaganda Oblast. Most heavy contributors to hazardous waste production in the oblasts under study are Aktobe, Karaganda and Pavlodar, and are responsible in 2004 for 9 percent, 28 percent and 8 percent of the hazardous waste generation in Kazakhstan, respectively. Nationwide, the largest amount of hazardous wastes is generated in East Kazakhstan Oblasts. The petrochemical industry is not likely to be located there.

Industrial solid hazardous waste is accumulated and stored at the industrial sites, with little reuse and recycling.[11] Wastes storage sites are usually not equipped with appropriate environmental protection barriers to protect against pollution of the soil and leakage into the groundwater. The problem of accumulating hazardous waste at industrial sites is huge. Many uncontrolled dumpsites exist, with consequently heavy pollution of oil, oil products and heavy metals which exceed the permissible concentration levels. The wastes of the industrial enterprises contribute to the pollution of the soil. Monitoring of soil pollution is not carried out on a regular basis.

[11] Though slightly increasing the last years

In many oblasts, there is no system of properly functioning waste management, and no records of production, transport and disposal of hazardous wastes. There is no inventory of contaminated sites, pollution of soil and abandoned landfills. In most of the oblasts, problems with soil pollution are observed, the most notable problem being heavy metal pollution; though heavy metal pollution is not a major environmental problem in the chemical industry.

The available statistical data concerning generation, use and type of disposal facilities for hazardous waste as well as the amount of stockpiles of hazardous waste are presented in table 7 and table 8 below, for the years 1998 and 2004. The data exclude radioactive waste.

Table 7: Generation, use, disposal and stocks of hazardous waste in 1998 (thousand tons)

Oblasts	Hazardous Waste Generated	Total reused	Total neutrilised at the enterprise	Total exported to other countries	Total waste to be stored	Waste stored at factory sites	Waste stored in hazardous waste landfills	Annual volume, approved for storage		Total accumulated hazardous stocks at enterprises
								permissible by normatives	over normatives	
Total Aktobe	207.500	2.400			201.400	201.200	4.500	278.300	0.000	9,950.100
Total Atyrau	3.400	0.300	0.100		3.000	3.000		10.600		0.100
Total Karaganda	36,018.900	2,220.800	1,453.800		32,343.000	29,308.500	1,918.900	40,264.600		876,876.000
Total Mangystau	49.700	30.200			32.900	32.900	9.500	70.500	2.100	429.200
Total Pavlodar	5,086.800	300.000	0.000		4,695.600	3,561.400	85.400	8,034.500		165,683.100
Total South Kazakhstan	15.800				14.600	14.600	0.400	3.100		344.800
Total Kazakhstan	**83,911.800**	**12,558.300**	**1,459.900**	**1.300**	**70,385.800**	**64,807.500**	**2,491.100**	**110,247.900**	**2,041.400**	**2,964,881.400**

Table 8: Generation, use, disposal and stocks of hazardous waste in 2004 (thousand tons)

Oblasts	Hazardous Waste Generated	Total reused	Total neutrilised at the enterprise	Total exported to other countries	Total waste to be stored	Waste stored at factory sites	Waste stored in hazardous waste landfills	Annual volume, approved for storage		Total accumulated hazardous stocks at enterprises
								permissible by normatives	over normatives	
Total Aktobe	13,827.631	240.262	5,623.786		194.123	193.939	1.302	15,829.662	0.091	198,075.859
Total Atyrau	71.212	38.577	4.536		63.507	47.398	14.896	126.664	6.148	167.463
Total Karaganda	40,954.961	3,797.404	0.001	0.130	37,259.536	10,905.884	3.135	47,758.243	3.895	1,076,398.639
Total Mangystau	145.607	39.849	0.013	0.011	151.197	117.086	11.027	232.891	0.540	1,148.634
Total Pavlodar	12,136.713	1,027.852	0.305	2.902	7,262.058	13,585.491	3,382.268	12,338.721		282,678.917
Total South Kazakhstan	50.218	1.020	0.001		43.179	43.139	0.090	88.922		11,411.332
Total Kazakhstan	**146,116.830**	**24,619.669**	**5,739.925**	**37.450**	**91,461.666**	**54,667.144**	**3,784.477**	**205,766.824**	**63.805**	**4,248,885.346**

Source: ???

In the oil and gas sectors, sulphur is located at special landfills, but their size is not sufficient. Therefore waste storage sites were set up at each oil field, but even they are overloaded.

The amount of hazardous waste generated by the current petrochemical plants is negligible because the plants in Atyrau and Aktau are inactive, and chemical plants with related products (e.g., synthetic rubber in Saran) operate at low capacity utilization.

In Atyrau, the accumulated wastes of the Propylene Plant are disposed for utilization as filling material for the construction mixtures. Some wastes after incineration, such as catalyst lime and salt mixtures, are disposed to the city dump. The environmental impact of wastes from the current petrochemical production in Atyrau is minimal.

Historically, the Plastic Plant near Aktau city accumulated approximately 300 tons per year of wastes with toxicity classes 3 and 4. The wastes are disposed at the old storage site (built in 1981). According to local consultants, the contamination of topsoil by pollutants is minor and localized within the territory of the industrial site.

In Saran city, Karagandarezinotekhnika (KRT) and Saranrezinotekhnika (SRT) produce around 550 and 1,200 tons of waste, respectively. The rubber wastes that are generated during the process are processed into rubber crumbs and then used for rubber mixture preparation. Wastes of the conveyor belt are used as a border, while non-standard pieces of the conveyor belt are sold to the population and businessmen. Fiber wastes are used as packing material. Wastes consist of Ash-and-Slag, construction and demolition waste, as well as rubber and fiber wastes. Ash-and-Slag is partially reused (25 percent). The content of pollutants in soil (oil products and heavy metals) at separate areas of the industrial zone is low compared to the norms.

The present volume of wastes from the InterComSHina rubber plant originates from burning tires that failed to pass the quality tests. Ashes and fired metal are generated in this process. The metal is separated and reused at other plants. The wastes generated are 60 tons per year and have a minimal impact on soil because of the reuse program that reuses 75-80 percent of the wastes.

Box 3 describes the requirements under the EU directive on hazardous waste management.

Box 3: EU 1991/689/EEC "Council Directive of 12 December 1991 on hazardous waste"

According to the requirements of this Directive waste is categorized as hazardous if it contains certain hazardous substances and/or displays the properties that render it hazardous (table A1.1-A1.3 of the directive). The types of hazardous waste covered by the directive are defined in the directive (tables A1.1 and A1.2 of the directive).

Under this directive every company/institution that produces hazardous waste or carries out disposal or recovery operations must obtain a permit and are subject to periodic inspections covering, in particular, the origin and destination of the waste. Transporters, producers and disposal operators must keep a record of their activities and make this information available to the authorities.

In many countries, it is not allowed for industries to have hazardous waste stored on-site with the exception of intermediate storage, which is bound by specific regulations on the conditions under which storage may take place. If producers do have final disposal of hazardous waste on their territory, a separate permit designated for hazardous waste disposal is required and the disposal facility has to comply with EU Directive 1999/31/EC for Disposal of Hazardous Waste. In terms of final disposal, in many countries, hazardous waste has to be stabilized before disposal, for example by physico-chemical treatment in order to meet the acceptance criteria for landfills.

Similarly, in many countries, hazardous waste generation is often dominated by a relatively small number of sources. This means that hazardous waste management, prevention or recycling programs can be focused on the sources responsible for the generation of the majority of hazardous waste, thus allowing the maximum return on investment and effort.

In terms of future constraints on the location of petrochemical industry in Kazakhstan, the production of hazardous waste is not the critical factor when determining the location for petrochemical industry, if modern technologies are applied, which can produce limited amounts of waste. Atyrau and Mangystau Oblasts have comparatively less accumulated wastes improperly stored than any other oblasts. More information on expected tons of waste per ton of output can be found in the next chapter.

However, in general, the hazardous waste storage situation is a matter of concern due to the absence of incentives for reduction of industrial waste production, and the lack of appropriately engineered and operated hazardous waste landfills. Also, in some oblasts (for instance in Karaganda and East Kazakhstan Oblasts), current inappropriately stored hazardous waste at factory sites are already causing contamination of ground and surface waters and are thought by local population to cause significant health impacts.

Chapter 3 will discuss best available techniques in the petrochemical industry that avoid and minimize waste generation. Chapter 4 will address the issue of incentives to apply these techniques in practice by plant developers.

3. Environmental performance options for petrochemical industry: case study

The Program of Petrochemical Industry Development in the Republic of Kazakhstan for 2004-2010 identifies different potential options and schedules for reactivation of existing petrochemical production facilities that were taken out of production in the nineties after the breakup of the Soviet Union. Additionally, depending on the development and export potential, the Government scenarios envisage various scales of new green-field investments and vertical integration of petrochemical plants. The existing production facilities and sector development options have been reviewed in previous chapters.

3.1 Boundaries of the case study

At present, the petrochemical sector in Kazakhstan is limited in size and in its contribution to the economy. The three crude oil refineries and the three natural gas treatment and production plants do not yet produce petrochemical products. Kazakhstan has two inactive mothballed polymer plants – Plastic Plant Ltd. in Aktau and in Polypropylene Plant Ltd. at Atyrau. Their rehabilitation and possibly extension of production seems to be the top priority in the government program. For this reason, these two cases have been selected for the case study.

The objective of this chapter is to identify and discuss the technical options to avoid excessively negative environmental impact while reactivating existing petrochemical installations. Since the detailed development plans are not known, in the analysis of options, we have assumed hypothetical capacity targets for reactivation of plastic and polypropylene production in Aktau and Atyrau. The case study does not intend to analyze the overall environmental impacts of the petrochemical sector development. Neither does it attempt to be an environmental impact assessment of rehabilitation of these two plants, as this would be premature given uncertainties about the future of these plants. It was also not the objective of this project. This chapter, however, gives references for environmental performance of alternative environmental control measures and production techniques. The policy incentives to choose the best available techniques that avoid and minimize negative environmental impacts will be discussed in chapter 4.

One of the key themes in the Government program is that the petrochemical plants will use gas that is currently flared at the oil fields. This is potentially a very promising source of raw materials for petrochemical production associated with significant local and global environmental benefits. However, at this moment, Kazakhstan does not have the infrastructure and petrochemical facilities to produce petrochemical feedstock from production gases that are currently flared. Massive investments would be needed to collect, extract and transport the raw materials from associated gas from oil production that can be utilized for the production of petrochemicals. The feasibility of these options has been studied by the Government and by private potential developers. Yet, due to remaining uncertainties, we have left these projects outside of the scope of the case study.

3.2. Environmental control options

In line with the Government Program, the following technical options for reactivating existing, non-operational petrochemical plants can be envisaged:

1. **Simple Reactivation** – This option envisages putting to operation existing production facilities, more or less as they were designed, without special technological improvement and without additional environmental control measures.
2. **Reactivation with Additional Control Measures** – This option assumes that production would be resumed with investment budgets that include additional environmental control measures. Measures that are internationally regarded as Best-Available-Techniques (BAT) in older plants would be the reference to assess environmental control measures and for both investors and regulators to decide on implementation.
3. **Reconstruction with New Technologies** – This option assumes that existing assets would be scrapped and that new production facilities will be built in full compliance with international benchmarks for Best Available Techniques for new installations, where minimization of overall environmental impacts will be major design parameters for all technological solutions.

The choice between the options will be made by investors and developers of these plants. They will ultimately determine what product, what production process and what technologies will be used. Their choices will be determined by many different factors, the analysis of which is beyond the scope of this study. In the industrial OECD countries, the governments generally refrain from influencing commercial factors of production choices. The OECD governments, however, tend to intervene in so far as the choices made by industry can affect important strategic interests of the state or when these choices adversely affect the economic viability of third parties or the wellbeing of people through non-market means. Pollution is one of such non-market negative impacts that affect other economic agents. Therefore is prompts government to intervene in order to protect potential victims.

In particular, with respect to new or significantly modernized industrial plants, the OECD countries developed a system of policy incentives to encourage developers to apply the best available techniques (BATs).[12] BATs are meant not only to improve overall manufacturing efficiency but to prevent and minimize negative environmental impacts as well. For example, the European Commission in the context of the IPPC regulation has made major efforts to investigate environmental performance of various industries, including petrochemical processes and existing production facilities in order to identify best available techniques that avoid, minimize or even eliminate negative impacts on the environment as a whole. The results of these investigations are published as "Reference Documents on Best Available Techniques" (BREFs) for various industrial sectors, including large volume chemicals, and the production of polymers. For example, the draft BREF for the Production of Polymers provides good references for Kazakh authorities to identify and evaluate best available techniques applied for these processes in other countries. The documents investigate both process and production technologies as well as additional environmental control measures (end-of-pipe techniques) in the production of polypropylene and polystyrene. It also refers to certain good management practices.

It needs to be stressed, that under the European legislation, governments refrain from recommending any specific technologies or suppliers of equipment. The technical guidelines for BAT should be written in a way that prescribes numerical, but generic emission limit values or other environmental performance indicators of the production processes when

[12] Please note that in the modern regulatory tradition the concept of 'technique" is wider than the concept of 'technology' and includes also the ways, in which industrial installations are designed, operated and decommissioned. More on this can be found in the chapter on policy and institutional framework (chapter 4).

appropriate. They also suggest sets of environmental control measures as well as management and housekeeping practices as BAT, but not specific technologies and brand names.

3.3 Environmental performance options of polypropylene production in Atyrau

Plant and Process Description

Polypropylene Plant Ltd. - Atyrau City (Polypropylene Plant) started the production of granular polypropylene of molding and fiber types in 1966 and stopped operations in 1996. The plant is located in the south-eastern part of the city at the distance of 1,000 m from residential areas. Lines for production of the plastic bags and hay-binding cord were put into operation in 1993. The design capacity per year was: propylene production – 30,000 tons; polyethylene co-polymers - 3,500 tons; hay-binding cord - 2,300 tons; and polypropylene bags - 6 million units. The plant operated with imported raw materials. The polypropylene production is based on the suspension method. The government is planning to resume production and increase the overall production capacity from 50,000 to 100,000 tons per year. The required investments are currently under investigation.

The Polypropylene Plant Ltd. of Atyrau City, with capacity of 50 thousand tons/year, used technological water for:

- circulation in the cooling system (volume of 1 million m^3);
- technological processes, including water backwashing of the polymeric suspension (polymer homogenization in the demineralized water, temperature - 50-60^oC, pH=3-4; in the process of mixing the homogeneous water suspension is formed, containing remains of the catalyst decay products) and the process of steaming and drying of the polypropylene (industrial wastewater is not generated).

At the time of operation, the Polypropylene Plant Ltd. discharged 455.5 thousand m^3/year of mixed wastewaters of which 46 percent (209.2 thousand m^3/year) consisted of chemically polluted waters. The wastewater was delivered to the mixing chamber (reinforced concrete reservoir) by the pressure collector installed at the surface. From the mixing chamber they went by gravity to the canal of untreated water and then to the pond belonging to the OJSC "Atyrau Oil Refining Plant" (AORP). Based on the data of the average values of the pollutants concentrations in wastewaters, they can be classified as heavily polluted because they exceed by 10 times the maximum permissible concentrations of suspended substances, spirits and titanium and aluminum hydrates. The wastewaters also contained oil products, SS and polypropylene power (16.4 mg/l). The OJSC "AORP" is the owner and main water user of the wastewater pond, and discharges 3,540.4 thousand m^3 of wastewater per year.

Below, we discuss the forecasted environmental performance of Atyrau Plant under three reactivation options. Selected available design environmental performance indicators are presented at the end of this section in table 10.

Option 1: Simple reactivation without additional environmental control measures

Air emissions

The main sources of air pollution are the polymerization reactor, granulation facility, pneumatic transport, and the homogenizer. Table 9 shows the calculations of forecasted emissions of major air pollutants from the Atyrau Plant, assuming the planned capacity of 100,000 t/y of polypropylene. According to local consultants, these emissions are not likely to lead to violation of maximum allowable concentrations (MACs) of these pollutants in the air.

Table 9: **Forecasted composition and volumes of atmospheric emissions from the Atyrau Plant at the planned capacity of 100,000 tons polypropylene and design emission factors**

Pollutant	Emissions, ton/year
Soot	0.010
Carbon oxide	175.140
Nitric oxide	56.900
Hydrocarbons saturated	87.500
Hydrocarbons unsaturated	22.440
Spirits	35.500
Sulfur dioxide	0.010
Styrene	0.014
Others	7.100

Source: Karlygash Yeleuova, local consultant

The total projected emission of volatile organic compounds (VOC) would be 1,355 grams per ton (g/t) of produced polypropylene.

Water consumption and wastewater discharge

Water consumption occurs at:

- Water circulation in the cooling system (volume of 1 million m^3);
- Backwashing of the polymer suspension (polymer homogenization; washing out of catalyst decay products) and steaming and drying of the polypropylene product (industrial wastewater is not generated).

Based on a nominal production capacity of 50,000 t/y of polypropylene, 455,000 m^3/y of mixed wastewaters of the Polypropylene Plant, including 46 percent process wastewater (209,000 m^3/y), would be discharged to a concrete reservoir and subsequently to the wastewater treatment pond of OJSC "Atyrau Oil Refining Plant" (AORP) without pre-treatment. Based on the data of average pollutant concentrations, the wastewater would be classified as heavily polluted because it would lead to a 10-fold violation of the maximum permissible concentrations of suspended solids, organic solvents and titanium and aluminum hydrates (from catalysts) in the receiving waters. Wastewaters also contain oil products and polypropylene solids (16.4 mg/l).

With the planned increase of production capacities up to 100,000 t/y and use of the existing water disposal practice, the volume of contaminated wastewater would double to 418,000 m^3/y. Total wastewater discharge to the pond, including AORP's wastewater would be 3,500,000 m^3/y. It would be necessary to construct additional treatment facilities or more deeply modernize the production line in order to reduce wastewater generation.

Waste Generation

Industrial waste generation is expected to reach 90 t/y in the future at the production level of 100,000 t/y. In the past, waste ponds were utilized for waste disposal. Certain types of waste have also been used in construction materials where special types of waste have been sent to incineration (catalyst sludge, salt mixtures and others) with slag disposal at a city dump. At present the Kazakh government does not seem to allow to incinerate these wastes.

<u>Option 2: Reactivation with additional environmental control measures</u>

Many modern European industries have, in varying degrees, retrofitted traditional industrial processes with a combinations of environmental control measures that can be regarded as best available techniques. Consolidated data for polypropylene have not been collected but the indicators of environmental performance of traditional HDPE production in the European Union can serve as an adequate benchmark for polypropylene production facilities in Kazakhstan. They are presented in table 10 under scenario 2 column, and compared with other scenarios.

Arguably, the best reference for identifying and discussing environmental control measures that can be included into plant design and operations is the Draft Reference Document on Best Available Techniques (BREF) in the Production of Polymers. This document was prepared by the European Commission Bureau for Integrated Pollution Prevention and Control (IPPC) in April 2005 as a reference for issuing environmental permit to polymer production installations. The BREF identifies both generic and production specific best available techniques (BAT). They are summarized in box 4.

Box 4: European technical guidelines (BREFs) on best available techniques (BAT) in the production of polymers

According to the European BREF, the generic best available techniques in the production of polymers are:

1. Introduction of environmental management tools such as EN ISO 14001 and EMAS.
2. Environmental best practice in equipment design.
3. Fugitive loss assessment and measurement.
4. Equipment monitoring and maintenance.
5. Reduction of dust emissions.
6. Minimization of plant stops and start-ups.
7. Application of containment systems.
8. Water pollution prevention.
9. Post treatment of air purge flows coming from blending silos and reactor vents.
10. Flaring systems and minimization of flared streams.
11. Use of power and steam from cogeneration plants.
12. Recovery of exothermic reaction heat through generation of low pressure steam.
13. Use of gear pump instead of or in combination with an extruder.
14. Compounding extrusion.
15. Reuse of potential waste.
16. Pigging systems.
17. Waste water buffer.
18. Biological wastewater treatment.

According to the European BREF, the product specific best available techniques for the production of polyolefins and in particular for HDPE and polypropylene are:

1. Lowering hydrocarbon content in polypropylene in the extrusion section – application of closed-loop nitrogen purge systems to remove monomers and/or solvents from polymer particles. Removed monomer can be collected and sent to a thermal oxidation unit.
2. Optimization of the stripping in the suspension process – The deactivation and stripping is carried out in a stirred steamer. Thus the homogeneity and contact time with the steam will improve. By subsequent condensation, the stripped monomer is recovered and after purification recycled back into the process. Before the installation of the steamer off-gas recycling unit, these gases were flared.
3. Condensation of solvent – the solvent evaporating from the fluidized bed dryer after the centrifuge in the slurry process is condensed and recycled back into the process.
4. Solvent and co-monomer selection – in principle, the more volatile the suspension solvent the easier is the removal; however, low boiling point solvents require a more complex condensing/recovery system. Furthermore, the plant design (unit operations and design pressure) can prevent the application of low boiling solvents in the range of C4-C6.
5. Increase of the polymer concentration in the reactor system to the maximum possible – the maximum viscosity of the slurry limits the maximum concentration of polymer solids in the hydrocarbon diluent. The slurry has to be maintained transportable. Depending on particle size distribution, this means that typically the solid concentration has to be maintained between 30 and 35 wt-%.
6. Closed-loop cooling water systems.

For existing petrochemical plants in Europe, using traditional suspension technology, for example polypropylene or HDPE production, environmental authorities usually incorporate into installation-specific environmental permits the requirements to achieve as many BAT parameters as practically possible to prevent and avoid most risky environmental impacts without causing excessive economic burden on the plant operator. The schedule of specific measures to achieve compliance with individual BAT characteristics is subject to negotiations under certain levels of public control.

Option 3: Reconstruction and introduction of new technologies

This option assumes that the production processes designed originally for the Atyrau plant would be replaced by modern, new technologies meeting (almost) all characteristics of the best available techniques (BAT) in industry. Processes applied to the production of polypropylene are very similar to those used to produce high density polyethylene (HDPE). The traditional ‘slurry’ process using an organic diluent, such as in Atyrau, are more and more often replaced worldwide by so-called ‘bulk’ processes using liquid monomer as a solvent. A second widely applied category of technologies are the ‘gas phase’ production processes where gaseous propylene comes into contact with dry catalyst and immediately disperses into dry polymer powder.

Since the 1960s, various types of catalysts have been developed known as ‘generations’. The first generation catalyst had low yields, consuming 1 kg of catalyst per ton of product. Modern fourth and fifth generation catalysts yield up to 50 tons of product per 1 kg of catalyst and are tailored to produce quality output. Some manufacturers have converted traditional slurry plants to apply high yield catalysts.

Typically, all newly designed petrochemical plants in Europe are expected to comply with all parameters of the best available techniques in industry. Traditional slurry (suspension) processes are nowadays only used to produce specialty products, e.g., for medical application where all traces of catalyst need to be removed. This expectation of the highest level of environmental performance is translated by authorities into specific environmental permit requirements for the new plants listed in table 10.

Typical emission factors for modern ‘gas phase’ plants and modern suspension ‘bulk’ processes (best available techniques) are presented in the last two columns of table 10 below under the heading ‘Option 3’.

Table 10: Environmental performance indicators for polypropylene production under three options

Indicators	Unit of measurement	**Option 1** Projections for reactivated Polypropylene Plant Atyrau*	**Option 2** Traditional suspension HDPE/ polypropylene technologies Benchmark (1999)		**Option 3** Modern HDPE/polypropylene technologies Benchmark (1999)	
			European average	Average top 50%	European average	Average top 50%
Monomer consumption	Kg/ton prod	No data	1027	1008	1026	1015
Direct energy consumption	kWh/ton prod	No data	700	570	680	580
Primary energy consumption	kWh/ton prod	No data	1420	1180	1150	810
Water consumption	m^3/ton prod	**9.1**	2.3	1.9	1.8	1.1
COD emissions	Gram/ton prod	No data	67	17	68	39
Dust emission	Gram/ton prod	No data	97	56	27	11
VOC emission	Gram/ton prod	**1,355**	2,300	650	730	180-500
Inert waste	Kg/ton prod	No data	2.8	0.5	1.3	1.1
Hazardous waste	Kg/ton prod	No data	3.9	3.1	2.7	0.8
Total waste	Kg/ton prod	Data unreliable	6.7	3.6	4.0	1.9

Source: Draft EU BREF on the Production of Polymers

* Indicators for Atyrau plant are preliminary and need to be double checked.

3.4. Environmental performance options of polystyrene production in Aktau

<u>Plant and Process Description</u>

Plastic Plant Ltd. in Aktau City once had a full production chain of ethylene, ethyl benzene, styrene monomer and polystyrene (PS). Benzene was imported from Russia. The plant has been out of operation since 1993 with the exemption of the period 2001-2003 when a pilot level of production of some 5,000 t/y polystyrene was launched from imported styrene monomer. The former production facilities with a capacity of 300,000 t/y PS are still on site but need substantial investments before this level of production can be resumed. Now, only three out of sixteen PS production lines are in a more or less operable condition. The ethyl benzene plant has been severely damaged by fire; therefore PS needs to be produced from imported styrene monomer. Plastic Plant Ltd. is envisaged to resume production from 50,000 t/y of two types of polystyrene: high impact PS (HIPS) and expandable PS (EPS) from 2005. Future plans are to increase PS production in steps to 300,000 and possibly 450,000 t/y and resume or add the production of styrene, ABS, ethylene, ethyl benzene, benzene and polyethylene.

Technological water use in the Plastic Plant Ltd. of Aktau City included:

- Circulation in the cooling system (sea water with volume of 23 million m^3/year; it is 81.6 percent of the total water consumption; recirculation - 100 percent);
- Distillate use in the polymerization washing process (10 million m^3/year; it is 18.4 percent of the total water consumption; reuse - 100 percent); and
- Volumes of industrial wastewater are; from 7 thousand m^3 when producing the general use and shockproof polystyrene, applying the continuous polymerization method; and up to 200 thousand m^3 when producing the foaming polystyrene, applying the suspension polymerization method.

All domestic and chemically polluted process wastewaters generated at the plant were delivered for treatment to the plant treatment facilities (micro-filters and pressure coal filters) with further discharge into the pond-evaporator. Wastewater quality according to official statistics met the standards; however, there are records [5] that in an area of the pond-evaporator and landfills for solid and liquid wastes of the plant, the underground waters were polluted with aromatic hydrocarbons of the benzene group (ethyl-benzene, chlorine-benzene, toluol and styrene).

Option 1: Simple Reactivation without additional environmental control measures

Air emissions

Table 11 presents emissions to air as observed during 2003 when the pilot scale production was launched with a capacity of some 5,000 tons of polystyrene per year. The second column includes a forecast of emissions in 2006 if production is resumed at an anticipated level of 50,000 t/y.

Table 11: Composition and volumes of atmospheric emissions from the Aktau Plant at different capacities with design emission factors

Pollutant	2003 (capacity: 5K t/y of polystyrene)	2006 (capacity: 50K t/y of polystyrene)
Nitrogen dioxide	10.00	118.40
Nitric oxide	0.50	6.08
Soot	0.20	0.42
Sulfur dioxide	90.00	1107.90
Carbon monoxide	45.00	469.20
Aromatic hydrocarbons	1.00	12.70
Hydrocarbons C_{12}-C_{10}	0.01	0.14
Penthane	60.00	644.10
Methane	10.00	107.00
Benzene	0.40	3.90
Styrene	0.70	6.50
Others	17.10	4.50

Emissions of VOCs to air from the simply reactivated polystyrene production plant would sum up to 15.6 kg per ton of product. There is no difference between emissions from expandable polystyrene production and from other types of polystyrene manufacturing.

Water consumption and wastewater discharge

Water consumption that can be expected after reactivation:

- Hundred percent water used in the cooling system can be re-circulated (seawater 23 million m^3/y, 81.6 percent of total water consumption);
- Hundred percent of water used in polymerization washing process can be reused (10 million m^3/y, 18.4 percent of total water consumption)
- Volumes of industrial process wastewater could be: about 7,000 m^3/year when producing general purpose polystyrene or high impact PS, applying the continuous polymerization method; and up to 200,000 m^3 when producing the expandable polystyrene, applying the suspension polymerization method.

Waste Generation

Waste is disposed of at the old (1981) storage yard. Data on waste volumes and hazardousness classes were not available.

Option 2: Reactivation with additional environmental control measures

The same reference used for benchmarking polypropylene will be used to identify and discuss control measures that can be included into polystyrene plant operations. The 18 generic best available techniques of the Draft Reference Document on Best Available Techniques (BREF) in the Production of Polymers, presented in the section on Atyrau plant, can be applied to the production of polystyrene as well. However, the product-specific best available techniques (BAT) will be slightly different for polystyrene than for polypropylene. The European Union technical guidelines (BREFS) further differentiate BAT by specific type of polystyrene production, in particular, to reduce air emissions. They are listed in box 5 below.

Box 5: European technical guidelines (BREFs) on best available techniques (BAT) in the production of polystyrene

According to the European BREF, the generic best available techniques in the production of polymers are:

1. Introduction of environmental management tools such as EN ISO 14001 and EMAS.
2. Environmental best practice in equipment design.
3. Fugitive loss assessment and measurement.
4. Equipment monitoring and maintenance.
5. Reduction of dust emissions.
6. Minimization of plant stops and start-ups.
7. Application of containment systems.
8. Water pollution prevention.
9. Post treatment of air purge flows coming from blending silos and reactor vents.
10. Flaring systems and minimization of flared streams.
11. Use of power and steam from cogeneration plants.
12. Recovery of exothermic reaction heat through generation of low pressure steam.
13. Use of gear pump instead of or in combination with an extruder.
14. Compounding extrusion.
15. Reuse of potential waste.
16. Pigging systems.
17. Waste water buffer.
18. Biological wastewater treatment.

According to European BREF, the product specific best available techniques for the production of polystyrene and in particular to reduce emissions to air are:

- ***For General Purpose polystyrene (GPPS) and High Impact polystyrene (HIPS)***: collection and treatment of vent gases; reduction of dust emissions from pelletizers through design and additional equipment such as filters and hydrocyclons.
- ***For Expandable polystyrene (EPS)***: vapor balance lines and vent recovery to external treatment during preparation of organic reactor charges; adsorption/desorption systems and flaring to control pentane emissions after polymerization.
- ***For HIPS' dissolving system***: cyclone to separate conveying air; high concentration pumping system; continuous dissolving system; vapor balance lines; vent recovery to treatment; condensers.
- ***For all polystyrene product types***: systems control measures for storage emissions should be considered: minimize level variations at integrated sites; gas balance lines; floating roof tanks (large tanks); installation of condensers; vent recovery to treatment.

Additionally, general good housekeeping measures are suggested to minimize waste production and (biological) wastewater treatment for liquid discharges. These are measures that can be implemented at the production facility to minimize but not fully eliminate the generation of solid waste. Unfortunately, a proper outlet to dispose hazardous waste is not available in Aktau. Hence, on-site storage for some time will be the only solution to manage hazardous waste volumes in the short run. In the long run, a proper waste treatment facility would need to be developed, preferably on a regional basis, to achieve certain economy of scale in industrial waste management.

Many modern European industries have, in varying degrees, applied combinations of environmental control measures that can be regarded as best available techniques. Benchmark indicators of environmental performance of polystyrene production facilities are presented in table 12. The average European environmental performance standards shown in table 12 can be regarded as BAT benchmark for traditional retrofitted production processes.

Option 3: Reconstruction and introduction of new technologies

Unlike the production of polypropylene, the history of technology development for polystyrene production has seen more gradual improvements to the production process that to a large extent have been incorporated in existing production facilities. Further improvements are continuously made to reduce emissions of organic compounds to the atmosphere in particular fugitive emissions from vents, small leakages and storage facilities. Most improvements are incorporated in the environmental performance standards that also European industry is meeting, as presented in table 12. New installations are normally required to meet environmental performance indicators of the top 50 percent of European enterprises as BAT.

Table 12: Key environmental performance indicators for polystyrene production in Europe and in Kazakhstan

Benchmark 1999 (per ton product)	Unit	General Purpose PS		High Impact PS		Expandable PS		Design of the Plastic Plant Aktau
		European average	Average top 50%	European average	Average top 50%	European average	Average top 50%	
Air Emissions								
Dust	g	4	2	4	2	30	30	
VOC, total	g	120	85	120	85	700	600	**460**
Pentane	g					2500	1000	**12,800**
Water Emissions								
COD	g	40	30	40	30			
Suspended Solids	g	10						
Hydrocarbons	g	4	1.5	4	1.5			
Dissolved solids	g					0.3		
Wastewater	t	1.1	0.8	1.1	0.8	6	5	**0.14-4**
Cooling water purge	t	0.5		0.6		1.7		
Solid Waste								
Hazardous	kg	0.6	0.5	0.6	0.5	3	3	
Non-hazardous	kg	4	2	4	3	8	6	
Inputs								
Total Energy	GJ	1.08		1.48		1.8		
Styrene	t	0.975		0.91		0.939		
Pentane	t					0.065		
Mineral Oil	t	0.02		0.02				
Rubber	t			0.07				
Cooling Water (closed circuit)	t	50		50		17		
Process water	t	0.596		0.519		2.1		
Nitrogen	t	0.022		0.010		0.01		
Diluent	t	0.001		0.001				
Additives	t	0.005		0.005		0.03		

Source: Draft EU BREF on the Production of Polymers

3.5. Costs of best available techniques in petrochemical industry

Polypropylene

In order to compare costs of traditional and more modern technologies for polypropylene production, the benchmark investment and production unit cost data from the draft BREF for polymers can be used. The data of certain polyethylene processes can give an insight into the features of the most common polypropylene production processes (see table 13). These unit costs are indicative and for comparison purposes only. Detailed cost estimates require specific feasibility studies and quotes from technology suppliers.

Table 13: Indicative unit costs of best available techniques in polypropylene production processes

Product (feedstock at 984 US$/t)	LLDPE, reference for polypropylene gas phase and polypropylene suspension bulk processes	HDPE, reference for traditional polypropylene slurry processes
Technology	Gas Phase	Slurry Loop
Catalyst / Initiator	Ziegler / Natta	Ziegler / Natta
Capacity (kt/y)	250	200
Plant Capital (million US$)	172-187	177
Production cost (US$/t)		
Monomer plus co-monomer	657	654
Other raw materials	39	33
Utilities	22	33
Variable Costs	**719**	**720**
Direct Costs	19	23
Allocated Costs	19	23
Total Cash Costs	756	765
Depreciation	60	74
Total Production Costs	**816**	**840**

Legends: LLDPE – Linear low density polypropylene; HDPE – high density polypropylene

Source: Draft EU BREF on the Production of Polymers

*Note: * The original costs in 1999 price level was converted to 2004 dollars using the gross fixed capital formation price deflator.*

In recent years, prices of raw materials and the end product polypropylene have risen substantially. Investment costs vary widely depending on the availability of infrastructure, utilities and process choices. For example, polypropylene can be produced from ethylene and butane or from methanol in a natural gas (C1) to monomer integrated process. Investments of US$200 to 250 million are not uncommon for plants with a capacity of 300-350 kt/y.

In general, modern polypropylene plants are characterized with lower production cost and lower emissions to the environment than traditional slurry processes. However, initial capital investments may be higher under some circumstances. The decision to build a new (or revamped) facility versus reactivating an old non-productive plant needs to weigh both financial and environmental factors. Investments for reactivation of facilities that have been out of operation for many years will normally cost a substantial percentage (30-60 percent) of new investments. Additional investments to existing production units to collect and treat VOC emissions will cost up to US$100,000 per annual ton of VOC. Other environmental controls may add costs to the reactivation option as well. Most likely, production and product quality parameters will be the most important factors in deciding between reactivation and new (revamped) facilities in comparison to the cost of additional (end-of-pipe) environmental control measures to meet modern (international) standards.

Polystyrene

As stated earlier in this chapter, polystyrene production technologies have developed in a different manner to those for polypropylene production. Therefore, it is more difficult to give relevant benchmarks for unit costs of various technologies. In particular, the references to older traditional technologies may not be applicable. On the basis of international experience, it is more likely that the existing plants will be rehabilitated provided there is a good market basis and a reliable and cost-effective supply of raw materials and utilities. Also, for polystyrene production, the main challenge is the reduction of VOC emissions to the atmosphere and in particular, styrene monomer emissions. Investments in control measures range from US$20,000 to over US$100,000 per annual ton of reduced VOC.

In European OECD countries, costs in the sector are driven by world prices. Feedstock price (oil and gas) is very important. Distance to feedstock and port is also important. Labor costs and exchange rate have impacts on competitiveness. A greater focus on corporate responsibility can be observed in the sector. One can see an increased emphasis on water efficiency and on reducing pollutant loads, including moderate pollution load of COD, BOD ammonia, lead and zinc. In the petrochemical industry, the main use of water is for cooling, particularly non-contact cooling, although water is also used for the manufacture of some products.

3.6. Conclusions related to the choice of technical options

For the development of petrochemical industry in Kazakhstan, it will be important to consider and decide on the adequate benchmarks for environmental performance prior to reactivation of existing non-operating installations or building new ones. The environmental impact assessment (EIA) and environmental permitting process – analyzed in chapter four – will provide the framework for these considerations. During the EIA and permit negotiations, the European BREFs can be used by the government authorities, plant developers and the public as a reference for the identification of the best available techniques (BATs) that can be applied to reactivated plants. For individual control measures and technology choices, a balance will always need to be found between the need to avoid excessive risk to the people and the environment on the one hand, and practical feasibility, costs and economic impacts of implementing the measure on the other. The case study presented above provides benchmarks and references for what is internationally considered as best available techniques with high environmental performance standards in industry producing polymers. It also gives references for the costs of certain best available techniques in this sector, which are considered reasonable by international practice. This model of identifying and describing best international practices can be followed by the Government of Kazakhstan for other petrochemical products envisaged in the program as well as for upstream activities, such as oil refining, gas processing and transportation.

This case study was not meant to substitute a formal Environmental Impact Assessment or a feasibility assessment. It was intended to provide guidelines on the environmentally responsible course of action under different possible scenarios of reactivation of petrochemical production at two priority sites. Two broad options are, in principle, plausible: (i) reactivation of existing processes with additional environmental control measures; and (ii) reconstruction of the sites with new technologies and processes.

If old production plants are reactivated with additional control measures added, efforts should be made towards environmental control that are reasonably achievable. Due distinction should be made between requirements with respect to existing and to new plants. It is suggested that during the environmental impact assessment and the permitting procedure, the developers who will reactivate plants will report to the permitting authorities about the actions and investments that will be made to eliminate or minimize environmental impacts and waste generation. They should also demonstrate how remaining emissions and waste volumes relate to international benchmarks of best available techniques (BAT). If a project developer cannot meet certain emissions levels below the BAT standards, s/he should elucidate why it is beyond reasonable effort to meet the standards for these emissions. S/he should do it by demonstrating the practical impossibility and/or the excessive cost it would take to comply. The benchmarks reviewed in this chapter can help all the parties involved to have a constructive dialogue on what is meant by ‘reasonable’, ‘practical’, possible’ or ‘excessive’.

If new production facilities are built with new technologies, it should be reasonable to require developers to meet the European benchmarks of the best available techniques (BAT) or go beyond them. Petrochemical products are international commodities, subject to internationally established product market prices and a limited variation in investment and operating costs due to geographical factors. Most important factors that geographically create differences in profitability of petrochemical production are the local presence of raw materials, logistic possibilities to transport products to markets and the cost and availability of energy and utilities. If Kazakhstan – after reactivation of old facilities – is moving forward towards constructing new facilities, these plants will need to be capable to compete internationally and should be able to meet the same environmental performance standards as leading foreign companies in this sector. Therefore, there is no ground to apply different (lower) environmental standards in Kazakhstan than what is internationally accepted as best available technique (BAT). International experience shows that compromising on environmental standards does not make an industry more competitive internationally and makes it less beneficial to local economy.

Incremental contribution of these new facilities to local ambient air and water quality is not likely to be significant. Conflicts with other water users are not likely in Atyrau, where water stress is low (see chapter 2.2.1), but in Aktau, fresh water is a scarce resource and about 25 percent of available resources are already used mainly by industry. Water consumption by the proposed plastic plant will need to be minimized by applying the BAT standards in order to avoid conflict with other users over access to water. These conclusions may not hold for other petrochemical facilities in other locations in Kazakhstan where water stress is more severe. Air pollution is already believed to cause serious health problems and soil and groundwater is contaminated due to the lack of proper waste treatment and disposal facilities. However, these problems are not localized in the areas of the proposed petrochemical plants.

The analysis presented in chapters 4 and 5 may serve as a model for identification of potential environmental conflicts and technical measures to avoid them in the industry. The next chapter will analyze whether the existing policy incentives in Kazakhstan would actually encourage developers to apply the best available techniques to prevent and minimize the negative environmental impact of newly growing industries.

4. Policies and institutions to mitigate environmental impact of growing industrial sectors

In the previous chapters, we have analyzed the environmental performance indicators of various options of development of the petrochemical industry in Kazakhstan. The conclusion is that the most environmentally friendly scenarios would also be associated with lower production costs, but initial capital investments may be slightly higher under some circumstances. It is a typical policy dilemma that all governments face: how to influence short-term decisions of individual economic agents to serve the long term interests of industry and of the country as a whole. The fundamental question is whether the existing policy and institutional framework provides adequate incentives to the developers of petrochemical and other potentially hazardous plants to apply best available techniques and adequate environmental control measures, without imposing undue constraints on socially and environmentally responsible industrial development. This chapter will review the existing environmental policy framework in Kazakhstan and try to evaluate its performance in mitigating environmental impact of rapidly growing industries. In the end, we will also identify the areas for possible policy reforms and institutional strengthening to generate adequate incentives to plant developers. Box 6 lists the various institutions that are responsible for environmental policies in Kazakhstan.

Box 6: Environmental policy institutions

- Ministry of Environmental Protection
- Ministry of Emergencies
- Committee of the State Sanitary and Epidemiological Supervision of the Ministry of Health Care
- Committee of Land Resources of the Ministry of Agriculture
- Committee of Water Resources of the Ministry of Agriculture
- Fishery Committee of the Ministry of Agriculture
- Forestry and Hunting Committee of the Ministry of Agriculture

The key institution is the Ministry of Environmental Protection and its territorial departments in oblasts. The main responsibilities are typical as for similar agencies in OECD countries, except that the role of the Ministry is protective rather than proactive.

4.1. Environmental policies and programs

General statements on the need to protect the environment are typically included in the strategic program and policy documents of the highest levels of the government. On December 3, 2003, the Concept of Environmental Safety of the Republic of Kazakhstan for 2004-2015 was approved by a Decree of the President of the Republic of Kazakhstan. The action plan associated with this concept and approved by Resolution No.131 of the Government of Kazakhstan on February 3, 2004 envisages a few measures, which are important to prevent and mitigate pollution of the growing petrochemical sector as well as other growing industries:

- Carrying out institutional reforms of the state environmental enforcement and inspection agencies (second quarter of 2005);
- Optimization of environmental permitting system (second quarter of 2005);
- Development and introduction of the legal, economic and other mechanisms to avoid occurrence of new pollution (fourth quarter of 2005); and
- Carrying out of research on development of means and methods of preventing and control of pollution, on rehabilitations of polluted sites, and on recycling of dangerous

waste products (fourth quarter of 2005).

The Program *“Environmental Protection in the Republic of Kazakhstan for 2005-2007”* was approved by Resolution No. 1278 of the Government of the Republic of Kazakhstan, on December 6th, 2004. Its stated objective is to “*reduce level of environmental pollution and development of a complex of measures to stabilize it*”. The envisaged measures, however, are ambiguous. The program envisages legal and institutional reforms but does not specify clear directions or priorities for these reforms. The program calls for “*optimization of environmental permitting system and environmental expertise*” but fails to provide a diagnosis of the shortcomings of the present system or essential functions of a future one. Application of voluntary ISO 14000 standards is erroneously considered to be associated with harmonization of environmental standards in Kazakhstan with international standards and easier membership in WTO. Objectives can be considered declarative and wishful because the program does not include any specific reforms of instruments to achieve these objectives. On the contrary, the chapter on “Ecologization of the Economy” declares “*optimization of environmental permitting system and environmental expertise*“, but in fact reaffirms the traditional post-Soviet permitting system that relies on “*the proven assessment of impact of each entity on environment, taking into account background level of pollution and environmental situation and possible effects of incremental harmful impact on health of the population and on environment*”.

Several official statements stress that it is a priority for the Government to improve environmental legislation by convergence towards the European Union standards, but government programs, so far, include very few priorities or concrete steps to this convergence.

4.2. Legal and regulatory framework

The core of legislative basis for environmental management (except nuclear, military and space installations that have special legislative basis) consists of about 10 legal acts and about 200 pieces of secondary regulations The acts and secondary regulations most relevant to the petrochemical industry are presented in annex 2.

The ***Law on Environment Protection*** plays a key role in the legal basis for environmental management. It determines the objectives of environmental policy in Kazakhstan as environmental safety, prevention of detrimental impacts on natural ecological systems, conservation of biological diversity and efficient management of natural resources. The Law also determines the main principles of environment protection and certain environmental standards. It introduces the Environmental Impact Assessment and State Environmental Review and sets the basis for economic mechanisms of environmental policy. The law also defines competences of state and local bodies, as well as rights and responsibilities of citizens and public organizations in the field of environment protection.

The legal basis for environmental permitting is laid down in the ***1997 Law on State Environmental Review*** (see chapter 4.7).

The management of surface and ground waters is regulated by the ***Water Code***. The Code specifies the water protection zones and belts where special use conditions apply in order to prevent water pollution, scarcity and protect other environmental functions. The Code also provides the framework for the regulation of domestic, industrial and agricultural water use. The Water Code does not seem to focus on efficiency of water use. Yet, the Environmental Protection Program of the Republic of Kazakhstan for 2005-2007[13], sets the objective to maintain the volumes of wastewater discharges at the existing level of 155-156 million m^3/year, notwithstanding the increase of economic output. On the other hand, the Water

[13] Approved by decree No. 1278 of RK Government as of 6 December 2004

Balance of the Republic of Kazakhstan until 2020[14] envisages an increase in the water consumption volumes in the country by up to 43.0 billion m^3/year (i.e. by 21 percent in the period 2002–2020). Reaching this water consumption limit in the country, in general, seems to be possible only by means of an increase in the underground water intake volumes. Both these programs imply that the government targets to increase efficiency in water use and wastewater treatment. The programs do not specify if these caps also apply to the level of each oblast and the city, or if regional diversification of stringency of the caps is envisaged to take into account different water stress in different oblasts. If so, this may be one of the important parameters in the decisions of location of water intensive industrial activities in the zones where water is scarce and wastewater discharges are large already.

Some environmental provisions are stipulated also in the Constitution, the Land and Forest Codes, as well as in the Criminal, Administrative and Tax Codes.

The legal basis for environmental protection in Kazakhstan is quite modern and provides the policy makers with a relatively wide menu of tools to influence environmental performance of the industry. The coverage of instruments is broadly in line with international practices. All key command and control, administrative instruments – that form a core of environmental policies in OECD countries – are embedded in the legislation. It includes ambient quality standards, environmental impact assessment, strategic environmental impact assessment, emission limit values, environmental permits and non-compliance sanctions. These instruments are described below and their performance will be analyzed. As we shall see, the design of some of these instruments deviates from the international practice in OECD countries, and hence may not be familiar and attractive to reputable strategic international investors. Several investors and foreign analysts have also been stressing some inconsistencies, overlaps and contradictions in the legislation. Intense legislative and regulatory works have addressed some of these concerns. The Ministry of Environment is now working on a more comprehensive overhaul of the environmental legislation in the framework of an Environmental Code, expected in 2006. Experience of some new EU members states shows that this is not an easy process.

The Environmental Performance Review of Kazakhstan conducted by UNECE in 2000 highlighted that the large gaps in the secondary legislation undermined implementation of the key policy instruments stipulated in Parliamentary Acts. Of particular importance were operational regulations on environmental monitoring, procedures for environmental review [and permitting], environmental auditing, environmental insurance, public access to information and participation, procedures for certification, and on handling emergencies. In recent years, Kazakhstan has made significant progress in establishing a more comprehensive basis of secondary legislation to facilitate implementation of primary Acts. The most relevant regulatory documents of the Government in the field of environmental management are included in annex 2.

4.3. Ambient quality standards

The sanitary and hygienic norms of Maximum Allowable Concentrations (MACs) of hazardous substances in different environmental media (air, water and soil) developed in the former USSR have been carried over to the legislation of the sovereign Republic of Kazakhstan. The MACs have been re-approved on 27.07.92 by the Ministry of Ecology and Bio-Resources of the Republic of Kazakhstan (presently Ministry of Environmental Protection) and by the Deputy Senior Sanitary Doctor of the Republic of Kazakhstan. These ambient quality standards have been derived in the 1980's from the academically sound scientific theory of maximum absorptive capacity of environment and atmospheric diffusion of pollution.

[14] Approved by the Committee for Water Resources under RK Ministry of Agriculture, 2002 [3]

They are based on the concept of zero risk to humans and the environment during the worst possible circumstances (e.g., worst-case meteorological conditions, most vulnerable part of population). Transposing academic approaches to the legal system of the real world resulted in the strictest ambient quality standards in the world.

In OECD countries, ambient quality standards are also based on sound scientific data, but are derived from scientific assessment of acceptable risk levels under precautionary conditions. The desired level of ‘quality’ is not only scientific prescription but also a political and social decision.

In Kazakhstan, ambient quality standards (MACs) play a different policy role than in OECD countries. They are considered to be binding limits for all the users of a given environmental medium. Therefore, individual limits for emissions to the air, discharges to water and waste disposal (thereafter Emission Limit Values or ELVs) are derived primarily from MACs. Every economic agent who wants to emit, discharge or dispose polluting substances is required by law to prove to environmental authorities that his incremental pollution will not lead to infringement of MACs. Albeit based on solid scientific method and high level of precaution, such an approach has a number of shortcomings discussed in chapter 4.4 on emission limit values.

In OECD countries, ambient quality standards (concentrations of polluting substances in air, water and soil) are policy objectives rather than binding limits. Governments are held politically accountable for achieving these desired objectives. In some countries (e.g., US) the accountability goes so far that governments may be sued by the victims of pollution for failing to achieve objectives of ambient environmental quality. Governments are responsible for translating policy objectives into a system of incentives for economic agents to improve environmental performance. Incentives are embedded in the mix of various policy instruments (permits, sanctions, taxes, tradable permits, subsidies).

There are several advantages of treating ambient quality standards as policy objective rather than legally binding norms, from which emission quotas for individual plants are derived. First, when more than one polluter contributes to excessive concentration of pollutants in air and water, it is neither fair nor realistic to hold every plant accountable for quality of ambient environment. Operators of these plants cannot control each other and least of all – dispersed sources of pollution, such as automobiles, buildings, agriculture. Instead of controlling emissions from small and dispersed sources, environmental authorities often try to attribute their impact to the plants for which emissions permits can be issued. They impose excessively stringent emissions caps on permit holders to offset the impact of emissions from uncontrolled sources. Large plant operators perceive it as extremely unfair, but learned how to play the game by the “catch 22” type rules. They accept unfair and excessively stringent emission caps only with an understanding that the emission caps do not have to be complied with. Enterprises do not oppose impossible permit requirements in return for lax enforcement, “temporary” relieves that can be rolled over for ever, subsidies and other various concessions (e.g. emission tax offsets). Another advantage of treating ambient quality standards as policy objectives is that it allows to design, agree and implement realistic programs that cover all emission sources in order to improve air and water quality in excessively polluted areas. When these standards are legally binding norms, as in Soviet tradition, they apply immediately when permits are issued, even if they are exceeded several times. This puts all permit holders into immediate non-compliance and replaces realistic programming for the whole polluted area with ad hoc negotiations with individual permit holders about the sanctions for non-compliance.

Air

Maximum Allowable Concentrations (MACs) of polluting substances in the air are established for 635 pollutants. Approximately Safe Impact Levels (ASILs) are temporal hygienic standards for pollutants (1,497 substances). Both have been approved by the Ministry of Health Care of the Republic of Kazakhstan as of 18.08.2004 No. 629. The number of pollutants for which MACs and ASILs are determined is significantly larger than the number of regulated substances in OECD countries (see table 14) and growing much faster. Each time a plant developer proposes a production process associated with emissions of substances, for which a MAC standard does not exist in Kazakhstan s/he will not get an environmental permit until such a standard is established by Government. This practice, exotic by OECD standards, has to be followed whether or not the substance is considered very hazardous or not. It originates from the obsolete provisions of the post-soviet laws that stipulate that release of any substance to the environment is not allowed without a permit, and permit cannot be granted without corresponding MAC standard.

Table 14: The number of air pollutants for which maximum concentration limits are established

EU	UK	US	WHO	Kazakhstan
13	7	6	22	650 (MAC) 1,497 (ASIL)

Sources: Annex I of Directive 96/62/EC (http://europa.eu.int/comm/environment/air/ambient.htm); UK "Air Quality Limit Values Regulations 2003, Statutory Instrument 2003 No. 2121" (http://www.opsi.gov.uk/si/si2003/20032121.htm); US EPA National Ambient Air Quality standards (http://www.epa.gov/air/criteria); WHO Air Quality Guidelines-2nd edition (2005)

The MAC standards in Kazakhstan (as elsewhere in former Soviet Union) are not easily comparable with the OECD countries ambient quality standards and WHO recommendations for similar substances. However, it can be stated that they are often stricter and less flexible (see table 15). Comparison is difficult among others because ambient quality standards for air in Kazakhstan are averaged over different periods than in OECD countries. For example, short term MACs (30 min, 24h) for SO_2, NOx and CO in Kazakhstan are stricter than comparable limit values in OECD. Also, annual average/mean limit values are absent in Kazakhstan, even though long term exposures to relatively small doses has proven to cause chronic respiratory diseases and be particularly damaging to ecosystems. Perhaps, the most startling difference is with the concentration standards for particulate matters. Short term concentration limits are stricter in Kazakhstan than in OECD countries, however, following Soviet tradition, Kazakhstan measures so called 'suspended dust' irrespective of the size of particles. In OECD, following WHO recommendations, the limit value is attached only to the finest particles (10 and 2.5 µm), which are known to be the most hazardous for human health.

Table 15: Kazakh and international ambient quality standards for selected air pollutants

Substance	Unit	Period	Kazakhstan	WHO	Canada	USA	EU
Nitrogen dioxide	µg/m^3	30 min.	85 (20 min)	-	-	-	-
		60 min.	-	200	400	-	200[i]
		24 h.	40	-	200	-	-
		Year	-	40	100	100	30[ii]/40[i]
Sulfur dioxide	µg/m^3	10 min.	500 (20 min)	500[i]	-	-	-
		30 min.	-	-	-	-	-
		60 min.	-	-	870	-	350[i]
		24 h.	50	125[i]	300	365	125[i]
		Year	-	50[i]/10-30[ii]	60	78	20[ii]
Carbon monoxide	mg/m^3	15 min.	-	100	-	-	-
		30 min.	5	60	-	-	-
		60 min.	-	30	35	40	-
		8 h.	-	10	14	10	10
		24 h.	3	-	-	-	-
Particulate Matter (PM)	µg/m^3	30 min.	50 (S. Dust)	Dose-response [iv]	-	-	-
		60 min.	-	Dose-response [iv]	-	-	-
		24 h.	15 (S. Dust)	Dose-response [iv]	120 (TSP)	65 ($PM_{2.5}$) 150 (PM_{10})	50[i] (PM_{10})
		Year	-	Dose-response [iv]	70 (TSP)	15 ($PM_{2.5}$) 50 (PM_{10})	40[i]/20[iii] (PM_{10})

Legend: TSP – total suspended particulates
Sources: Madi Kireev (local consultant); UNECE Environmental Performance Review-Kazakhstan (2000) (http://www.unece.org/env/epr/countriesreviewed.htm); WHO Air Quality Guidelines-2nd edition (2005); National Ambient Air Quality Objectives & Guidelines in Canada (http://www.hc-sc.gc.ca/ewh-semt/air/out-ext/reg_e.html#3); US EPA National Ambient Air Quality Standards; EC Air Quality Daughter Directives (http://europa.eu.int/comm/environment/air/ambient.htm) – Directive 1999/30/EC relates to limit values for SO_2, NO_2 and NOx, PM and lead; and Directive 2000/69/EC relates to limit values for carbon monoxide and benzene .

[i] the limit value for the protection of human health

[ii] the limit value for protection of ecosystems/vegetation

[iii] the limit value to be achieved by 2010

[iv] For particulate matter, WHO has not established a guideline value because the available information for short- and long- term exposure to PM_{10} and $PM_{2.5}$ did not allow a judgment regarding concentrations below which no effects could be expected. Instead, WHO provides risk estimates based on available dose-response relationships.

The strict and inflexible nature of Kazakh MAC creates problems in environmental policy. For example, there is a seeming equivalence between some local and OECD standards - if Kazakh daily average concentration for NOx (40 µg/m^3) is never exceeded over a period of one year, the annual averages recommended by WHO and EU (also 40 µg/m^3) are also complied with. However, due to fluctuations in emissions and meteorological conditions, compliance with short term standards at all times is unrealistic. European legislation leaves some flexibility for occasional non-compliance with short term standards, providing that the human health and ecosystems are not threatened by (i) acute exposures, (ii) regular non-compliance, and (iii) long term exposure. An example of these flexibility mechanisms is provided in box 7.

The strict and inflexible quality standards in Kazakhstan, developed during central planning, obscure identification of environmental priorities. They yield confusing information about the real environmental risks. The public and the policy makers cannot distinguish between non-compliance on paper (e.g., caused by random weather patterns) and real persistent health hazards. This may lead to and misplace focus away from major source risks and towards an excessively cautious regime in relatively safe areas. The strict standards created inevitably lead to regular non-compliance and in fact public and political tolerance of pollution. Their rigidity undermines their credibility in public eyes.

Box 7: Short term versus long term ambient quality standards in the European Union

The EU ambient quality Directives (so called daughter directives) specify the ambient concentrations limit values averaged over a certain period of time – usually one hour, 24 hours and one year. The EU Directives contain a number of additional provisions to protect human health and vegetation from long term exposure to concentrations which are higher than annual average. For instance, the Directive on limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air specifies the maximum number of incidences of non-compliance with any short-term ambient limit value over a period of a year. The hourly limit of SO_2 concentration must not be exceeded more than 24 times a calendar year and the 24h limit, no more than 3 times per calendar year. Additional measures to protect human health from long term exposure to short term limits are upper and lower assessment thresholds for concentrations over specified periods of time. The table below illustrates the example of NO_2 and NOx:

NITROGEN DIOXIDE AND OXIDES OF NITROGEN

	Hourly limit value for the protection of human health (NO_2)	Annual limit value for the protection of human health (NO_2)	Annual limit value for the protection of vegetation (NO_x)
Upper assessment threshold	70 % of limit value (140 µg/m³, not to be exceeded more than 18 times in any calender year)	80 % of limit value (32 µg/m³)	80 % of limit value (24 µg/m³)
Lower assessment threshold	50 % of limit value (100 µg/m³, not to be exceeded more than 18 times in any calender year)	65 % of limit value (26 µg/m³)	65 % of limit value (19,5 µg/m³)

If these limit values are exceeded, the competent authority must prepare and implement measures that would provide effective incentives to polluters and lead to attainment of ambient quality standards. In the cases of persistent non-compliance and the lack of efforts by competent authorities, the European Commission may launch a procedure that eventually may lead to sanctions imposed on government.

Source: Council Directive 1999/30/EC of 22 April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air

Water

Standards are established both for potable water, and economic-domestic objects and water bodies used for fishery. There are three main groups of MAC standards for water, with a large number of substances subject to MAC in each group:

- SanR&N (sanitary regulations and norms) of RK No. 3.01.070-98 MACs of chemical substances in water bodies used for domestic-potable and recreation needs. MACs have been approved for more than **1,300 substances**.
- MACs and ASILs of hazardous substances for fishery ponds, developed in Moscow, 1990. MACs have been approved for **912 substances**, ASILs for **40 substances**.
- SanR&N of RK 3.02.003.04 as of August 16, 2004 (3.01.067-97) on potable water And hygienic requirements of the water quality in the centralized water supply system. Standards for **more than 1,400 substances** have been approved.

Under the law, MAC refer to the maximum concentrations under which substances do not have a direct or indirect impact on human health (when affecting a human organism during the whole life) and do not deteriorate hygienic conditions of the water use.

Waste classifications and standards

In Kazakhstan, the classification of waste is based on 5 classes of toxicity as presented in table 16.

Table 16: Categories for wastes based on their toxicity class

Class of Toxicity	Hazardous level	Type of wastes
I	Extremely hazardous	Chemical industrial, radioactive wastes, asbestos, mercury
II	High	Sulphuric acid, oil products, arsenic containing substances, halogen containing organic substances, methanol, amines
III	Medium	Organic due remains, oil-slime
IV	Low	Miscellaneous
V	Non-toxic	Domestic

Source: Methodology for environment contamination payment calculations. Ministry of Environment Protection and bio-resources of the Republic of Kazakhstan, 9 August 1994 (Appendix 4)

The maximum allowable concentrations (MACs) of hazardous substances, micro-organisms and other biological substances in the soil have been set in "*Standard documents of maximum permissible concentrations of hazardous substances, detrimental microorganisms and other biological substances polluting soil*", approved by the Decree of the Ministry of Health Care of RK No.99 as of 30.01.2004 and the Ministry of Environment Protection of RK No. 21-P as of 27.01.2004. MACs have been approved for 321 substances. According to local consultants, a soil is considered safe below 1 MAC, relatively safe between 1 MAC and10 MAC, hazardous between 10 and 100 MAC, and highly hazardous over 100 MAC. Obviously there is a problem here with rigid and overly strict standards.

For waste, as part of the EIA process, the investor has to provide information on the types and quantities of waste formation, the peculiarities of pollution of the territory with regard to consumption and production residue (hazard class, toxicity, physical status). Recommendations on neutralization, utilization and disposal of all the types of waste should be included [15].

For Kazakhstan, hazardous waste (toxicity class I-IV) requires specific disposal conditions and safety requirements, but industries are allowed to store hazardous waste on site. Industries should provide statistical reports two times a year together with the results of annual monitoring to get approvals for the following year. All power stations, metallurgy, chemical, oil & gas and refinery plants are included in category I and are subject to obligatory inspection two times a year. Also, all other industries that produce more than 3000 tons of category I hazardous waste per year are subject to inspections twice a year. With lower production of waste or production of waste of lesser hazardous class, inspections are reduced to once a year or once every two years.

4.4. Emission limit values

On the basis of data on Maximum Allowable Concentrations (MACs) of different pollutants in ambient environment, every enterprise has to calculate its own **Maximum Permissible Emissions into the air (MPEs)** and **Maximum Permissible Discharges into water bodies (MPDs)**. Each enterprise must also develop its Waste Generation Limits and Waste Disposal Limits. Following the OECD approach, the **MPEs and MPDs hereinafter will be referred to as Emission Limit Values or ELVs**, to avoid terminological inconsistency.[16] Environmental quality standards and approaches to ELV setting are mostly based on the group of old Soviet

[15] Order of the Minister of Environment of the Republic of Kazakstan N 68-II of February 28, 2004.

[16] OECD-EAP Task Force (2003) Review of Environmental Permitting Systems in Eastern Europe, Caucasus and Central Asia, Paris

standards developed in the period 1977-1981, and on a set of guidelines and methodologies developed in 1986-1987[17].

The MPPs and MPDs are denominated in emission/discharge loads in a specified period of time – tons per year – for each emission source (stack) within a site. The key principle in the methodology of calculating ELV is that after being released into the environment, these loads of emissions and discharges will not result in concentrations exceeding respective MACs in receiving media. Therefore, project developers need to take several factors into account when making these calculations, such as emission loads, location and characteristics of discharge points, background concentrations, local conditions, total volume of emissions from other facilities and potential synergetic effects in the toxicity of substances. Input information also should refer to parameters of add-on devices, non-source and fugitive pollution, meteorological conditions, influencing pollutants' dispersion, data on possible accidental releases of pollutants and demographic information. Legislation obliges the developer to measure the background concentration of all relevant pollutants. The ELVs should not be exceeded when the facility works at full capacity.

Emission Limit Values have to be calculated at the pre-design stage, during preparation of feasibility study and Technical Report of any new investment or significant rehabilitation that may adversely affect environment. The information required to calculate ELVs is extremely comprehensive. Credibility of input data is usually questionable due to the inherently inadequate accuracy of measurement and modeling techniques and sheer costs of collecting accurate data for so many variables. The methods for ELV calculation are complicated and require computerized pollution dispersion models, which are not transparent to anybody but a few experts in the country. Only consulting companies and experts licensed by MoE can calculate the Emission Limit Values for enterprises in Kazakhstan.

Because of the stringency, multiplicity and rigidity of MAC standards and high background pollution in certain areas of the country the project developers may often find out that properly calculated ELVs may be economically unfeasible, and even technically unattainable. In the areas where MACs are already exceeded, in principle, no new economic activity should be allowed. Environmental Protection Law even stipulates (Article 68) that certain industrial activities with significant environmental impact can be restricted or prohibited if the authorities declare Critical Environmental Conditions in a particular area. This can be done if "*deep and stable negative changes in environment that poise hazard to population and nature*" are persistent in a zone.

Some OECD countries in the 1970s also used total load based emission limits and faced similar dilemmas between protecting human health and allowing new industries in the areas where ambient quality standards were exceeded. Two broad environmental policy innovations have emerged in the OECD countries' to overcome this dilemma: (i) emission offsets; and (ii) emission limit values based on benchmarks. They are described in box 8.

[17] Ibidem, pp27

Box 8: Two main regulatory responses to rigidity of load-based emission standards in the OECD countries

Emission offsets approach has been first used in US acid rain program in the late 1970s. Some new plants have been outraged by zero emissions permits when registering activities in the air sheds where concentration of pollutants in the air were above allowed standards. In order to integrate environmental protection with economic development, US environmental authorities would allow new entrants to receive a normal emissions permit if they paid to reduce emissions from existing sources by more than they added emissions from new sources. Similar emission offset opportunity was used in Germany over 20 years ago. In the US, this principle has evolved into wider application of tradable emissions permits. In Germany, following very modest amount of offset transactions, this instrument was abandoned and replaced with establishing emission limit values (ELVs) by reference to benchmarks as in many other OECD countries. In the US, they evolved into emission trading programs.

Setting emission limit values on the basis of benchmarks became the most common approach in the industrialized world. Instead of imposing limits or absolute caps on emission sources, the benchmark-based ELVs are established by reference to the best environmental performers in similar sectors under similar conditions in a given time. Therefore, benchmark-based ELVs are established not in absolute, but in relative terms – usually as concentrations of pollutants in exhaust gases of discharged effluent or emissions per unit of productive output.[18] Sometimes other, more descriptive rather than numerical performance standards are prescribed in addition to emission limit values. They may refer to special ways of managing inputs to production (e.g., water or energy), the ways to operate the plant or decommission certain facilities (e.g., landfills, or nuclear power plants). Benchmark-based ELVs usually are differentiated by the type of economic activity and the size of installation. The larger the installation, the more stringent are ELVs (less pollution per unit of output or per cubic meter of exhaust gases). This is motivated by the need to protect the environment against very large loads of pollution, but also by the economic considerations, because larger facilities can enjoy economy of scale of emission control investments. They find it cheaper to reduce emission by one unit than smaller facilities. Benchmark-based ELVs are established on the level of 'installations' within enterprises rather than on the level of individual emission sources (stacks). This encourages improvement of environmental performance by process integrated technological solutions or good housekeeping measures and not mainly by installing end-of pipe control equipment. In particular, large enterprises may consist of a few technically and functionally integrated productive installations.

Both approaches were aimed at reconciliation of environmental protection with industrial growth. They represented attempts to attract new investments and new enterprises to the polluted zones without further degradation to the quality of life and health conditions. Over time, benchmark-based ELVs became the core of modern environmental permitting in Europe and – for new sources of pollution – worldwide in the OECD countries. Emission offsets have evolved into less cumbersome and larger scale emission trading programs, mainly in the US, and targeted primarily at existing pollution sources facing challenging emission reduction targets. Recently emissions trading has also emerged in Europe. It has been applied to CO_2 reduction targets and is considered for acidifying emissions from large combustion plants.

Advantages of benchmark-based ELVs over MACs-based ELVs include their relative transparency to the regulated entities and to the public. They are also usually easier to establish and enforce. Standard monitoring protocols to control compliance have been developed for various sectors to ensure a level playing field between various enterprises. They also involve less transaction costs to enterprises compared to MAC-based standards or emissions offset regime.

Benchmark-based ELVs are criticized for the absence of the casual direct link to ambient quality standards. Setting emission limit values based on benchmarks is less environmentally safe because the total emission increases when new enterprise enters the market, unlike under emission offsets regime. In principle, it is easy to envisage that in an industrial zone with a

[18] In the EU IPPC Directive, "emission limit value" is defined as the mass, expressed in terms of certain specific parameters, concentration and/or level of an emission, which may not be exceeded during one or more periods of time. Emission limit values may also be laid down for certain groups, families or categories of substances (…). The emission limit values for substances shall normally apply at the point where the emissions leave the installation, any dilution being disregarded when determining them. (…)

large number of installations, each installation could meet the relative ELVs, but their combined pollution loads could lead to excessive concentration of pollutants in ambient air, water or soil. The danger is mitigated by the principle of accountability of environmental authorities for ambient quality standards as policy objective. This accountability encourages environmental authorities to continuously look for innovative and proactive ways to create incentives to reduce emissions from all possible sources, in order to meet the environmental objectives without constraining economic growth. This elevates the position of environmental agencies in the government and in the public opinion. They are perceived not just as environmental police that threatens growth by chasing and punishing polluters. Instead, they are perceived as providers of public goods and services such as clean water, air, soils and recreation, sometimes in competition with other goods and services provided by polluting economic activities. Well performing environmental policy makers can win this competition without constraining economic development.

The disadvantages of MAC-based ELVs have been recognized in Kazakhstan both by domestic and foreign investors. The Ministry of Environment has already introduced some technology-, or performance-based requirements when licensing certain economic activities. For example, environmental permits for nuclear installations and oil extraction facilities include a number of requirements related to monitoring environmental impact, preventing accidental spills and managing associated gases. The 2004 Law on State Environmental Review and the 2004 Decree on EIA stipulate that industrial project developers should apply modern and best technologies. However, the legal requirement to derive emission limits from MACs remains binding. Moreover, the references to the technology based considerations in permitting process are difficult to apply because the Government has not issued any definitions, guidelines, benchmarks or reference values for environmental performance of these 'best' technologies. Actually, it may be a matter of concern as one more discretionary element, which makes a permitting process vulnerable to abuse.

4.5. Environment impact assessment (EIA) of development projects

EIA is required by the Law on Environment Protection and the Law on Environmental Review for every new economic activity. On February 28, 2004, the Ministry of Environment Protection of the Republic of Kazakhstan issued a long awaited instruction (No. 68-P) for the environment impact assessment of planned activities during pre-planning, pre-design and design documentation development stages. This instruction replaced earlier widely criticized "temporary" instruction which had been effective since 1993. The 2004 instruction brought the content and process of EIA in Kazakhstan closer to good international practices.

In general, EIA assessment is required for projects that will use natural resources and may negatively impact on the environment. The decision on its need is taken by the regional or central environmental authorities. The recent instruction on EIA presents an extensive and detailed list of industrial activities for which full EIA is recommended. These activities include, inter alia, oil refineries (except enterprises producing only lubricants from crude oil), and facilities for storage of oil, petrochemical or chemical products with capacity of 200 thousand tons and more. Chemical plants producing phosphoric, nitric or potassium fertilizers are subject to full EIA as well. So are pipelines for transportation of gas, oil or chemicals in diameter more than 800 mm and length more than 40 km. Gas processing or petrochemical production are not explicitly listed as requiring a full EIA.

Box 9 presents the EIA requirements that petrochemical projects in the European Union have to comply with.

Box 9: EIA requirements with respect to petrochemical projects required in EU

The EU Directive on Environmental Impact Assessment (EIA) of the effects of projects on the environment was introduced in 1985 and was amended in 1997. The EIA procedure ensures that the environmental consequences of projects are identified and assessed before authorization is given. The public can give its opinion and all results are taken into account in the authorization procedure of the project. The public is informed of the decision afterwards. The EIA Directive outlines which project categories shall be made subject to an EIA, which procedure shall be followed and what will be the content of the assessment.

Full EIA is required for projects listed in Annex I to the Directive, including, inter alia:

- Crude-oil refineries (excluding undertakings that only manufacture lubricants from crude oil) and installations for the gasification and liquefaction of 500 tons or more of coal or bituminous shale per day.
- Integrated chemical installations, i.e., those installations for the manufacture of substances on an industrial scale using chemical conversion processes, in which several units are juxtaposed and are functionally linked to one another and which are:
  - (i) for the production of basic organic chemicals;
  - (ii) for the production of basic inorganic chemicals;
  - (iii) for the production of phosphorous-, nitrogen- or potassium-based fertilizers (simple or compound fertilizers);
  - (iv) for the production of basic plant health products and of biocides;
  - (v) for the production of basic pharmaceutical products using a chemical or biological process;
  - (vi) for the production of explosives.
- Pipelines for the transport of gas, oil or chemicals with a diameter of more than 800 mm and a length of more than 40 km.
- Installations for storage of petroleum, petrochemical, or chemical products with a capacity of 200,000 tons or more.

For projects listed in Annex II, the Member States should determine through a case-by-case examination, or thresholds or criteria set by the Member States whether the project shall be made subject to a full EIA in accordance with the EU Directive. Annex II include, inter alia:

- Chemical industry (Projects not included in Annex I)
  (a) Treatment of intermediate products and production of chemicals;
  (b) Production of pesticides and pharmaceutical products, paint and varnishes, elastomers and peroxides;
  (c) Storage facilities for petroleum, petrochemical and chemical products.
- Rubber industry: Manufacture and treatment of elastomer-based products.

Source: *Council Directive of 27June 1985 on the assessment of the effects of certain public and private projects on the environment (85/337/EEC) Official Journal 175, 5.7.1985, p. 40)*

The second list in the Instruction 68-P includes those activities for which state environmental authorities may require full EIA on the basis of preliminary expert review or on the basis of threshold levels (or other set of criteria), stipulated by other regulatory documents. This category includes those projects in chemical industry, which have not been included in the previous list, such as processing semi-finished items, manufacturing of chemicals, manufacturing of elastomers and peroxides[19]; and storage of oil, petrochemical and chemical products. The rubber industry, production and working articles on the base of elastomers fall into this category too.

The new instruction has incorporated many comments of the previous 1993 temporary regulation. It introduced a phased approach to environmental impact assessment at different stages of project preparation. In particular, a brief indicative Environmental Conditions Review was introduced at early, pre-feasibility study phase of project development when various design options are still open.

[19] Peroxides are inorganic materials and therefore are not considered petrochemical products.

Table 17 shows the essential stages of project development, at which EIA is required.

Table 17: Project development stages that require an EIA

Phases	EIA stage	Project Development phase
Phase 1	Environmental Conditions Review	Pre-feasibility
Phase 2	Preliminary EIA	Feasibility
Phase 3	EIA	Preliminary Engineering Design*
Phase 4	Chapter on "Environmental Protection"	Detailed Engineering Design*

* If preliminary and detailed engineering designs are included in one phase, then only phase 4 is required.

The phased approach to EIA encourages project developers to consider environmental impacts at the stage when this impact may be minimized by alternative project design options and preventive measures, instead of only end-of-pipe controls. It also gives environmental authorities, in principle, an opportunity to suggest approaches to prevent pollution and to introduce less polluting and less resource-intensive technologies, innovative project designs and management practices when it is still cost-effective to do so. It can save time and resources of project developers in case of potentially controversial project options, which they may consider. Developers can get an early warning from authorities, when significant resources have not yet been invested in detailed engineering design.

At each stage, EIA is an update and specification of the assessments conducted at a previous stages. Such an approach introduces also more predictability to project developers and investors. They can maintain continuous communication with the permitting authorities conducting State Environmental Review of EIA that eventually leads to a smoother approval of the Project. At each phase, the EIA is subject to the State Environmental Review (see next section). At each stage, the State Environmental Review can relieve the project developer from the requirement to prepare the next phase EIA if negative environmental effects are determined to be absent, small, and temporary. The essential elements of EIA at each stage are described in box 10.

Box 10: Content of EIA at different phases in Kazakhstan

Phase 1 shall be implemented based on performance characteristics of envisaged (planned) operations that are available from archives and records, other special reference sources and similar projects.

Phase 2 involves a Preliminary Environmental Impact Assessment of Intended Project Operations (hereinafter pre-EIA), which shall identify potential trends of changes in the components of natural environment, social and economic conditions and effects as caused thereby on life of humans and environment. The pre-EIA assessment of the envisaged (targeted) operations shall be carried out based on evaluation of alternative basic options and available literature sources including special research materials. Complicated and large-scale front-end engineering developments shall require engineering and environmental pre-studies.

Phase 3 is the Environmental Impact Assessment, which involves a detailed full-scope analysis of all aspects of impacts from specific facilities and structures organic to intended project business operations on the environment. The assessment is done separately for impact on air, water, soil surface, solid waste, vegetation, social and economic conditions and other types of impact. Assessment of risk of accidental pollution is also required.

Phase 4 will involve development of Environmental Protection Section (hereinafter Section) to a detailed design. The Section will be developed if individual design principles of envisaged operation as adopted at the stage of Project Design change essentially in the process of the detailed design development (Attachment 2). If this happens, this section will be developed with the aim to update the EIA material completed in Phase 3 of the EIA process. The composition and content of the Section will be fairly similar to those in the EIA Phase 3 materials.

Source: Local consultants after Decree 68-P

Although in principle the new instruction gives more opportunities for pollution prevention, these opportunities are rarely used in Kazakhstan. The main objective of the EIA remains to demonstrate that the proposed project will not infringe upon ambient quality standards

(MACs). An assessment of whether the project proponent employs state-of-art environmental management practices and minimizes environmental impact is not essential in EIA process. Therefore, project developers do not have incentives to propose best available techniques. If their project will infringe on MACs, e.g., because other obsolete plants in the area already heavily pollute the environment, it does not matter what technique is used. On the other hand, if the new project will not affect MACs, the project developer does not have incentives to minimize waste and pollution anyway even if waste minimization practices would be cheap and efficient to the enterprise and economic in the long run. By not applying BAT even if ambient quality is good, a new project exhausts more of the environmental carrying capacity and prevents other enterprises from entering the area in the future. Environmental authorities also are not accountable for encouraging improvement of environmental performance for protecting MACs. They also do not have information or guidelines on the best available techniques for various sectors and production processes.

4.6. Environment impact assessment (EIA) of government programs

In June 2003, the Minister of Environmental Protection of Republic Kazakhstan issued a regulation "On the rules of assessing the impact of planned activities on the environment during preparation of national, sectoral and regional programs of development of branches of the economy, and the schemes of location of productive assets". This document corresponds to the Strategic Environmental Impact Assessment (SEIA) of government programs as stipulated for example by the EU Directive[20]. The essential elements of the content of the SEIA stipulated by this resolution are presented in box 11. According to this Resolution of State, agencies developing national, sectoral or regional development programs should conduct such an assessment as an instrument aiding decision making. Evidently, enforcement of this resolution within the government is less than perfect. The government program for the development of Petrochemical industry was approved by the government six months after the MoE SEIA Resolution became effective. However, its short chapter on environmental impact can hardly be considered as SEIA according to the content and rules required by the MoE.

Box 11: Required content of environment impact assessment of government programs in Kazakhstan

1. Information on the main elements and objectives of the program, and its relations with other programs.
2. Existing environmental conditions and probable changes of these conditions after program implementation.
3. Characteristics of a condition of an environment in the areas where the program will be implemented
4. Environmental problems related to the program.
5. Environment objectives established on international, national and local levels related to the program, and also ways taking these and other environmental objectives into account.
6. Probable ecological consequences (short-, medium-, and long-term; permanent and temporary; positive and negative; side, cumulative and synergistic effects).
7. Measures to prevent, reduce or mitigate harmful consequences to the environment, which can result from implementation of the program.
8. A summary of the reasons for a choice of considered options and description of a course of conducting an impact assessment, including identification of difficulties in providing needed information, such as failures of technical equipment or gaps in knowledge.
9. Measures envisaged for monitoring of environmental consequences of program implementation.
10. Probable essential trans-boundary environmental impacts.
11. The resume of the submitted information for dissemination to the public.

Source: Resolution of the Ministry of Environment 9 June, 2003 N 129-p

[20] Directive 2001/42/EC of the European Parliament and of the Council as of 27 June 2001, on the assessment of the effects of certain plans and programs on the environment [Official Journal L 197 of 21.07.2001].

Under the Convention on Environmental Impact Assessment in a Transboundary Context,[21] the United Nations Economic Commission for Europe has developed guidelines for conducting SEIA for certain sectors. It includes a consolidated Environmental Impact Assessment Checklist for the production of plastics and synthetic rubber. This checklist can help to systematically identify possible environmental problems associated with plastic and rubber plants required under point 4 and 6 of the SEIA content, which is required by the MoE.

4.7. Environmental permitting

In Kazakhstan, an amalgam of an environmental permit known to OECD countries is a license, which is issued following the State Environmental Review (SER) of Environmental Impact Assessment (EIA). According to the law on State Environmental Review (Expertise), the stated objective of SER is "*to prevent possible unfavorable impact of the planned economic and other activity upon the health of population and the environment*".

Contrary to this official objective, the State Environmental Review seems to be "protective" rather than "preventive". In their review, the Government experts refer to environment quality standards as: standards for impact upon the natural components or separate environment components (air, surface and underground waters, soils, flora and fauna); standards and rules of other state bodies, which have authority in environment and natural resources protection; as well as various other standards and norms established by various government agencies. A project developer calculates Emission Limit Values (MPEs, MPDs and waste limits) and must submit it for State Environmental Review together with the EIA as a permit application package. At each phase, the EIA should include a separate "Environmental Impacts Statement", which summarizes the key findings of the completed EIA. The applicant may be asked to revise its application when proposed emission limits do not ensure attainment of Maximum Allowable Concentrations. Once approved in an environmental permit, ELVs are binding immediately.

The main focus in the SER seems to be to ensure compliance with various norms and standards rather than to minimize environmental impact and encourage improvement of environmental performance. The latter considerations do not translate into permit conditions and monitorable indicators. Therefore, SER is perceived by industry as just an additional bureaucratic burden rather than a policy instrument.

If the conclusion of the state environmental review is positive, the license (permit) for the 'special use of the environment' will be issued. The permits are issued for enterprises as legal entities rather than for installations as in the OECD countries[22]. Environmental authorities may revoke the permitted ELVs and require the enterprise operator to revise maximum permissible emission limits if ecological and hydrological conditions in the region change, if new sources of pollution emerge or if characteristics of existing sources change, or if certain structural units are privatized or restructured into independent entities.[23] Therefore in principle, if a new enterprise applies for environmental permit in a particular area, the government may discretionary require the existing enterprise to change their permit conditions and reduce pollution. This introduces a sense of unpredictability in investment decisions and renders the system vulnerable to abuse by powerful and well connected enterprise groups to fight competitors with bureaucratic tools.

[21] http://www.unece.org/env/eia/

[22] In the IPPC Directive 'installation' is defined as a stationary technical unit where one or more activities are carried out, and any other directly associated activities which have a technical connection with the activities carried out on that site and which could have an effect on emissions and pollution.

[23] Order of the MoE 21 March 2002, N 83-p

In practice, the SER rarely fulfill even its primary stated objective – to protect MACs. In order to cope with the stringency and inflexibility of MACs-ELVs system in the zones that MACs are exceeded, temporary ELVs (TELVs) are granted in environmental permit. This practice emerged as an ad hoc solution to a permanent structural problem with the rigidity of the current system. The temporary ELVs are granted at a current or at a reasonable baseline emission and discharge levels. They provide some relief to enterprises that cannot meet strict MPPs and MPDs at the time of commissioning operations. For the total loads of emissions within the permitted limits, enterprises pay regular emission fees, which are treated as regular costs of doing business for income tax calculations. Otherwise they would have to pay non-compliance fines, which are not only ten times higher rates, but are also paid from after tax profit. Temporary ELVs are granted usually for one year through less than transparent negotiations when the enterprise tries to convince authorities that compliance with "protective" ELVs would cause significant economic difficulties. The definition of 'significant economic difficulties' is not specified in regulations. Benchmarks, references or guidelines have not been published. Therefore, the decision of granting temporary ELVs is subject to discretionary judgment by environmental authorities under asymmetric information, because local environmental officials have neither capacity nor guidelines to evaluate the economic consequences of compliance for enterprises. Temporary ELVs can be renewed every year and, in practice, many are routinely rolled over from year to year for a long period of time.

The temporary emission limits may have been a genuine effort to introduce common sense and flexibility to a very rigid system of deriving emission limit values from MACs. However, this arrangement does not solve the fundamental problem of wrong incentives. TELVs do not encourage the continuous improvement of environmental performance of enterprises. They worsen the investment climate for reputable investors who usually expect predictable rules of the game. This practice may be easily overused and can lead to disregard of the law by giving excuse to persistent non-compliance with MACs. The discretion of decision making, may also result in corruption and distortion of ELVs. For instance, a peculiar interpretation of "economic considerations" results in tougher ELVs for good economic performers and lax regulation of poor performers considered not able to pay the costs of compliance, therefore they can obtain less stringent ELVs which later on may not even be enforced.[24] TELVs are Soviet-made alternative to benchmark-based ELVs or emission offsets described earlier.

Technocratic procedures for setting ELVs restricts opportunities for public participation and stakeholders' dialogue. The approach to MPEs and MPDs encourage polluters to apply traditional and simple end-of-pipe solutions rather than pollution prevention through more advanced technologies and better management practices. Incentives to decrease resource/energy consumption or pollution per unit of production are not embedded in this concept. Also the single-medium approach allows transfer of pollution between different environmental media, as cross-media environmental impacts are neglected.

The legislator has noticed that the rigidity of MAC-based emission limits may deter foreign investments. Some reform initiatives are underway (see box 12), but so far has gone only half way towards introducing an incentive structure common in OECD practices.

[24] OECD EAP Task Force, Force (2003) Review of Environmental Permitting Systems in Eastern Europe, Caucasus and Central Asia, Paris

Box 12: Initiatives to reform permitting system in Kazakhstan.

In June 2001, the reform of the permitting system in Kazakhstan was launched at a stakeholder meeting that brought together officials from the Ministry of Natural Resources and Environmental Protection (MNREP) and four of its sub-national departments, representatives of the Parliament, oil and gas industry and the scientific community. During the stakeholder meeting, it was agreed that the current system of air quality regulation needs substantial improvement. Specifically, the MNREP practices for setting pollution limits needed to be improved. Representative of oil companies mentioned that the process they have to go through every year to obtain permits is too cumbersome.

A Working Group (WG) was established with participation of representatives from authorities and industry and elements of its working plan developed. The WG received the mandate to review the environmental permitting procedures and come up with recommendations for their improvement. As a result, proposals for secondary legislation were developed. Among others, the document called "Rules Concerning Issuing Environmental Pollution Permits" was drafted to describe procedures for issuing and registering of the environmental pollution permits. The Rules were enacted through a government decision.

Source: Central Asia Natural Resource Management Project, 2002, after OECD EAP TF, ibidem, p.45

In the OECD countries, the primary function of environmental permits is to prevent pollution and minimize waste in an integrated manner to protect the environment as a whole. Ambient quality conditions are considered in the permitting process, but they are not binding constraints. As mentioned earlier, ambient quality standards are policy objectives for government, rather than binding limits for business. The permit conditions are benchmarked against the best environmental performers among comparable enterprises, which use best available techniques (BAT).

Regulatory reforms in many countries focused on administrative simplification, improving consistency of regulations, transparency, accountability and compliance assistance to regulated entities. In the United States and Canada, substantial efforts were put to improve public service within single-medium permitting approaches. Recently, codes of good practices for certain industrial sectors have been introduced as a special guide to improve customer service in permitting. In several regions, institutional integration took the form of “one-stop shopping” permits, where the enterprise faces just one permitting agency that coordinates all types of permits.

Integrated permitting, which regulates cross-media transfer of pollution, is considered a good regulatory practice in the EU and most OECD countries. The integrated environmental permit should protect the environment as a whole, and prevent the transfer of pollutants from one media to another. A competent government agency should set the relevant permit conditions. An integrated permit also considers noise, odor, vibration, consumption of water, other raw materials and energy effectiveness. Measures related to conditions, such as start-up, leaks, malfunctions, accidents, etc., should be part of a permit. Emission monitoring requirements are also embedded. Finally, the competent authority might set other conditions as necessary, including specific rules for housekeeping and managing of installations.

Many countries already use or gradually adopt this approach. For example, in the United States, the Action Plan for Achieving the Next Generation of Environmental Permitting of 1999 sets, among others, the goal of “moving toward a more integrated permitting system”. The European Union Directive on Integrated Pollution Prevention and Control (IPPC) marks a very clear transition towards a new permitting philosophy in Europe. Several EU member states had used the concept of integrated permitting even before the EU introduced the IPPC Directive. Sweden introduced integrated permitting, the use of BAT, and case-by-case permitting in the Environmental Protection Act of 1969. Australia followed with similar provisions in 1971. Denmark introduced integrated permitting legislation in 1974, the UK in

1990 and Ireland in 1992. The major features of IPPC permitting philosophy are summarized in box 13.

Box 13: Major features of EU Directive on Integrated Pollution Prevention and Control (IPPC)

- Permitting on a case-by-case basis considering local conditions;
- Not allowing significant pollution
- An integrated approach to protecting the environment as a whole, avoiding the transfer of pollutants from one medium to another;
- Focus on pollution prevention in particular through application of the best available techniques
- Considering not only pollution and discharges but also, noise, vibration, consumption of water and other raw materials, and efficient use of energy;
- Application of "waste management hierarchy", which means first avoiding, then recycling, reuse, recovery and safe disposal of waste;
- Accident prevention and minimization of the consequences of accidents;
- Return of the site to a satisfactory state when the installation is closed; and
- Emission monitoring requirements embedded into permit.

Not all categories of industrial activities are subject to integrated permitting. The IPPC Directive covers only large installations in the selected sectors listed in Annex I to the Directive. The petrochemical and related activities falling under the IPPC are listed in box 14 below. Operators of all these installations must obtain integrated permits.

Box 14: Categories of petrochemical and related industrial activities falling under the requirement of integrated permit under the IPPC Directive

- Mineral oil and gas refineries
- Production on an industrial scale by chemical processing of basic plastic materials (polymers synthetic fibers and cellulose-based fibers)
- Production on an industrial scale by chemical processing of synthetic rubbers
- Production on an industrial scale by chemical processing of fertilizers

The best available technique (BAT) is a fundamental concept in the environmental permitting philosophy in the European Union (see box 15). Instead of deriving permit conditions from ambient quality standards (as in Kazakhstan), European (and most other OECD) legislators decided to derive permit conditions from the best environmental performance practices in a given industry. The most advanced enterprises using the best environmental practices are used as benchmarks for the sector. Environmental performance standards of their production processes and their environmental management practices are defined as best available technique (BAT) in any given industrial sector at a given time period. They are described and published by government experts in technical guidelines (BREFs). The Directive defines what "available" means, and also proposed a concept of technique – not technology! Technique includes technology and the way in which the installation is designed, built, maintained, operated and decommissioned. Such an approach stresses behavioral aspects of permit requirements and comprehensive approach to environmental management of the enterprise. It is also meant to prevent the governments from prescribing specific technologies and brand names as BAT, as this could distort competition and trade.

Box 15: Best Available Technique in the IPPC Directive

"… the emission limit values and the equivalent parameters and technical (…) measures shall be based on the best available techniques, without prescribing the use of any technique or specific technology, but taking into account the technical characteristics of the installation concerned, its geographical location and the local environmental conditions. In all circumstances, the conditions of the permit shall contain provisions on the minimization of long-distance or transboundary pollution and ensure a high level of protection for the environment as a whole."

'Best available techniques` shall mean the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole:

Technique includes both the technology used and the way in which the installation is designed, built maintained, operated and decommissioned.

Available means those techniques developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into account the costs and advantages whether or not the techniques are used or produced inside the EU member state as they are reasonably accessible to the operator.

Best means the most effective method to achieve a high, general level of the environment protection as a whole.

As discussed in chapter 5, best available techniques can mean somehow different permit requirements in different contexts. The concept "available" was introduced to allow diversification of permit conditions for smaller enterprises or those in poorer countries and regions who could not afford the best approaches available on international markets. Diverse permit conditions are usually tailored to what can reasonably be expected from an operator of an installation, taking into account all possible efforts to avoid or minimize environmental impact, environmental risk posed by installation and economic burden on operator. Specific technical guidelines, numerical performance indicators and references included in BREFs constrain discretion of permitting government officials and aim to minimize the room for corruption. An example of such guidelines for the production of polymers was presented in chapter 3. The permitting authorities and plant operators use BAT technical guideline documents as references during negotiations of permit conditions. They provide all parties of permitting process with information about the benchmarks for the best environmental performance achieved by similar enterprises. BREFs are drafted on the basis of surveys of available technologies and business practices and revised periodically – usually every five years. In addition, the government discretion is controlled by transparency provisions, such as public participation in permit negotiations and publicly accessible registries of permit conditions, where key environmental performance parameters are published in a language that is understandable to the concerned public. Public registries also include regularly updated information about compliance with permit conditions by each installation.

The IPPC Directive does not require BAT to be always defined through quantitative thresholds for emission limit values (ELVs). Member states are required to set quantitative ELVs only to those pollutants, which are likely to be emitted in significant quantities and which can create significant damage to health or ecosystems and have potential to transfer pollution from one medium to another (water, air and land). In particular, pollutants listed in Annex III to the Directive should have ELVs specified in permit conditions. They are listed in box 16. However, these limit values can be supplemented or replaced by equivalent parameters or technical measures. For instance, the permit can include requirements to reuse and recycle water and waste, which are intended to ensure protection of soil and ground water and safe management of waste generated by the installation. Threshold values are given for certain activities only and are commonly differentiated by size of installation (production capacity or outputs) and by age of installation – stricter for new and large installations, laxer for existing and smaller installations. The use of media-based sector emission standards is not favored when implementing the IPPC directive.

Box 16: Indicative list of the Main Polluting Substances to be Taken into Account if they are Relevant for Fixing Emission Limit Values (Annex III to IPPC Directive)

AIR

1. Sulphur dioxide and other sulphur compounds
2. Oxides of nitrogen and other nitrogen compounds
3. Carbon monoxide
4. Volatile organic compounds
5. Metals and their compounds
6. Dust
7. Asbestos (suspended particulates, fibers)
8. Chlorine and its compounds
9. Fluorine and its compounds
10. Arsenic and its compounds
11. Cyanides
12. Substances and preparations which have been proved to possess carcinogenic or mutagenic properties or properties which may affect reproduction via the air
13. Polychlorinated dibenzodioxins and polychlorinated dibenzofurans

WATER

1. Organohalogen compounds and substances which may form such compounds in the aquatic environment
2. Organophosphorus compounds
3. Organotin compounds
4. Substances and preparations which have been proved to possess carcinogenic or mutagenic properties or properties which may affect reproduction in or via the aquatic environment
5. Persistent hydrocarbons and persistent and bioaccumulable organic toxic substances
6. Cyanides
7. Metals and their compounds
8. Arsenic and its compounds
9. Biocides and plant health products
10. Materials in suspension
11. Substances which contribute to eutrophication (in particular, nitrates and phosphates)
12. Substances which have an unfavorable influence on the oxygen balance (and can be measured using parameters such as BOD, COD, etc.).

Another provision to minimize potentially adverse competitiveness impact is that permit conditions do not require to apply BAT immediately. In particular, existing enterprises are given a certain time period to adjust to new, more environmentally friendly techniques of production (compliance schedule) in order to take into account variations in business cycles in different enterprises. Compliance schedule is often marked with intermediary targets, milestones and progress monitoring protocol. Sanctions for non-compliance are high and predictable enough to really deter operators from delaying or compromising on adjustment to BAT.

The political economy of determining BAT is essential in forming the incentive structure of EU environmental permitting. Periodic revisions of BREFs (usually every five years) take into account progress that the industry makes with technologies and environmental management practices. This gives firms incentives to innovate with environmental management because their "technique" is likely to be considered as the benchmark for others at the time of their next BAT review. Thus, the firms that continuously innovate and improve environmental performance get a competitive edge over other firms, which have to adjust under the pressure of environmental permitting authorities. Several business surveys showed that firms with the best environmental performance track records are usually most competitive internationally and financially viable.

European legislators also acknowledge the potential threat that BAT-based permits can be abused to drive competition out of business. This may happen if BAT are defined in such a way that they can be achieved only by specific technologies or industrial process licensed by certain enterprises. Owners of such licenses could possibly lobby authorities to declare their technology as a binding standard and force competitors to purchase it. In order to mitigate this risk, it is recommended that BATs are determined by reference to the generic, albeit numerically specified performance standards rather than to the specific technologies. Therefore, the EU IPPC definition refers to technique and not to technology.

In Kazakhstan, the permitting system is not tailor made to the specifics of different sectors and economic activities. There are some exceptions, such as nuclear facilities and oil and gas extraction, where special laws and regulations specify the guidelines for environmental permitting authorities. Although it is not advisable to develop spec-laws on environmental permitting for different sectors, diversification of technical permit requirements by sector can enhance environmental effectiveness of a permit and make it more useful to enterprises. A good international practice includes: (i) a comprehensive, uniform legal basis for environmental permitting, where the principles, procedures and authorized government agencies for all sectors and enterprises are the same; and (ii) sector-specific technical guidelines for permitting authorities enacted through secondary regulations.

The present environmental permitting system in Kazakhstan, where permit conditions are ultimately derived from MACs, may not be conducive to effective mitigation of environmental impacts of growing petrochemical industry and to improvement of the general investment climate. The IPPC Directive may be a useful reference model for reforms of a permitting system for large enterprises. These reforms can be gradual and evolutionary. Not all elements of integrated permitting regime have to be implemented at once. The roadmap for the gradual reform of environmental permits towards the model, based on practical experience of Central European countries is provided in annex 1.

4.8. Environmental liability

Liability for damage caused by pollution is an environmental policy instrument which is gaining importance in the EU and other OECD countries in managing hazardous industrial activities, especially those which are vulnerable to accidents causing large damages to the environment and to human health.

The EU Environmental Liability Directive came into force in 2004 (box 17). The Directive holds operators, whose activities have caused environmental damage, financially liable to remedy this damage. It is expected to provide incentives to plant operators to take preventive actions and precautionary approaches. The Directive holds those, whose activities are an imminent threat to causing damage to the environment, liable to take preventive actions. The Directive covers damage to life, health, property and biodiversity. The underlying principle behind this Directive is to make polluters pay. An operator responsible for damages will bear the burden of expenditure associated with environmental protection, rather than the costs being passed to society in general. In economic terms, it means that costs are internalized. [25]

[25] Directive 2004/35/EC of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage

Box 17: The main features of the European Union Directive on Environmental Liability

The Directive provides for two distinct but complementary liability regimes. The first one applies only to operators who professionally conduct risky or potentially risky activities. These activities include, among others: industrial and agricultural activities requiring permits under the 1996 Integrated Pollution Prevention and Control Directive; waste management operations, the release of pollutants into water or into the air; the production, storage, use and release of dangerous chemicals; and the transportation, use and release of genetically modified organisms (GMOs). These activities are listed in Annex III of the Directive. Under this regime, an operator can be held liable even of he has not committed any fault, though there are a few cases in which he can be exempted from liability.

The second liability regime applies to all professional activities. However, an operator is only held liable if s/he was at fault or negligent and if s/he has caused damage to protected species and natural habitats protected at EU level under the 1992 Habitats and 1979 Birds Directives. This is one type of environmental damage that the Directive covers. In addition, it defines environmental damage as damage to waters covered by the 2000 Water Framework Directive (all water resources in the EU) as well as land contamination that risks harming human health.

Public authorities will play an important role under the proposed liability scheme. It will be their duty to identify liable polluters and ensure that they undertake themselves, or finance, the necessary preventive or remedial measures, which the Directive details.

The provision of financial security by the insurance and banking sectors for the risks resulting from the Directive takes place on a voluntary basis. Member States should take measures to encourage the use by operators of any appropriate insurance or other forms of financial security and the development of financial security instruments and markets in order to provide an effective coverage for financial obligations under this Directive.

Public interest groups, such as non-governmental organizations (NGOs), will be able to require public authorities to act, if this is necessary, and to challenge their decisions before the courts, if those decisions are deemed illegal. This offers an additional safeguard.

In most EU Member States, there are public law provisions that allow authorities to pursue polluters in cases of water or soil pollution. But the authorities usually have a wide margin of discretion whether to really act against the polluter. Only a few Member States, for example Sweden and Denmark, have enacted a more general regime dealing with compensation for damage to the environment

In Kazakhstan, the discussion on environmental insurance has been ongoing for almost 10 years. Finally, on June, 1, 2005, the draft Bill "On Mandatory Environmental Insurance" was discussed at a plenary session by Mazhilis – the Parliament of the Republic of Kazakhstan. In June, the Bill was discussed by the Senate of Parliament RK. Once it becomes a Law, this would lay out the legal basis for mandatory insurance against liability of individuals and legal entities engaged in environmentally hazardous activities for damages to life, health and property of third persons or environment as a result of accidental pollution.

Mandatory insurance is not required by the EU Environmental Liability Directive. Some European countries apply it in specific high-risk areas only. Examples are nuclear installations, some listed sites (in Germany and France) and toxic and hazardous waste. Sweden requires licensed sites to pay into the environmental civil liability fund. The majority of insurance policies available in the general insurance markets are limited to sudden and accidental damage. Insurance pools covering pollution risks provide specialized insurance in some countries (notably Denmark, Spain, France, Italy and the Netherlands). Those pools, as well as some policies available from individual insurers in countries such as Germany, Ireland, Sweden, the UK and Switzerland, provide cover which extends to gradual pollution.[26]

It is not known to the authors of this report if petrochemical operations will be subject to mandatory insurance in Kazakhstan. We advise the Government of Kazakhstan to consider the pros and cons of making insurance mandatory for petrochemical production and a wide range

[26] European Commission, White Paper on environmental liability COM(2000) 66 final 9 February 2000

of other industrial activities. Indeed, investors from Kazakhstan or non-OECD countries may not have risk management systems as effective as their counterparts in OECD countries. When they cause damage, they are also less likely to have the financial resources to pay for redressing it. They may also be more inclined to try to circumvent liability. Insurance availability reduces the risks to which companies are exposed (by transferring part of them to insurers). They should therefore also be less willing to try to evade liability. However, insurance is just one of the possible ways of having financial security, alongside bank guarantees, internal reserves or sector-wise pooling systems. Before making insurance mandatory for industrial operators, the Ministry of Environment may want to investigate the availability at reasonable costs and on conditions of insurance and other types of financial security in Kazakhstan. Anyway, the major issue is to establish and ensure predictable and enforceable regime of civil liability for environmental damage supported by credible sanctions and enforcement of compensation for damages. The choice of a financial security instrument (such as insurance) is a secondary issue.

Where a polluter is insolvent or cannot be found, there is, in general, no civil remedy available to authorities. In the EU, only Sweden has an environmental liability fund for this purpose. Similarly, where clean-up of land is required and a polluter cannot be made to pay, the cost falls upon the authorities to fund operations. A number of specific funds exist, for example, in Germany for contaminated land remediation, in France for airport noise compensation, and in the Netherlands for air pollution and amongst oil companies for clean-up of contamination at old petrol stations. In the US, the Superfund was established with a similar mandate. In Kazakhstan, the liability for past environmental damage is not always clearly assigned and the responsibility for remediation decision falls into cracks. This ambiguity may potentially deter some high profile, reputable foreign investors. It can also mount contingent liabilities to the state as well as decrease net privatization revenue if the value and/or allocation of liability is unclear at the time of transferring old industrial site to new developers.

4.9. Economic mechanism of environmental policy in Kazakhstan

The menu of economic instruments of environmental policy in Kazakhstan is a bit narrower than in OECD countries. For example, emission taxes, environmental product charges (except liquid and gaseous fuels from mobile sources), tax differentiation or emissions trading lack legal and regulatory basis. This is not necessarily a problem in the short run, because environmental policies in OECD have traditionally relied on command and control instruments for a very long time. It may also not be a big problem with managing the environmental impact of the petrochemical industry. As environmental economic literature suggests, economic instruments are not first best policy response to deal with relatively small number of polluters and hazardous pollutants.

The economic instruments in Kazakhstan consist mainly of emission fees (so called payments for the special use of the environment). Essential design characteristics of the environmental fee system have remained practically unchanged since Soviet times, except for limited changes in the formulas and the rates. The basic system of pollution charges exists for a very large number of air and water pollutants and solid waste. They are still closely integrated with systems of physical emission limits which are laid down in environmental permits. Standard pollution charge applies only to emissions within these limits whereas non-compliance fines apply to emissions in excess of the limits.

The fee rates differ among regions. According to the data reported by the Ministry of Environmental Protection to OECD, the rate for SO_2 emissions ranged from 3,000 to 9,380 tenge per ton (US$22-70) in 2001, with the highest level in Almaty. For Almaty City, the rates for NO is 7,817 tenge/ton and for NO_2 1,725 tenge/ton. Country average fee rate for NO_x

emissions was assessed to be around 2,500 Tenge/ton.[27] These rates are not trivial as compared to those OECD countries where pollution fees have a mainly revenue raising function (such as Poland or US). However, they fall much short of the marginal cost of reducing most pollutants. Therefore, the rates are very small in comparison to the countries that use environmental taxes to provide true incentives to reduce pollution, such as Sweden (table 18).

Table 18: Selected pollution fee rates in Kazakhstan and OECD countries

Indicator	Kazakhstan rates, US$ per ton (2001)	Reference rates in OECD countries, US$ per ton
SO_2 from stationary sources	22 – 70 Av 38.5	2,046 (Sweden[1]) 105 (Poland) 20-30 (US)
NOx from stationary sources	Av. 17	5,900 (Sweden) 105 (Poland) 20-30 (US)
Discharges of polluting substances into water bodies (BOD)	24.4	896 (Poland) n.a. (Sweden) Variable (US)
Least hazardous solid waste (least hazardous)	0.9	390 (Sweden) 2-7 (Poland)
Most hazardous solid waste (most hazardous)	28.2	21 (US- on average) 32-47 (Poland)

Source: Website of the Ministry of Environmental Protection http://www.nature.kz/obsuzhdenie/metodika_1_1.htm (Nov 2005); OECD, 2002[28]; OECD/EEA database of environmental taxes (http://www2.oecd.org/ecoinst)*).*
Notes: [1] In Sweden, sulfur charge/tax is imposed on sulfur content in fuel. Rate per SO_2 was calculated using a combustion equation for sulfur, where the mass ratio between S and SO_2 is approximately 1:2. Annual average exchange rates for 2004 were used to convert SEK to Euro and further to US dollars.

The fee base is extremely wide and fragmented. Over 1,200 air pollutants and 1,345 water pollutants were subject to environmental fees in 2001. Such a large number of pollutants cannot possibly be measured or even estimated accurately. Therefore, a great deal of discretion is present in determining the base (emission) of individual fees. In OECD countries, emissions fees and taxes are usually few and well targeted at key pollutants that can be robustly measured (see table 19).

Table 19: Number of pollutants subject to emission fees in Kazakhstan and in selected OECD countries

Country	No. of pollutants charged	
	Air	Water
Kazakhstan	1,217	1,345
Poland	62	28
United States	6[1]	1[2]
Sweden	3	1

Source: Data for Kazakhstan July 2002: OECD EAP TF (ibidem), data for OECD countries: OECD/EEA database of environmental taxes (http://www2.oecd.org/ecoinst)
Notes: [1] *In the US, charges are levied on criteria pollutants subject to permit and on several ozone depleting substances (here all ODS taxes are treated as one); [2] In the US, water effluent charge is variable – usually flat rate per type of source, or volume (and sometimes toxicity) of wastewater discharge*

[27] OECD, EAP Task Force: The Use of Economic Instruments for Pollution Control and Natural Resource Management in EECCA, CCNM/ENV/EAP(2003)5
[28] Ibidem, pp 71

The revenues of environmental fees in 2001 amounted to US$38.7 million and constituted 0.8 percent of the public revenue. Until 2001, revenues from environmental fees were earmarked for budgetary environmental funds at different levels of government. These funds had a very poor track record of expenditure management and have eventually been abolished.[29] Since 2002, 100 percent of this revenue went into local budgets.

An unfortunate combination of major design features – relatively high rates, fragmented base and poor monitoring capacity – leads to very unpredictable collection of revenues through less than transparent negotiations of the amounts of emissions that are subject to various fees. Sometimes enterprises agree to pay if the local government promises them all or portion of the money back for environmental projects. Local authorities often agree but have no capacity and no incentive to check how the money was really used. It may discriminate against smaller entities, which do not have sufficient weight in negotiations with Akhimats.

Charges for water abstraction were introduced in Kazakhstan in 1995. Prices are the same for industry and individual users. The rates for abstracting surface waters are in the range US$0.6-0.8 per 1,000 m^3. They have the status of royalty payments. Rates differ by river basin.

The characteristics of the emissions fee system in Kazakhstan indicate that they were not designed to serve incentive purposes. The prime purpose of the emissions fee system is to extract rents from industry and raise local government revenues. Out of several thousand emission fees, perhaps, only a handful play some marginal incentive role and few more generate majority of total revenue. It is advisable for the Government of Kazakhstan to consider whether emission fees represent an efficient fiscal instrument of raising the revenue of Akhims' budgets. Probably for the majority of fees, the cost of collection outweighs the value of revenues. The Ministry of Environment may want to analyze which few selected fees should play an incentive function and redesign them to play this role effectively (higher rate, better monitoring, less discretion). The rest of the fees can be abolished without any negative consequences for environment or public finance.

In OECD countries, economic instruments play a secondary role in mitigating environmental impacts of new industries. Their comparative advantage is to encourage reduction in emissions from existing enterprises in a way that reduces the overall cost of emission reduction to industry. If emission fees are designed to play an incentive role (like NOx and SO_2 fees in Sweden and in Denmark), their rates are set at the level of marginal cost of achieving the desired emission reduction target in industry. Revenues either go into the general budget or are returned to the industry in a competitive manner. The relevance of economic instruments to mitigate the environmental impacts of the growing petrochemical industry in Kazakhstan is minor – there are few polluters, all will be new and emissions are potentially hazardous. Priority should be given to environmental permits, emission limit values, non-compliance sanctions and liability for environmental damages. However, economic instruments, if properly designed, can be important supplementary sources of incentives for economic agents to improve environmental performance.

4.10. Enforcement and compliance assurance

Violations of environmental permit conditions are common according to Kazakh experts. Accidents and emergency situations happen frequently in industrial plants, resulting in leakages of hazardous pollutants, fires and oil spillages. Box 18 gives examples of recent violation of environmental permits by oil and gas companies in Kazakhstan.

[29] OECD EAP TF, Performance Review of the Kazakh State Environmental Protection Funds. Paris, 2001

Box 18: Non-compliance of oil and gas enterprises with environmental regulations

According to the regulations for the development of oil and gas fields, their industrial development are permitted if the associated gas is used in national economy or injected into special storing facilities, fields for temporary storing. Despite these exact requirements oil companies are provided annually with a temporary permit for associated gas incineration during the industrial operation.

The oil company **"Aktobemunaigas"**, for the period from 2001 to 2002, increased the volume of burned gas from 373 to 787 million m^3. A permit was taken only in 2003 for incineration in the volume of 444 million m^3. Last year, the company burned two times as much.

None of the oil enterprises implement the required utilization of gas. The gas utilization rate in some companies based on the results of checks is as follows: "**Texaco North Buzachi**" - 13%; "**Karazhanbasmunai**" - 49%; "**Embamunaigas**" - 56%; "**Kazturkmunai**" - 63%; "**Matin**" - 75%.

TengizChevroil (TCO), for the period from 2001 to 2003, exceeded the limits for the associated gas incineration and burned at flares 803 million m^3 of acid and unstripped gas with the gross emission of 27.3 thousand tons, not permitted by the MPE draft. In addition, while the pollutants emission per 1 [WHAT?] of the oil produced was 6.9 kg in 1997 and 13.1 kg in 2002, this year it is even higher.

TengizChevroil (TCO) accumulated several million tons (8.4) of lump sulfur when purifying the associated oil gas from the hydrogen sulphide. The present sulfur utilization program implemented by the company does not resolve the problem. The launched facilities for granulation and scales removing make possible to produce only 800 thousand tons of marketable sulfur a year. The remaining generated sulfur is subject to accumulation only.

"Intergas Central Asia" did not fulfill the requirements of the State Environmental Expertise issued in 2002 and 2003 for arrangement of the monitoring wells around the filtration fields. Furthermore, during the gas main pipeline operation period from 1997 to 2000, Intergas Central Asia did not implement any prophylactic, repair and diagnostic works. As a result of it, for the period of 2002 -2004, five bursts took place, releasing 21 million m^3 of the natural gas, and 1.5 ha of fertile soil layer were lost. The damage was about 2 million tenge.

"KazTransOil", due to the malfunction of the control devices of the gas analyzer, does not implement a regular production monitoring of industrial emissions by boiler and pipe furnaces. It also does not monitor the ground waters around the Inder settlement and the records of industrial wastes generation.

There are no record devices of burned gas and its content in the hydrogen sulphide at **"KazakhOilAktobe", "Kazakhturkmunai", and "Aktobemunaigas".**

Almost all oil companies do not fulfill their commitments to environmental investment plans. For example, in 2002 only 8% of the **Agip's** plan was fulfilled. The measures necessary to conduct emissions and impact monitoring, and responses to oil spillages have not been not fully developed violating regulations for reserve areas. Taking into account the planned investments for 2003 amounting to 11.7 million tenge only 2.3 million tenge was allocated to "**KazTransOil**", and only 229.8 thousand tenge of this amount was used.

Source: Madi Kireev after the Collegium of the Ministry of Environment Protection, 16.07. 2004

The law grants environmental enforcement authorities a full right to enter at any time the territory of any production facility, to get complete information and access to documents and data related to the inspection. Inspections are done once a year and have to be announced in advance. In fact, according to local Kazakh experts, even these modest inspectors' rights are often rebuffed by powerful enterprises, particularly those in oil and gas extraction sectors (whether locally or foreign owned according to experts). Authorized persons do not have lawful and social guarantees for independent and objective decision making. In addition, local and republican governments exert pressure on the environmental inspection authorities for lax enforcement of permit conditions. As local experts point out, many enterprises undertake environmental measures at their own discretion. Quite often, enterprises operate very polluting activities without environmental review and environmental permits. This negative attitude to environmental inspectors is likely to be a part of a larger structural problem described earlier. Inspectors are sent to enterprises often with an impossible task - to enforce conditions of environmental permits which cannot be met in any other way than closing the plant. This is the case, for example, if background pollution exceed ambient quality standards. No wonder that inspectors are perceived as a nuisance, obstacle to growth and rent-seekers. With the technique-based environmental permits, the tasks of inspectors would be more fair, transparent and conducive to economic development.

Existing non-compliance fines are imposed routinely on the same pollutants as regular emission fees but with the 10-fold higher rates. They are also a bit more "biting" because they have to be paid from after tax income. The flaws in the design of the environmental fees system discussed earlier undermine the effectiveness of the system of non-compliance fines as well. Calculation and collection is blemished with ambiguity and discretion embedded in the system. The major problem, however, is related to the perverse incentives conveyed by the present system of non-compliance fines. Contrary to the intention of the legislator, non-compliance fines in Kazakhstan not only fail to deter non-compliance but help polluters circumvent liability for accidental pollution spills. By paying moderate and negotiable fines for pollution above limits, polluters in fact "buy" the right for regular violation of the permit conditions. In fact, the cost of damages that the polluter would have to face under the effective liability regime could have been several (hundred?) times higher than the actual payment of non-compliance fines. For example, just in 2004, Agip has paid sanctions for oil spillage into the sea three times.[30] Evidently, these fines have not effectively encouraged the company to take preventive measures to avoid spillage. Due to design characteristics and wide margins of discretion, they are also vulnerable to corruption.

It is advisable to reconsider the system of sanctions by making it proportional to the severity, frequency of violations and negligence of violator. In many OECD countries, daily, weekly or monthly fines for violation of environmental standards are applied, sometimes with rates increasing in proportion to the length of non-compliance. Instead of being cheap, they would just keep mounting until either the plant fixes itself, or closes. An "enforcement response pyramid" often guides compliance assurance in OECD countries. Sanctions begin from warnings (which are frequent and immediate) for first-time and minor violations and become more severe as the incidences of violation continue or become more hazardous (OECD-EAP Task Force, 2003). Sanctions also have to be perceived as inevitable to have a deterrence function. Expectations of corruption or discretionary negotiations must be minimized if not eliminated. Also, it would seem a small matter of law to prevent payment of fines from exempting anyone from civil liability.

The underlying condition to win political acceptance of any rationalization of sanctions is to make environmental standards realistic and fair. Even a small sanction will face fierce resistance of regulated entities and its enforcement will not be politically feasible if the standard being violated is perceived as impossible to meet under any reasonable conditions.

4.11. Environmental monitoring and information systems

The state monitoring system is weak according to local consultants. The number of monitoring and sampling stations is low (see chapter 2.1 on air quality) and equipment is technically worn out. There seems to be inadequate interdepartmental coordination of the monitoring systems. Even the oil refining industry is not covered by a consolidated environmental monitoring system. Enterprises also fail to fully comply with self-monitoring and reporting requirements. For example, according to local experts, oil extraction companies often do not have monitoring wells around the tank fields, do not install instruments to measure the associated gas and often falsify records of gas production and flow. Public control is not developed due to complicated access to the environmental data on the enterprises performance and environmental impacts. Also, the complexity of environmental permitting process does not make it easy for the public to participate. People simply cannot understand the complexity of thousands of MACs and dispersion models.

[30] Madi Kireyev after Report of the Ministry of Environment Protection for 2004

The old Soviet system for preparation of statistical data still operates mechanically. It is characterized by multiplicity of indices and indicators which are difficult to measure and not always useful to users. It makes it difficult to monitor the evolution of environmental conditions over time. Besides, inconsistency of statistical indices between different departments is observed. For instance, the annual water consumption volumes according to the data from the Committee of Water Resources differ from the data reported by the territorial Environment Protection Departments. Enterprises do not provide the actual or accurate statistics on pollutions due to the absence of the measuring devices.

One particular weakness of the environmental information system in Kazakhstan is an absence of the robust system for tracking the generation and movement of hazardous waste. This may significantly hamper the ability of the environmental authorities to manage environmental impact of growing petrochemical industry. The key characteristics of such systems (which are know as Pollutant Release and Transfer Registers) are illustrated in box 19 below.

Box 19: Pollutant Release and Transfer Registers (PRTRs)

PRTRs are inventories of pollution from industrial sites and other sources. The PRTR should be based on a reporting scheme that is mandatory, annual, multimedia (air, water, land), facility-specific, pollutant-specific for releases, and pollutant-specific or waste-specific for transfers. The Protocol requires each party to establish a PRTR, which:

- Is publicly accessible through Internet, free of charge;
- Is searchable according to separate parameters (facility, pollutant, location, medium, etc.);
- Is user-friendly in its structure and provides links to other relevant registers;
- Presents standardized, timely data on a structured, computerized database;
- Covers releases and transfers of at least 86 pollutants covered by the Protocol, such as greenhouse gases, acid rain pollutants, ozone-depleting substances, heavy metals, and certain carcinogens, such as dioxins;
- Covers releases and transfers from certain types of major point sources (*e.g.,* thermal power stations, mining and metallurgical industries, chemical plants, waste and wastewater treatment plants, paper and timber industries);
- Accommodates available data on releases from diffuse sources (*e.g.,* transport and agriculture);
- Has limited confidentiality provisions; and
- Allows for public participation in its development.

Source: www.unece.org/env/pp/prtr.ng.htm

In OECD countries, an important function is played by self-monitoring and self-supervision and reporting by enterprises. It is a mandatory requirement, which should be applied by any holder of an environmental permit. Large facilities are required to have individual programs of self-supervision that reflect their risk for the environment and their compliance history, while smaller ones can be subject to uniform requirements defined in primary and secondary legislation. The government inspection agencies undertake adequate checks of accuracy of self-monitoring systems and enforce their transparency in order to ensure the environmental integrity of self-supervision. Public review of self-supervision must also be enabled. Kazakhstan has initiated an analysis of opportunities of self-monitoring and self-supervision protocols within the framework of an OECD EAP Task Force[31]. Follow up of these pilot efforts is encouraged.

4.12. Conclusions

The analysis shows that while Kazakhstan has made commendable progress in modernizing its post Soviet regulatory and institutional framework for environmental management, these reforms are not sufficient to effectively mitigate environmental conflicts associated with

[31] OECD EAP Task Force, Modernizing Environmental Self-Supervision in Kazakhstan: Policy Recommendations, Draft September 2005, ENV/EPOC/EAP/POL(2005)4/REV1

rapidly growing new industries, such as petrochemicals. The present mix of environmental policy instruments is designed to allow certain levels of emissions and discharges by enterprises without incentives to encourage pollution prevention, minimize the impact on environment as a whole or to continuously improve environmental performance. In fact, the present policy instruments have failed to fulfill their stated objective – they have not ensured safe levels of pollution in air, waters and soils, hence they have not effectively protected the environment from industrial pollution. They also do not improve the domestic climate for new investments. In particular, they may deter reputable high profile investors who are serious about their corporate responsibility image.

The key problem seems to be an environmental permitting system inherited from Soviet regulatory framework (State Environmental Review). It is perceived by enterprises and by most policy makers as one more bureaucratic constraint to economic activities rather than a tool that helps industrial operators to identify better technology and management approaches to improve overall plant efficiency and prevent adverse environmental impact.

The present permitting system is cumbersome, not transparent and difficult to enforce. It triggers improvised ad hoc solutions, such as rolling temporary emission limits, or environmental fee waivers and offsets, which opens a room for corruption. This situation adversely affects the investment climate and introduces uncertainty to investment decisions. The unpredictable regulatory framework may deter some reputable strategic investors who are very sensitive to keeping a socially and environmentally responsible business image.

Environmental fees that are complementing environmental permitting are not providing incentives to reduce pollution. Instead, they provide opportunities for government officials to extract rents from industry in non-transparent ways. They are designed as additional taxes to raise revenues to local budgets, although they seem to be inefficient fiscal instruments. Enterprises perceive them as such and as an opportunity for corruption.

Non-compliance fines do not deter non-compliance and do not encourage enterprises to prevent pollution and take precautionary approaches. Moreover, they provide perverse incentives as an instrument to "purchase" the right to violate the law and circumvent liability for damages. Therefore, accidental pollution spills are relatively frequent, causing damages with costs that are several times higher than the fines paid for non-compliance.

The environmental liability regime is inadequate. This may be a serious gap in the regulatory framework if the country considers the growth of potentially hazardous industrial activities. The Law on environmental insurance has been submitted to the Parliament. However, it may put a misplaced focus on a particular financial security instrument rather than on the establishment of a clear regime of civil liability for environmental damage, supported by quick and effective execution through the courts system. Moreover, the mandatory characteristic of the insurance envisaged in the new Bill raises the question of availability at reasonable costs and on conditions of insurance in Kazakhstan.

The authorities and the public do not have sufficient and relevant environment information for decision making.

As a result of inadequate design of policy instruments, the environmental regulations are poorly enforced. Violations of permit conditions, serious industrial accidents are common. Enforcement agencies are not effective.

The Ministry of Environment has recognized several shortcomings of the post-Soviet regulatory system and has already undertaken commendable steps towards reforms (e.g., self-environmental monitoring by enterprises, voluntary integrated permits, financing of enforcement agencies). Most of these reforms, however, have experimental characters. What investors need are not experiments but a predictable regulatory framework for environmental requirements and clear incentive structure during the lifetime of their investments.

5. Recommendations and ways forward

The way forward with reforms will need to be based on the following principles:

- High, but reasonable level of environmental protection (in particular, preventing risk to human health and to irreversible damage to high value environmental resources);
- Transparency and participation;
- Efficiency (bureaucratically simple, low administrative and transaction costs, encouraging low-cost measures to achieve environmental objectives);
- Consistency (different regulatory instruments must not contradict each other and must not erratically change);
- Predictability and stability of "rules of the game";
- Incentives for prevention of pollution, for precautionary actions, for compliance with standards, integrated solutions, and continuous improvement of environmental performance;
- Improvement of investment climate for reputable strategic investors;
- Improvement of long-term international competitiveness of industry based in Kazakhstan; and
- Facilitating access of Kazakh products to high quality export markets.

For the purpose of mitigating and preventing negative environmental impacts of petrochemical and similar industries, it is recommended to begin from reform of permitting and enforcement systems. According to international experience, economic instruments are not the first-best instruments to prevent and control relatively hazardous pollutants in relatively small sectors. The permitting and enforcement reform priorities could consist of:

- Aligning Maximum Allowable Concentration (MAC) standards with internationally accepted ambient quality standards, including annual quality standards; and
- Gradual, but consistent with environmental permitting system modeled after EU IPPC approach, replacing the current State Environmental Review:
    - (i) Treating Maximum Allowable Concentrations (MACs) as policy objectives and not the source of individual permit requirements;
    - (ii) Deriving permit requirements, including maximum permissible emission limits, from best available environmental performance standards, technologies and practices of design, operation and decommissioning of industrial operations (Best Available Techniques BAT), rather than from MACs;
    - (iii) Developing sector-specific technical guidelines for permitting authorities and for plant operators – benchmarks and references for Best Available Techniques tailored to Kazakhstan conditions. These technical guidelines should be periodically revised (e.g., every 5 years) to trigger technological and management improvements. They should also contain indicators of costs of various BAT approaches and schedules for implementation of BAT approaches in new and existing installations;

(iv) Integrated approach to avoid transfers of pollution between media and to consider also energy efficiency, input management, good house-keeping and decommissioning;

(v) Improvement of monitoring protocols and equipment (PRTR for waste, greater reliance of self-monitoring by enterprises, targeted strengthening of technical base for ambient monitoring system of state laboratories for most hazardous pollutants to air, water and soil);

(vi) Streamlined enforcement and compliance assurance, including measures to reduce incentives for corruption and rent seeking;

(vii) Differentiated approach to different plants (e.g., integrated permits for the largest installations and simpler requirements for SMEs);

(viii) Issuing permits for "installations" and not for individual stacks in enterprises

(ix) Involving the industry, citizens, NGOs and environmental inspection in the process of environmental impact assessment, as well as in designing and monitoring environmental permits;

(x) One stop-shop for environmental permitting; and

(xi) Public registry of non-confidential permit conditions and compliance status.

These reforms will not have to be implemented at once. International experience shows that a step-by-step process usually takes 2-4 years to lay the basic legal and regulatory framework. Establishing and building capacity of institutions may take even longer. Coverage of sectors can be gradual and can take many years for all the relevant industrial installations. Piloting transition with certain sectors and industrial champions help to make the transition smoother and friendly to stakeholders. Petrochemical plant developers may be interested to serve as a model and pilot for modern environmental management reform tailored to the specifics of a sector. The list of priority reforms and their sequencing is proposed below (table 20).

The World Bank can help with TA activities to prepare and implement selected priority reforms. Assistance can include short term and medium term activities. The short term assistance can consist of study tours, training and preparation of action plan for representatives of the Ministry of Environment and environmental inspectorates. Analytical work on strategies and roadmaps for reforms of regulatory and enforcement framework towards integrated, BAT-based permits can also be conducted in the short run. This may include identification of pilot sectors and installations for implementation. In the medium term, the Bank can assist in transposing of good practices in integrated legal and institutional framework for integrated environmental permitting to Kazakhstan and tailoring it to local situation. A more detailed action plan and road map for the recommended priority reform of environmental permitting is presented in annex 1.

Table 20: Priorities and sequencing of reforms to strengthen policy incentives to prevent and control pollution from rapidly growing industries in Kazakhstan

	Task	Importance	Urgency	Sequencing issues
(1)	Gradually replace MAC-based environmental permits by BAT-based integrated permits for selected largest and most hazardous industrial installations	High	High	Right permit is a key instrument of environmental policy.
(2)	Monitoring system (emissions and ambient quality)	High	High	Continued imperfect information will undermine other reforms. PRTR is particularly urgent.
(3)	Strengthen enforcement agencies	High	Medium	Continued expectations of lax enforcement will undermine all other reforms.
(4)	Introduce strict civil liability regime for environmental damages with credible sanctions proportional to the value of damages	High	Medium	Without clear and enforceable liability – no incentives to prevent accidents
(5)	Replace routine non-compliance fines with sanctions that deter non-compliance	High	Medium	Not urgent if (4) works well
(6)	Harmonize environment quality standards (MACs) with the international benchmarks (e.g., World Health Organization)	Medium	Medium	Not urgent if permits linked to BAT
(7)	Streamline environmental fee system by abolishing at least 90% of them and redesigning those which are supposed to provide incentives to economic agents.	Medium	Low	If other instruments work properly, fees are not essential to provide incentives to petrochemical enterprises.

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26. Report of the Committee of Water Resources of the Republic of Kazakhstan

27. Articles of the Ministry of Environment Protection in magazines and mass media (2003 -2005)

Annex 1. Roadmap for introduction of integrated environmental permitting system

i. ***Drafting the program document of the Government on Pollution Prevention and Control in Kazakhstan.*** " The document will be developed by the Ministry of Environmental Protection in cooperation with the Ministry of Economy and the Ministry for Oil and Gas as appropriate. It will describe the rationale and objectives of transition to the integrated environmental permitting regime. The program should also include the description of the key elements of a new system, analysis of changes facing various stakeholders and the implementation plan. The document will also contain the program of legal consolidation and analyses of the scope of changes needed in other legal and regulatory acts. The document (of a "White Paper" type), which may be built upon the work of the OECD/EAP Task Force, will be subject to reviews and consultations with all stakeholders, including line ministries, the Parliament, regional and local governments, NGOs, academia and, above all, the industry. Drafting and consultations of the program will be coordinated by the integrated permitting working group or organizational unit to be established within the Ministry of Environmental Protection. It is advisable to also establish the government agency subordinated to MoE – a BAT Technical Centre. Following consultations, the government program would be submitted to the Cabinet for endorsement.

ii. ***Conducting an inventory and building electronic data base of installations that fall under the scope of integrated permitting and public registry of permits***. Judging by experience of other industrialized countries and relative size of Kazakhstan industry, between 300 and 500 industrial installations in Kazakhstan may be subject to integrated permits. Database and public registry will be needed for environmental authorities to facilitate monitoring of permit conditions and enforcement, as well as for the public to ensure transparency, integrity and additional compliance assurance.

iii. ***Introducing legal and regulatory changes enabling integrated environmental permitting.*** Detailed legal and regulatory assessments will be conducted. The major output of this task will be a detailed strategic action plan for the legal and regulatory changes, including proposed amendments to the law on Environmental Protection and other legislative acts as appropriate. A bundle of secondary regulations need also to be prepared to ensure effective implementation. Following public consultations on the government strategy (the "White Paper"), legal experts will analyze and describe the key pieces of primary and secondary regulation for the introduction of integrated permitting for large industrial installations and a simplified permitting regime for the rest of the regulated community. New legal and regulatory framework will need to systematically define and codify all the relevant concepts and general building blocks of environmental permits for different types of installations (e.g., large and small, existing and new). It will also need to define the allocation of permitting responsibilities and the key agents in the permitting procedure. The proposed legal reform package will be subject to a round of wide stakeholder consultations.

iv. ***Drafting procedural guidelines.*** These tools will be developed for both integrated and simplified permitting regimes in a form of implementing regulations. They will represent a toolkit for the permitting authorities and for industry, including permitting procedures, application and permit forms. They will be consistent with Kazakhstan's regulatory framework and good international practice.

v. ***Training in integrated environmental permitting for the MEP central office staff, regional (Akhim) permitting officials and enterprise environmental managers.*** The new permitting regime will require a significant change of the way environmental authorities do business in Kazakhstan. The establishment of new Permitting Departments is envisaged in the MEP and in oblast (Akhim) environmental agencies. Oblast agencies will be charged with demanding responsibilities to negotiate and issue most integrated permits. New responsibilities will require a set of new technical and procedural skills for permitting officers. Training program for government staff will augment skills in technique-based permitting, including procedures of negotiating and issuing of integrated permits, evaluation of alternative approaches to pollution prevention and control, determination of BAT for Kazakhstan, integrated approach to setting emission limit values, identification and evaluation of options for efficient use of energy, water, and other resources, accident prevention, etc. Training for enterprise managers will augment skills in new permitting procedures and in identification and evaluation of Best Available Techniques in Kazakhstan conditions. To the extent possible, available training materials for institutional strengthening related to the implementation of the EU IPPC Directive in the new EU Member States and in other post-Soviet countries will be used to build the curriculum.

vi. ***Developing and publishing pilot technical guidance notes for priority industrial sectors.*** For the selected priority industrial sectors (e.g., petrochemicals), detailed technical guidance notes will be prepared by adjusting the existing EU BREFs (Best Available Technique reference documents) to Kazakh conditions. The aim of these notes will be to offer information to Kazakh permitting authorities, industrial operators, foreign investors and the public at large to guide the determination of BAT-based permit conditions and general rules. They will not interpret the permitting laws, nor will they remove the obligations on operators and permitting authorities to make decisions on specific permit conditions. These pilot technical notes will serve as models for Kazakhstan to develop similar technical guidance for other sectors that will be covered by the integrated permits.

vii. ***Conducting stakeholders consultations, information and dissemination campaign.*** The main outputs will be public hearings and workshops, involving enterprises, industry associations, NGOs, inspectorates, other government stakeholders, publications and promotional materials on the new permitting regime.

Table A1.1: Timetable for preparation and introduction of integrated environmental permits in Kazakhstan

Task	Responsible bodies	Cooperation with Other Stakeholders	2006				2007				2008				2009				2010-2012	2013-2015
			Q1	Q2	Q3	Q4	Q1		Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4		
Establish Interagency Task Force on Integrated Environmental Permitting	MEP, MIP, MAP, MFE	MH, MF, other relevant government agencies																		
Develop general strategy and scope of integrated permitting	KHM, MEP	Other stakeholders (including industry)																		
Identify legal, institutional and information requirements of the new permitting system	KAZHM, MEP	Stakeholder consultations																		
Prioritize sectors for integrated permitting and prepare transition plan for industry	KAZHM, MEP	Other agencies, industry associations																		
Draft the Program of the Government on Pollution Prevention and Control in Kazakhstan	MEP	KAZHM, Industry associations																		
Build electronic data base of installations that fall under the scope of integrated permitting	MEP, MIP	Enterprises																		
Political approval of the Program on Pollution Prevention and Control in Kazakhstan	Cabinet of Ministers	Interagency and stakeholders																		
Establish institutions: e.g., Permitting Department in MoE, BAT technical center	MEP, PA	Other relevant agencies, research institutes																		
Conduct legal and regulatory assessment and prepare strategic action plan for the legal and regulatory changes	MEP	Stakeholders																		
Prepare, consult and adopt procedural guidelines	MEP	Stakeholders																		
Develop/adjust technical BAT guidance notes for petrochemical sectors	KAZHM, BAT Centre	MIP, MAP, industry associations, experts																		
Develop pilot permit applications and issue pilot permits	MEP, PA	Industry, NGOs																		
Public consultations	MEP	Other agencies, industry associations, experts																		
Training	MEP, PA	IPPC Centre, MoE, Oblast authorities																		
Prepare and establish national permit register	MEP, PA																			
Prepare BAT technical guidance notes for other sectors	BAT Centre	MEP, KAZHM, industry , experts																		
Requirements for new installations to obtain permit prior operation come into force	PA	Industry																		
Introduce integrated permits for existing installations	PA	Industry																		

Annex 2. Selected relevant legal and regulatory documents

Selected laws relevant to managing environmental impact of petrochemical industry:

- The Act of the Republic of Kazakhstan “On Environmental Protection”, 1997
- The Act of the Republic of Kazakhstan “On State Environmental Review” No. 85-1, 1997
- The Act of the Republic of Kazakhstan “On Protection of Atmospheric Air”
- The Act of the Republic of Kazakhstan 8 July 2005, no 71 amending existing laws on issues related to environmental audit.
- The Act of the Republic of Kazakhstan “On Emergency Situations of Natural and Technical Character”
- The Act of the Republic of Kazakhstan “On Specially Protected Natural Territories”
- The Act of the Republic of Kazakhstan “On Energy Efficiency”
- The law of Republic Kazakhstan от10 February, 2003 N 389 “On accession of Republic Kazakhstan to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal”.
- Decree of the President of the Republic of Kazakhstan “On Mineral resources and their Management”
- Decree of the President of the Republic of Kazakhstan “On Oil”

Secondary regulations:

- Technique of definition of payments for environmental contamination, authorized by the order of Minister of Environmental Protection of the Republic Kazakhstan from 2005 № _161-p
- The order of Minister of Environmental Protection of Republic Kazakhstan from February, 28, 2004 N 68-P, "Instruction for the environment impact assessment of planned economic activities during pre-planning, pre-design and design documentation development stages" (effective March, 31, 2004 N 2779)
- The decision of the Government of Republic Kazakhstan from January, 8, 2004 N 19 "On the List of ecologically dangerous economic activities and rules for their obligatory licensing by the State"
- The decision of the Government of Republic Kazakhstan on a proposed bill of Republic Kazakhstan about amendments of the Act of Environmental Protection on the issues related to waste products of manufacturing and consumption (14 November 2003)
- The decision of the Government of Republic Kazakhstan from October, 8, 2003 N 1039 "On certain issues related to licensing of environmental design works, normalization and Environmental Expertise"
- The decision of the Government of Republic Kazakhstan from August, 14, 2003 N 815 "On the rules of the organization and carrying out the state control of protection of atmospheric air"
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- Manual for the clients and engineers of pre-project and project documentation on the organization of study and registration of public opinion during the EIA.

Annex 3. EU Directive on discharges of certain dangerous substances to water

Council Directive 76/464/EEC of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community. Since there are thousands of petrochemical processes, many compounds of the I and II lists can be found in the sector. For example, molybdenum can be found in the wastewater generated by the production of styrene monomer when a specific technology is applied. In many cases, due precaution applied in petrochemical process management allows to avoid the discharges of substances listed in this Directive. Attention is always required for mineral oils (item no. 7 on List I). Since the list number I stipulates zero emissions, other components such as organohalogen compounds need attention too, since they include chlorinated solvents which are largely phased out Europe but can still be used in other countries for degreasing metal surfaces.

List I (zero emission) of families and groups of substances:[32]

1. Organohalogen compounds and substances which may form such compounds in the aquatic environment
2. Organophosphorus compounds
3. Organotin compounds
4. Substances which have been proven to possess carcinogenic properties in or via the aquatic environment
5. Mercury and its compounds
6. Cadmium and its compounds,
7. Persistent mineral oil and hydrocarbons of petroleum origin
8. Persistent synthetic substances which may float, remain in suspension or sink and which may interfere with any use of the waters

List II (reduced emission) of families and groups of substances

- Biocides and their derivatives not appearing in list I
- Substances which have a deleterious effect on taste and/or smell
- Toxic or persistent organic compounds of silicon
- Inorganic compounds of phosphorus and elemental phosphorus
- Fluorides
- Ammonia and nitrites

And the following metalloids and metals and their compounds:

- Zinc; Selenium; Tin; Vanadium
- Copper; Arsenic; Barium; Cobalt
- Nickel; Antimony; Beryllium; Thallium
- Chrome; Molybdenum; Boron; Tellurium
- Lead; Titanium; Uranium; Silver

[32] Limit values and quality objectives for discharges of the substances from the list I are set in the COUNCIL DIRECTIVE of 12 June 1986 (86/280/EEC)

Annex 4. State of environmental monitoring system

Table A4.1: Atmospheric air

			Atmospheric Air																				
			Sampling stations	Dust	SO2	NO	NO2	CO	CO2	NH3	H2S	H2SO4	SO4(2-)	HF	Phenol	Formaldehyde	Cl2	HCl	As	Cd	Cu	Pb	Zn
1	Monitoring Centre, Astana region																						
	Astana city		2	+	+		+	+		+		+	+	+									
2	Almaty city and Almaty region																						
	Almaty		3	+	+	+	+	+		+	+				+	+							
3	Aktyubinsk Monitoring centre		3	+	+	+	+	+			+					+							
4	Atyrau Monitoring centre																						
	Atyrau		2	+	+		+			+	+												
5	East-Kazakhstan Centre																						
	Ust-Kamenogorsk		5		+		+	+					+		+	+	+		+	+	+	+	+
	Ridder		2	+	+		+	+							+	+			+				
	Semei		2	+	+		+	+							+								
	Glubokoye		1	+	+		+								+	+			+				
6	Karaganda Centre																						
	Balkhash		2	+	+		+	+					+										
	Zhezkazgan		2	+	+		+	+					+		+								
	Karaganda		4	+	+	+	+	+		+	+		+		+	+							
	Temirtau		2	+	+		+			+	+		+		+								
7	Kostanai Centre																						
	Kostanai		2	+	+		+	+															
8	Kyzylorda Centre	sampling	1																				
9	Mangystau Centre																						
	Aktau		1	+	+		+	+		+		+	+										
10	Pavlodar Centre																						
	Pavlodar		2	+	+		+	+			+		+		+		+	+					
	Ekibastuz		1	+	+		+	+					+										
11	North-Kazakhstan Centre																						
	Petropavlovsk		2	+	+		+	+					+		+	+							
12	West-Kazakhstan Centre																						
	Uralsk		1		+		+				+												
13	Zhambyl Centre																						
	Taraz		4	+	+	+	+	+		+			+	+		+							
14	South-Kazakhstan Centre																						
	Shymkent		4	+	+		+	+		+	+			+		+							

Table A4.2: Water environmental monitoring system in Kazakhstan

			Water																				
			Sampling stations	Sampling sites	BOD-5	COD	Mineralization	Hardness	As	Be	Cd	Cu	Cr total	Cr (IV)	Cr (VI)	Fe total	Fe (II)	Fe (III)	Hg	Mg	Mn	Pb	Zn
1	Monitoring Centre, Astana region																						
	Astana city		17	26	+	+	+					+			+	+				+	+		
2	Almaty city and Almaty region																						
	Almaty		20	25	+	+						+				+					+		
3	Aktyubinsk Monitoring centre		6	9	+	+	+					+		+									
4	Atyrau Monitoring centre																						
	Atyrau		0																				
5	East-Kazakhstan Centre		13	24	+	+			+	+	+	+	+	+	+	+	+	+	+		+		+
	Ust-Kamenogorsk																						
	Ridder																						
	Semei																						
	Glubokoye																						
6	Karaganda Centre																						
	Balkhash		8	12	+		+					+				+				+	+		
	Zhezkazgan													+									
	Karaganda		11	14										+									
	Temirtau													+									
7	Kostanai Centre																						
	Kostanai		7	8	+	+		+				+	+			+	+			+	+		+
8	Kyzylorda Centre	sampling	3	4				+				+	+		+	+				+			+
9	Mangystau Centre																						
	Aktau		0																				
10	Pavlodar Centre		4	6	+	+			+	+	+	+	+	+	+	+	+	+	+		+		+
	Pavlodar																						
	Ekibastuz																						
11	North-Kazakhstan Centre																						
	Petropavlovsk		5	6	+											+	+			+			
12	West-Kazakhstan Centre																						
	Uralsk		7	9	+		+				+		+			+				+	+	+	+
13	Zhambyl Centre																						
	Taraz		6	7	+	+	+					+				+	+						+
14	South-Kazakhstan Centre																						
	Shymkent		11	12				+				+	+		+	+				+			+

Annex 5. Water resources and water pollution in different regions

Table A5.1: Water use in Kazakhstan by oblast and by sector

Oblast in Kazakhstan	population*, thous.people	rural population*, thous. people	Water Intake**		Water Consumption**							
					Total		for domestic needs		for industrial needs		for rural water supply	
			mln.m^3/year	m^3/year/people	mln.m^3/year	m^3/year/people	mln.m^3/year	m^3/year/people	mln.m^3/year	m^3/year/people	mln.m^3/year	m^3/year/people
Republic of Kazakhstan	14,570.0		21,856.0	1,500.1	15,157.0 100.0%		601.0 4.0%	41.2	3,983.0 26.3%	273.4	10,573.0 69.8%	725.7
Aktobe oblast	669.7	300.8 44.9%	231.0	344.9	181.0 100.0%	270.3	28.0 15.5%	41.8	20.0 11.0%	29.9	133.0 73.5%	198.6
Atyrau oblast	450.2	187.6 41.7%	245.0	544.2	154.0 100.0%	342.1	15.0 9.7%	33.3	91.0 59.1%	202.1	48.0 31.2%	106.6
West-Kazakhstan oblast	602.6	351.8 58.4%	748.0	1,241.3	287.0 100.0%	476.3	17.0 5.9%	28.2	9.0 3.1%	14.9	261.0 90.9%	433.1
Karaganda oblast	1,350.8	374.7 27.7%	1,305.0	966.1	1,354.0 100.0%	1,002.4	79.0 5.8%	58.5	1,249.0 92.2%	924.6	26.0 1.9%	19.2
Mangystau oblast	332.4	94.5 28.4%	663.0	1,994.6	670.0 100.0%	2,015.6	14.0 2.1%	42.1	653.0 97.5%	1,964.5	3.0 0.4%	9.0
Pavlodar oblast	758.9	244.7 32.2%	2,587.0	3,408.9	2,256.0 100.0%	2,972.7	39.0 1.7%	51.4	1,466.0 65.0%	1,931.7	751.0 33.3%	989.6
South-Kazakhstan oblast	2,045.4	1,316.3 64.4%	3,778.0	1,847.1	2,657.0 100.0%	1,299.0	40.0 1.5%	19.6	33.0 1.2%	16.1	2,584.0 97.3%	1,263.3

Sources:
*Rural Development in Kazakhstan: Issues and Perspectives. National Report on Human Development, UNDP, 2002

Atyrau Oblast[33]

Table A5.2: Water stress indicator for Atyrau Oblast (1990-2002)

	Renewable resources of fresh water, mln.m^3/year	Current water use, mln. m^3/year	Load on the water resources, %*	Main reasons or sources of the load
1. Surface water, including:				
Ural River	1,390.0	276.3	19.9% low stress	Agricultural and pond farms (51%), industry (37%) and public utilities (12%)
Volga delta (main pipeline)		20.8		
Small rivers	700.0	33.8	5% no stress	
2. Groundwater	47.5	23.8	50% Severe stress	Natural limitation of the available fresh water
3. Other water sources, including:				
Return water		13.6		Fishing plants Atyraubalyk
Recycled water and water of sequential use		180.0		

The load on the surface sources of water supply in the Atyrau Oblast is 17 percent and assessed as low stress, on the groundwater is 50 percent and assessed as severe water stress. Key measures for reduction of the load on water supply sources in the Atyrau Oblast include the following:

- Discharge of standard pure water back to the sources (rivers)
- Use of recycling water supply (37 percent of the total water use for industrial needs)
- Use of return water
- Pumping of the discharged industrial water to the underground beds.

Available and Forecasted Water Resources

Surface Water Resources

91.1 percent of oblast water needs is mainly satisfied by the surface water. It includes 89.0 percent of water taken from the Ural, Kigach and Sharonovka (Volga's delta) Rivers. The water intake from the Caspian Sea is 2.1 percent.

The Ural River is the only unregulated river in the midstream and downstream of the Caspian basin which determines its immense fishery role in the region, as it allows to maintain a full structure of the sturgeon population migrating to the river for spawning.

The average long-term water inflow into the Ural River on the oblast territory is estimated at 10,690 million m^3/year including 1,580 million m^3/year being formed at the territory of

[33] When comparing the data, several inconsistencies were found between the official statistics data and actually existing contamination of the water sources. For several regions, there is no data on the discharge of contaminating substances, although there is a reported high level of contamination. The existing situation is likely caused by the fact that water pollution control is carried out by different state agencies. For example, the quality of Transboundary Rivers and large lakes is controlled by the Regional Departments of the State Hydro-Meteorological Service, while the quality of the local surface water resources is controlled by the Sanitary-Epidemiological Services of the Health Protection Committee. The Geology Committee of the Ministry of Energy and Natural Resources controls quality of the underground water and quality of the wastewater and condition of the evaporation fields is controlled by the Territorial Departments of the Ministry of Environment Protection. There is a certain form of state reporting and data transfer to the national statistics bodies. However, there is no uniform monitoring database for the water supply sources. The data is not coordinated and belongs to different agencies, which makes it difficult to obtain it and analyze when carrying out the impact assessment.

Kazakhstan. Besides, 1,390 million m^3/year (13 percent of the total runoff volume) is consumed and lost, and 9,300 million m^3/year is then discharged to the Caspian Sea. During the high-water periods (1990, 1993, 1994) the total river runoff to the Caspian Sea varied within 13,100-15,900 million m^3/year [4].

Underground Water Resources

As a whole, Atyrau Oblast is located in unfavorable natural and hydro-geological conditions for formation of good-quality underground water (except for the eastern part of the oblast). The total value of the estimated regional useful resources is 378 million m^3/year [**11-13**]. Out of this value, water with mineralization level not exceeding 3 g/dm^3, which can be utilized for operation, is estimated at the level of up to 190 million m^3/year. Given the oblast economic profile, only 25 percent (about 47 million m^3/year) can be utilized for the public and industrial water supply.

Water Use and Discharge (surface and underground water)

Water Use

The average long-term total intake of fresh water in the oblast [4] is 430.0 million m^3/year, including: 403.3 million m^3/year – river water, where about 70 percent of water comes from the Ural River. Since 2000, water intake from the natural sources has remained at the level of 240-245 million m^3/year. During transmission within the oblast, water losses were estimated at 36-40 million m^3/year [3]. Maximum volumes of water intake from the natural sources exceeding the average annual indicator (472.4-763.3 million m^3/year) occurred during 1990-1994. The following decade was characterized by the indicators which were lower than the average long-term indicator by 3 times.

The average long-term indicators of groundwater intake are estimated at the level of 23.8 million m^3/year.

Generally, in 1990-2002, the use of fresh water for industrial needs remained at the level of 63-76 million m^3/year, and in 2003 it increased to 91 million m^3/year. 15 million m^3/year is steadily used for domestic drinking needs. 403 million m^3/year was used for irrigation, watering and agricultural water supply in 1990, 160 million m^3/year in 1995, and starting from 2000 this indicator decreased to the level of 48-74 million m^3/year.

Water Discharge

On average, 32.8 million m^3 of water is annually discharged in the oblast to fields for evaporation, to rivers or pumped to the underground beds. If in 1990-1993 up to 85-89 percent of wastewater was discharged to the fields for evaporation and 10-14 percent of standard pure water was discharged to the rivers, starting from 2000 discharge into the rivers increased up to 35-40 percent and the volume reached 9-14 million m^3/year.

In the oil production districts 74.2 percent of discharge from industrial enterprises and public utilities is transported to the fields for evaporation. Currently, reverse pumping of discharged water to the underground bed is introduced at the oil fields. Their volumes are up to 1.4 million m^3/year or 1.9 percent of the total discharge volume.

Load on the Water Supply Sources and Existing Policies and Measures for Its Reduction

According to the approaches of the European Agency for Environmental Protection, the indicator of the water supply deficit is the ratio of the annual water use to the total renewable resources. Based on the given data, load on the surface sources of water supply in the Atyrau Oblast is 17 percent and assessed as small, on the groundwater is 50 percent and assessed as heavy.

Key measures for reduction of the load on water supply sources in the Atyrau Oblast include the following:

- Discharge of standard pure water back to the sources (rivers)
- Use of recycling water supply (37 percent of the total water use for industrial needs)

- Use of return water
- Pumping of the discharged industrial water to the underground beds.

Quality of the Surface and Underground Water

Water resources of the rivers are used in all the sectors of the national economy in the Atyrau Oblast, which causes their pollution with fertilizers, and waste of industrial enterprises, public utilities and cattle-breeding farms.

Historically, the Ural River basin was characterized as polluted based on the water quality indicators. During 1990-2000, water pollution index (WPI) varied from 4,5 to 8,7. Such major pollutants as metals (copper – up to 0.012 mg l^{-1}, zinc – up to 0.08 mg l^{-1}, chrome – up to 0.004 mg l^{-1}, manganese – up to 0.047 mg l^{-1}) as well as the oil products (up to 0.65 mg l^{-1}), phenols (up to 0.005 mg l^{-1}), Synthetic Surfactants (SS) (up to 0.23 mg l^{-1}) part of which entered into the water in the river upstream beyond the territory of the Atyrau Oblast. In various years, the quality of river water within Atyrau City varied from class 5 (polluted) to class 3 (moderately polluted).

From 2001-2003 the Ural River within the territory of the Atyrau Oblast was characterized as pure based on the water quality (class 2, WPI=0.73-0.79). Standard indicators of the water quality were as follows: BOD_5 – 2.5, nitrites – 0.05-0.15, oil products – 0.03-0.07 mg l^{-1} (1.4 MAC), phenols – 0.0018 mg l^{-1} (1.8 MAC). During the flood period, increase of nitrite concentration up to 2.5 MAC was observed [**10**].

The same indicators characterize the water quality of the Caspian Sea in various years within the Atyrau Oblast: chrome concentration increase (up to 0.04 mg l^{-1}), iron (up to 0.028 mg l^{-1}), manganese (up to 0.081 mg l^{-1}), oil products (up to 0.56 mg l^{-1}), phenols (up to 0.02 mg l^{-1}).

Analysis of the impact of polluted surface and underground water on the quality of drinking water and population health, as well as on the local economy (agriculture, fishery, manufacturing)

Based on the data of the Statistics Agency of RK [3], the situation in the Atyrau Oblast looks as follows:

- Proportion of the population provided with tap water is 62-66 percent, which is lower than the overall republican indicator by 10 percent.
- Proportion of the population provided with drinking water from decentralized water supply sources is in average 4.5 percent.
- Specific weight of the water samples, which do not correspond to the quality standards based on sanitary-chemical and microbiological indicators, is 2.0-3.4 percent for centralized and 7.1-9.2 percent for decentralized water supply sources.

In 2000, UNESCO/UNDP mission was undertaken to evaluate drinking water in the Atyrau Oblast [**14**]. The mission experts noted a very poor condition of the drinking water sources in rural settlements: virtually their total lack. People living nearby the Ural River use river water almost without any treatment. Well digging is not possible due to very loose soil and high salinity.

Mangystau Oblast

Table A5.3: Water stress indicators for Mangystau Oblast (1990-2002)

	Renewable resources of fresh water, mln.m^3/year	Current water use, mln. m^3/year	Load on the water resources, %*	Main reasons or sources of the load
1. Surface water, including:				
Sea water	Desalination	658.1	0% no stress	Industry (88.7%)
Volga delta (main pipeline)	30.0	7.66	25.5% Stressed	
Small rivers	not available	-	-	
2. Groundwater	100.0	31.5	31.5% stressed	Natural limitation of the available fresh water
3. Other water sources, including:				
Return water		0.0		
Recycled water and water of sequential use		4.62	-	

The load on the surface sources of water supply in the Magystau Oblast is estimated from non-stress (0 percent on the Caspian Sea) to stressed (25.5 percent on the Kigash-Mangistau pipeline), as for the groundwater, the load is also stressed (31.5 percent). Key measures for reduction of the load on water supply sources in the Mangystau Oblast include the following:

- Standard pure water after sea water desalination and water used for cooling at TETs-1.2 and TETs-3, MAEC RSE is discharged to the Caspian Sea.
- Starting from April 2001, after primary treatment wastewater from the city treatment facilities is directed to the Koshkar-Ata tailing dump.

Existing and forecasted water resources

Surface water resources

Mangystau Oblast is the only one in Kazakhstan where the sea water (94 percent) is the main water source. About 93 percent of the total volume of the sea water intake in the oblast center (up to 1 million m^3 annually) is used for drinking water production. A significant volume of water is used to cool technological equipment of MAEC RSE and other facilities.

The other source of the surface water resources is the Kigash River (tributary of Volga). To supply water to refineries and population during the Soviet period, **Kigash-Mangistau main pipeline** was constructed. It is 1,041 km long and at present it is managed by the Kaztransoil Company. The volume of the pumped water along the total length of the pipeline is 51 million m^3/year, including 20.8 million m^3/year used on the Atyrau Oblast territory. The quality of water pumped through the pipeline is technical. Water for drinking needs is treated directly by the consumer. At present, the pipeline is in the working condition.

Underground water resources

Despite unfavorable climate conditions, the Mangystau Oblast possesses substantial estimated regional useful resources of groundwater. The total amount of the estimated regional useful resources is 662 million m^3/year. Out of this amount, water with the mineralization level not exceeding 3 g/dm^3, which can be utilized, is estimated at the level of up to 315 million m^3/year, including 60 percent or 180 million m^3/year for industrial water supply [**13**]. As of January 1, 2001, the approved groundwater reserves in each category amounted to 100 million m^3/year.

Water use and discharge (surface and underground water)

Water use

Main sources of water supply in the Magystau Oblast are: sea water (94 percent), ground water (5.0 percent) and Volga water (1 percent) [5]. In recent years (2000-2004), water intake in the oblast varied within 627-694 million m^3/year, which is lower than the level of 1990-1995 by 2-2.5 times, when it was 1,200-1,800 million m^3/year.

Desalinated sea water is used for domestic-drinking and industrial needs of the oblast. Maximum consumption of the sea water falls at Aktau City – 634.8 million m^3/year (95.6 percent). The following enterprises use sea water and desalinate it: Mangyshlak Power Complex RSE (MAEC) (623.0 million m^3/year, level of 2002), Uzenmunaigaz OJSC and Mangystaumunaigaz OJSC (now departments of Kazmunaigaz-Exploration and Extraction CJSC) (22.6 million m^3/year, level of 2002), as well as Bauta water desalinating plant (0.081 million m^3/year) and Kalamkasmunaigaz Production Division (0.144 million m^3/year) [5].

Use of fresh water for industrial needs, for example in 2004, amounted to 653.0 million m^3/year or 97.5 percent of the total water intake. Water use for domestic-drinking needs remains at the level of 12-21 million m^3/year (2.1-2.8 percent, 2.9-3.4 million m^3/year (0.4-0.5 percent) is used for agricultural needs, including irrigation and grassland watering. At the same time, a high level of unaccounted flow and losses of water is observed, which amounts to 55 million m^3/year (8.1 percent) based on the average data for 1999-2002, though based on the official data of the Statistics Agency of RK water losses during transmission within the Mangystau Oblast are estimated at 2 million m^3/year [3, 5].

One of the promising methods of water use in the oblast is **water reuse and recycling**. As for water recycling, produced oil-field water is mainly used at the oil fields. At present, use of recycled water amounts to 4.62 million m^3/year or only 0.7 percent of the total use of water for industrial needs.

Volga water, which comes through Kigash-Mangystau pipeline from the Atyrau Oblast, is mainly used for industrial and technical needs at Buzachi and Zhetybai oil fields, Kaztransoil divisions, railway stations and passing sidings from Sai-Utes station to Beineu Station. The volume of treated water used for drinking needs is 5.4 million m^3/year. It is treated by Degremon water treatment plant (Zhanaozen town).

Groundwater is used for domestic needs (9.19), in the industry (5.97), for agricultural water supply (0.504), for irrigation (0.327), for grassland watering (2.451) million m^3/year.

Water discharge

On average, 776 million m^3 of water is discharged every year in the oblast. 98.4 percent of is discharge of standard pure sea water to the Caspian Sea after its use for equipment cooling of Aktau City industrial enterprises [5].

In 2001, RSE "MAEC" used: sea water – 626.9 million m^3, underground – 7.9 million m^3. It was discharged into the Caspian Sea: standard pure water – 589 million m^3, to fields for evaporation – 4.9 million m^3.

Starting from April 2001, after treatment all the wastewater from the city treatment facilities are directed to the Koshkar-Ata tailing dump. At present, total water discharge to the evaporation fields is 10-12 million m^3/year (or 1.5-2.0 percent).

About 535 thousand m^3 of wastewater from the OJSC "Uzenmunaigas" and Uzen Gas Processing Plant is transported to the city treatment facilities of the Zhana Uzen City.

Load on the water supply sources and existing policies and measures for its reduction

Based on the given data, the load on the surface sources of water supply in the Magystau Oblast is estimated from zero (0 percent on the Caspian Sea) to average (25.5 percent on the Kigash-Mangistau pipeline). As for the groundwater, the load is average (31.5 percent) (table a5.3).

Key measures for reduction of the load on water supply sources in the Mangystau Oblast include the following:

- Standard pure water after sea water desalination and water used for cooling at TETs-1.2 and TETs-3, MAEC RSE is discharged to the Caspian Sea.
- Starting from April 2001, after primary treatment wastewater from the city treatment facilities is directed to the Koshkar-Ata tailing dump.

Quality of the surface and underground water

The long-term observations of the analytical control laboratory at the shore of Aktau City did not detect the pollution of the Caspian Sea. The main area of water protection zones is in the satisfactory condition. The greatest risk for pollution of the Caspian Sea water is represented by 23 temporarily abandoned oil-exploration wells located in the flooding and under-flooding zone at Karaturun, Komsomolskaya, Northern Karazhanbas, and Karazhanbas fields.

Underground sources pollution at the territory of the oblast is possible mainly because of the insufficiently treated and untreated wastewaters in reservoirs, wastewaters discharged to the filtration fields, etc. For example, within the location area of the reservoir and landfills for solid and liquid wastes of the Plastic Plant, underground waters are polluted with aromatic hydrocarbons.

Analysis of the impact of polluted surface and underground water on the quality of drinking water and population health, as well as on the local economy (agriculture, fishery, manufacturing)

Based on the data of the Statistics Agency of RK [3], in the Mangystau Oblast in 2001-2003:

- Proportion of the population provided with tap water is 69-71 percent, which is lower than the overall republican indicator by 5 percent.
- Proportion of the population provided with drinking water from decentralized water supply sources is 1 percent.
- Specific weight of the water samples, which do not correspond to the quality standards based on sanitary-chemical and microbiological indicators, is 4.1-9.4 percent for centralized and 3.6-9.2 percent for decentralized water supply sources.

It is planned to fully resolve the problem of water supply for the population of the Mangystau Oblast by completing reconstruction of the Kigash-Mangystau pipeline and construction of the Fetisovo-Zhanaozen pipeline with a capacity of 50 thousand m^3/day. Construction and reconstruction of pipelines, construction of water treatment facilities is envisaged. The estimated cost of the program implementation is approximately 150 million dollars.

West Kazakhstan Oblast

Table A5.4: Water stress indicators for West Kazakhstan Oblast (1990-2002)

	Renewable resources of fresh water, mln.m^3/year	Current water use, mln. m^3/year	Load on the water resources, %*	Main reasons or sources of the load
1. Surface water, including:				
Ural River	1,390.0	865.2	62,2% Severe stress	Agriculture (90%), industry (3%) and public utilities (6%)
Small rivers	979.0	-	-	
2. Groundwater	350	12.3	3.5% no stress	Public utilities (100%)
3. Other water sources, including:				
Return water				
Recycled water and water of sequential use		3.0		

Given the agricultural orientation of the oblast and that most of its territory is not provided with the good quality underground waters, severe water stress in the surface waters of the Ural River is observed (62.2 percent), at the same time there is no stress on the underground water supply sources of the oblast (3,5 percent) Key measures for reduction of the load on water supply sources in the Western-Kazakhstan Oblast include the following:

- Discharge of standard pure water back to the sources (rivers)
- Use of recycling water supply (33.3 percent of the total water use for industrial needs)
- Pumping of the discharged industrial water to the underground beds.

Existing and forecasted water resources

Surface water resources

Most of the water ecosystems of the West Kazakhstan Oblast (WKO) are confined to the river systems, as natural ponds and lakes are very scarce. The characteristic feature of almost all lakes is their closeness as well as drastic reduction of the water surface or drying up at the end of summer.

The **Ural River** is the largest river in the oblast crossing it from the north to the south. Its basin includes about 800 rivers. The average long-term volume of water flow in the Ural river through WKO is 10,690 million m^3/year including 9,300 million m^3/year – average annual run-off to the Caspian Sea. Total run-off of the **Ilek River** is 979 million m^3/year. The Ilek River flows at the distance of 20 km from the Karachaganak oil-gas condensate field (KOGCF) and flows into the Ural River. The river gets the largest volume of pollution from the enterprises of the Aktobe Oblast. The Ural River and its tributaries Ilek and Utva, as well as the Berezovka and Malyi Ilek rivers are used for fishery purposes. They are used for domestic water supply to the local population, recreation needs of population, and irrigation needs of the agriculture. The remaining water bodies – the runoff of small rivers and temporary waterways, water reserve after snow melting in non-inflow valleys – are used by the population and farmers for domestic and other needs.

Underground water resources

The West Kazakhstan Oblast is characterized by difficult natural and hydro geological conditions for formation of good-quality groundwater reserves. Total forecasted regional useful resources in the oblast for various sources are estimated at 820-1,009 million m^3/year [**13**]. This number includes water with the mineralization level which does not exceed 3 g/dm^3, which can be utilized and is estimated at the level of up to 703-978 million m^3/year, including water used for public and industrial water supply – up to 350 million m^3/year, and the remaining part used for irrigation, watering and agricultural needs.

Water use and discharge (surface and underground water)

Water use

Surface river water is the main source of water supply in the West Kazakhstan Oblast (98.4 percent). The proportion of groundwater use is 1.6 percent.

In recent years (2002-2003), water intake from natural sources in the oblast has been 714-748 million m^3/year, which is lower than the level of 1990 by 2 times, when it was 1,443 million m^3/year. It constitutes 1.2 thousand m^3/year per capita.

WKO is mainly an agricultural region. There, 90 percent of the total water intake is used for irrigation and pasture watering (261 million m^3/year). Use of fresh water for industrial needs of the oblast, for instance in 2002, was 9.0 million m^3/year or 3.1 percent of the total water intake. Use of water for domestic and drinking needs remains at the level of 17-18 million m^3/year (5.9 percent). At the same time, a high level of unaccounted water losses is noted, which is 458 million m^3/year (61.2 percent) based on the data for 2002. However, based on official data of the Statistics Agency of RK, water losses during transmission within the WKO amounted to 231 million m^3/year[**3**].

The proportion of recycling water use is 3.0 million m^3/year or only 1.0 percent of the total use of water for industrial needs.

12.3 million m^3/year of groundwater is used only for domestic needs (100 percent) [1].

Water discharge

The largest industrial complex in the oblast is Karachagan Oil and Gas Condensate Field (KOGCF), which is the main user of water for industrial needs.

Based on the study findings for 1996-2000 [**15**], wastewater discharge at KOGCF (IGPU-3) exceeds MAC values for BOD_5, suspended solids, chlorides and oil products, polyaromatic hydrocarbons, caused by a low level of wastewater treatment and lack of a special plan for its subsequent treatment. Besides, agricultural fields assigned for irrigation and described in the project were not developed, and wastewater flows into water-bearing horizons, especially into those which are located close to the surface.

Domestic wastewater after biochemical treatment is discharged to the irrigation fields. After primary treatment, industrial wastewater (water-methanol mixture) containing hydrogen sulfide, hydrosulfides, and corrosion inhibitors is pumped to the deep-seated seams.

Hydravit-500C biological treatment plant for domestic waste in Aksai provides for treatment with the capacity of 2500 m^3/day. The treatment process includes primary sedimentation of wastewater, aerobic biological treatment, anaerobic digestion of sludge and activated sludge. The guaranteed parameters of the treated water are: BOD_5 – max 10 mg/l, BOD20 – max 15 mg/l, suspended solids – max 15 mg/l.

The volume of the industrial wastewater of the KOGCF amounts to about 4,000 m^3/day (1.5 million m^3/year). Wastewaters are discharged to the landfill for underground disposal of industrial waste, which has three injection wells and three monitoring wells 2,000 m deep.

Load on the water supply sources and existing policies and measures for its reduction

Given the agricultural orientation of the oblast and that most of its territory is not provided with the good quality underground waters the high level load on the surface waters of the Ural River is observed (62.2 percent), at the same time there is no land on the underground water supply sources of the oblast (3.5 percent).

Key measures for reduction of the load on water supply sources in the West Kazakhstan Oblast include the following:

- Discharge of standard pure water back to the sources (rivers);
- Use of recycling water supply (33.3 percent of the total water use for industrial needs);
- Pumping of the discharged industrial water to the underground beds.

Quality of the surface and underground water

Contamination of rivers in the WKO with chemical substances occurs due to the discharge of industrial wastewater from industrial and agricultural enterprises and washout of pollution during snow melting and flooding periods. Besides, significant contamination of surface water with heavy metals (including copper, lead, and cobalt) and their mineralization are typical of WKO, taking into consideration a high level of the total mineralization.

According to the hydro chemical and hydro biological indicators, the Ural River is evaluated as the third class – moderately polluted water. Concentrations of copper and phenols in some cases exceed MAC by 10-16 times, chrome – 4 MAC, and oil products – 3.5 MAC. In 2003, according to the statistics data of RK [3], it was referred to the second class "pure" with a small exceeding of the permissible concentration in respect of phenols (0.002 mg/l).

The Ilek River refers to the category of maximum polluted water sources with a high level of mineralization of the waterway, first of all, as a result of the river recharge with groundwater extremely polluted with boron and chrome due to the industrial activity of the former chemical plant in Alga town. Concentration of Chrome (6+) can reach 50-120 MAC, in winter period – 250 MAC. During flooding period, higher quantities of organic substances and oil products (2 MAC), phenols and nitrite nitrogen (6-8 MAC) are observed.

Heavy pollution of underground and surface water salts of the heavy metals (copper, lead, cobalt) is characteristics of the southern part of WKO against the overall high salinity.

Analysis of the impact of polluted surface and underground water on the quality of drinking water and population health, as well as on the local economy (agriculture, fishery, manufacturing)

According to the data of the Statistics Agency of RK and Republican Sanitary and Epidemiological Center of RK for 2001-2003 [3], in the West Kazakhstan Oblast:

- Proportion of the population provided with tap water is 57-64 percent, which is lower than the overall republican indicator by 11-17 percent.
- Proportion of the population provided with drinking water from decentralized water supply sources is 33 percent.
- Specific weight of the water samples, which do not correspond to the quality standards based on sanitary-chemical and microbiological indicators, is 2.7-6.1 percent for centralized (towards improvement of the situation) and 6.6-8.5 percent for decentralized water supply sources (towards deterioration of the situation).

Besides, Karachaganak Petroleum Operating Company uses drinking water from the Zharsaut reservoir for technical needs, which creates a problem with water supply in Aksai town. To solve the problem, it was proposed to reconstruct the control structure at Konchubai hollow from where water was previously taken for the Karachaganak field.

Aktobe Oblast

Table A5.5: Water stress indicators for Aktobe Oblast (2002)

	Renewable resources of fresh water, mln.m^3/year	Current water use, mln. m^3/year	Load on the water resources, %*	Main reasons or sources of the load
1. Surface water	2,030.0	198.8	9.8% no stress	
2. Groundwater	1,419.0	38.0	2.7% no stress	
3. Other sources of water, including:				
Return water		0.0		
Recycled water and water of sequential use		51.0		

Given the agricultural orientation of the oblast (73.5 percent of the total water consumption), the territory provision with the surface and good quality underground waters in large volumes and implementation of measures aimed at the impact mitigation points out to the fact of the absence of the load on the oblast water supply sources (9.8 percent - on the surface sources and 2.7 percent - on the underground sources). Key measures for reduction of the load on water supply sources in the Aktobe Oblast include the following:

- Discharge of standard pure water back to the sources (rivers)
- Use of recycling water supply (74.8 percent of the total water use for industrial needs)
- Pumping of the discharged industrial water to the underground beds.

In the Aktobe Oblast, the percentage of recycling water supply is the smallest among all the Kazakhstan regions considered in this report.

Existing and forecasted water resources

Surface water resources

The Aktobe Oblast refers to the arid areas of Kazakhstan. Runoff of the rivers and temporary waterways is formed almost exclusively by winter precipitations. The main phase of the river water regime in the oblast is spring flooding, at which the largest part of the annual runoff falls. Hydro geographic network is presented by seven main rivers: Or, Ilek, Large Hobda, Uil, Sagiz, Irgiz, and Emba.

Surface water resources in the oblast amount to 3,610 million m^3/year in the year characterized by the average long-term water content. It includes 1,580 million m^3/year – the Ural River water discharge.

Underground water resources

Natural and hydro geological conditions of this oblast are favorable for formation of large reserves of mainly good-quality groundwater (from 0.5 to 3 g/dm^3, rarely 3-5 g/dm^3). Total estimated regional useful resources of groundwater reach 10,817 million m^3/year. 4,636 million m^3/year or 43 percent can be used for water supply, including 1,419 million m^3/year for public and industrial needs, and 883 million m^3/year for watering and agricultural water supply. The most highly productive resources, occurring at the depth of 50-500 m with flows up to 20-45 dm^3/s, are concentrated in irregular coarse sands and sandstones. Specific water availability of the stated artesian basins can reach 10-20 million m^3/km^2. Estimated regional useful resources of artesian water which can be used for economic needs of the oblast amount to 3,847 million m^3/year [**11**, **12**].

Water use and discharge (surface and underground water)

Water use

Based on the data of the Territorial Environmental Protection Department of the oblast [6], average long-term total intake of fresh water in the oblast amounts to 221.3 million m^3/year; including: 198.8 million m^3/year (84 percent) of surface water and 38.0 million m^3/year (16 percent) of underground water.

Water discharge

The water discharge in the oblast is 30.9 million m^3/year, where 20.9 million m^3/year (67.7 percent) is standard treated and 10 million m^3/year (32.3 percent) is polluted. About 79 percent is discharged to the fields for evaporation; and about 21 percent into the surface water bodies [**6**].

Pressure on the water supply sources and existing policies and measures for its reduction

Given the agricultural orientation of the oblast (73.5 percent of the total water consumption), the relatively large volumes of the surface and good quality underground waters ensure low stress on the oblast water supply sources (only 9.8 percent - on the surface sources and 2.7 percent - on the underground sources) (table a5.5).

Key measures for reduction of the load on water supply sources in the Aktobe Oblast include the following:

- Discharge of standard pure water back to the sources (rivers)
- Use of recycling water supply (74.8 percent of the total water use for industrial needs)
- Pumping of the discharged industrial water to the underground beds.

In the Aktobe Oblast, the percentage of recycling water supply is the smallest among all the Kazakhstan regions considered in this report.

Quality of surface and underground water

Though the oblast has sufficient water resources, their pollution levels are the highest at the territory of Kazakhstan. The Ilek River is the most polluted river in the Ural River basin, WPI is 15.39, and on the Alga-2 site it is under quality class 7, "extremely polluted". MAC is exceeded for boron – 103 MAC, phenols – 7 MAC, nitrites - 5 MAC, and chrome – 22 MAC.

The main pollutants in the oblast are the enterprises of the oil-gas and ore-mining sector. The areas for hydrocarbon extraction is remarkable for its high man-caused load.

Analysis of the impact of polluted surface and underground water on the quality of drinking water and population health, as well as on the local economy (agriculture, fishery, manufacturing)

At present, the Ilek River pollution with the sexivalent chrome and insufficiently treated wastewaters from the treatment facilities of Aktobe City, impacts strongly on water bodies pollution of the Aktobe Oblast.

According to the data of the Statistics Agency of RK for 2001-2003 [3], the situation in the Aktobe Oblast looks as follows:

- Proportion of the population provided with tap water is 71-76 percent, which is at the level of the overall republican indicator.
- Proportion of the population provided with drinking water from decentralized water supply sources is in average 23-28 percent.

- High specific weight of the water samples, which do not correspond to the quality standards based on sanitary-chemical and microbiological indicators, is 5.8-8.8 percent for centralized and 16.8-23.1 percent for decentralized water supply sources.

As the result of long-term operation without any major repairs, the complex of treatment facilities is in the emergency situation, the wastewater is not treated to the level of MAC for fishery bodies.

Synthetic biological treatment facilities with the capacity of 103 thousand m^3/day were put into operation in 1982. At present, many engineering structures of the wastewater treatment plant and regulating reservoir unit are partially out of commission. Because of this, every year Akbulak OJSC discharges up to 10 million m^3/year of insufficiently treated wastewater to the Ilek River.

Pavlodar Oblast

Table A5.6: Water stress indicators for Pavlodar Oblast (2003)

	Renewable resources of fresh water, mln.m^3/year	Current water use, mln. m^3/year	Load on the water resources, %*	Main reasons or sources of the load
1. Surface water, including:				
Irtysh River	15,900	2,577.8	16.2% Low stress	Industry (65%), agriculture (33%)
2. Groundwater	47.5	9.2	19.4% Low stress	
3. Other sources of water, including:				
Return water		2,823		

Based on the given data the load on the water supply sources in the Pavlodar Oblast is low stress (16.2 percent - on Irtysh River and 19.4 percent on groundwater). Key measures for reduction of the load on water supply sources in Pavlodar Oblast include the following:

- Discharge of standard pure water back to the sources (rivers)
- Use of the recycling and sequential water supply (125 percent of the total fresh water use for industrial needs).

Available and forecasted water resources

Surface water resources

The Irtysh River, Canal in the name of K. Satpayev and groundwater are the main water supply sources in the Oblast. According to the Resolution of the Government of RK No. 877 dated 27 June 2001, the status of the National Special Nature Reserve was imparted to the flood-lands of the Irtysh River.

Total runoff of the Irtysh River is 33.8 million m^3/year, including 26.2 million m^3/year, which is formed at the territory of Kazakhstan [3]. Taking into account the mandatory discharges and losses for evaporation and filtration, the available resources are estimated in the volume of 15.9 million m^3/year.

Underground water resources

Pavlodar Oblast is located within Priirtyshie in relatively favorable hydro geological conditions. Estimated regional useful resources of groundwater in the oblast amount to 4,730 million m^3/year. Out of this figure, it is recommended to use 2,208 million m^3/year, including 883 million m^3/year (40 percent) that can be used for industrial water supply and the remaining part – for rural water supply and watering.

Water use and discharge (surface and underground water)

Water Use

Surface water is the main source of water supply in the oblast (99.6 percent) and only 0.4 percent of the total water intake is represented by groundwater.

Based on the data of the Committee for Water Resources under the Ministry of Agriculture of RK, water intake from natural sources in the Pavlodar Oblast is 2,282-2,587 million m^3/year (2001-2003), which is lower than the level of 1990 by 34 percent. Water losses during transmission within the oblast amounted to 195 million m^3/year.

The following indicators characterize distribution of the water intake: 1,466 million m^3/year (65 percent) is used for industrial needs, 751 million m^3/year (33.3 percent) is used for rural water supply and 39 million m^3/year (1.7 percent) is used by the public utilities.

In 2003, the total use of fresh water for industrial needs in the oblast increased by 18 percent in comparison with the period of 2000-2002, but it did not reach the level of 1990-1995, when it amounted to 1,944-1,983 million m^3/year [3]. At the same time, use of water for domestic and drinking needs decreased by about 2 times in comparison with the level of 1990-1995 and amounted to 39-48 million m^3/year (based on the data for 2000-2003). Currently 751-774 million m^3/year of water are used for irrigation, watering and rural water supply, which is lower than the level of 1990 by 40 percent.

Volumes of recycled and sequentially used water amount to 2,823 million m^3/year, which exceeds the volumes of fresh water intake for industrial needs by almost 2 times.

Load on the water supply sources and existing policies and measures for its reduction

Based on the given data, the load on the water supply sources in the Pavlodar Oblast is low (16.2 percent on Irtysh River and 19.4 percent on groundwater) (table a5.6).

Key measures for reduction of the load on water supply sources in Pavlodar Oblast include the following:

- Discharge of standard pure water back to the sources (rivers)
- Use of the recycling and sequential water supply (125 percent of the total fresh water use for industrial needs).

Quality of surface and underground water

The most representative types of water body pollution sources include the city wastewater discharge to the Irtysh River, which amounted to 20.98 million m^3 / year in 2002.

In 2002, maximum exceeding of MAC norms was observed in relation to oil products – 0.27 mg/dm^3 (5.4 MAC), copper – 0.007 mg/dm^3 (**7** MAC), manganese – 0.056 mg/dm^3 (5.6 MAC) [7].

The results of the integrated inspection of the Pavlodar City Vodokanal (Pavlodar –Vodokanal Ltd.) showed that with the design capacity of 200 thousand m^3/day, the actual wastewater load on the facilities is 120-125 thousand m^3/day.

Analysis of the impact of polluted surface and underground water on the quality of drinking water and population health, as well as on the local economy (agriculture, fishery, manufacturing)

According to the data of the Statistics Agency of RK for 2001-2003 [3], the situation in the Pavlodar Oblast looks as follows:

- Proportion of the population provided with tap water is 74-77 percent, which is at the level of the overall Republican indicator.
- Proportion of the population provided with drinking water from decentralized water supply sources is in average 20-25 percent.
- Specific weight of the water samples, which do not correspond to the quality standards based on sanitary-chemical and microbiological indicators, is 4.1-4.9 percent for centralized and 7.2-17.6 percent for decentralized water supply sources.

Karaganda Oblast

Table A5.7: Water stress indicators for Karaganda Oblast (data for 2003)

	Renewable resources of fresh water, mln.m^3/year	Existing water consumption, mln. m^3/year	Load on water resources, %*	Main reasons or sources of the load
1. Surface water, including:				
Nura river	619	276.3	44.6% Severe stress	Industry (92.2%), including metallurgical enterprises (more than 60%); losses during transmission – (57%)
Irtysh-Karaganda canal	178.2	105.3 (including losses during transmission – 102.3)	59.1% Severe stress	
2. Underground water	820.0	125.1	15.3% Low stress	
3. Other sources of water, including:				
Return water (from the mines)		41.9		
Water of the reverse and successive usage		180.0		

According to the data specified, the load on surface and underground water supply sources in Karaganda Oblast is assessed as severe stress, including Nura River (44.6 percent) Irtysh-Karaganda Canal (59.1 percent). At the same time, there is large amount of water losses during the transmission via Irtysh-Karaganda canal - 57 percent of the total amount of water transmitted from Pavlodar Oblast. Further increasing of water consumption in the oblast is possible only due to the underground sources of water supply, the existing load on which is estimated as stressed (15.3 percent). or due to reduction of the surface water losses. Main measures for the reduction of the load on water supply sources in Karaganda Oblast include:

- Discharge of standard-based pure water back into the sources (rivers);
- Application of the reverse and recycling-successive water supply (158 percent of the total raw water consumption for industrial needs);
- Usage of the water from mines.

Available and forecasted water resources

Surface water resources

Main water sources in Karaganda Oblast are the Nura River with inflows Sherubai-Nura and Sokyr, Kara-Kengir River, Zhezdy River, Balkhash Lake and Irtysh-Karaganda Canal are the main water sources of Karaganda Oblast.

Peculiarity of the rivers' water regime is vivid spring tide and river drying up during the summer period that result in accumulation of water during the flooding period in accumulating tanks - reservoirs and it depends on the water content of a year.

Nura River is completely formed at the territory of Kazakhstan and has the total flow of 619 million m^3/year. ***Balkhash River*** has the water volume of 106 million m^3 [3]. ***Irtysh-Karaganda Canal*** is the main source of the potable water supply for Karaganda-Temirtau industrial area, which provides 53 percent of the water balance in the oblast and 91 percent in Karaganda. In 2001-2002, 173-178 million m^3/year of water was transported through the Canal from Pavlodar Oblast [9].

Taking into account the Irtysh-Karaganda Canal the total amount of the water resources in the oblast is about 3.4 million m^3/year.

Underground water resources

In general, geological and hydro-geological conditions in the oblast are favorable for the formation and allocation of significant resources of the underground water. Forecasted regional operational resources of the good-quality underground water are assessed to be 820 million m^3/year, out of which about 245 million m^3/year (30 percent) can be used for public utility services and industry.

Water use and discharge (surface and underground water)

Water use

Total average annual raw water intake in the oblast during 1990-2003 constitutes around 1,601 million m^3/year, including from the underground sources - 83.2 million.m^3/year [3].

Water consumption in the oblast is carried out due to the water intake from the surface sources (90.5 percent), mainly from Irtysh-Karaganda Canal; reverse water supply and recycling-successive water supply, which in 1.5 times exceeds (approximately 158 percent) the raw water intake for the industrial needs [9]. Water allocation according to the activities shows that the largest part belongs to industrial use (92 percent); the other 6 percent belongs to domestic use and 2 percent is used in agriculture.

There was the increase of the water consumption by 1.2 times in 2002 against the 1998 level because of the increase of the production volumes. There was also an increase in using the reverse water supply and recycling-successive water supply compared to the total water intake due to the production rehabilitation.

Water discharge

The volume of the wastewater discharge in the oblast is 983.9-1,004.8 million m^3/year [9], 98.3 percent of which returns to the surface reservoirs, including 84.7 percent of the normative-clean water.

The main enterprises that cause harmful impact on the change of the quality of water resources in Karaganda Oblast are enterprises of metallurgy, heat-and-power engineering and coal industry, which possess water intake facilities and wastewater treatment facilities.

Load on the water supply sources and existing policies and measures for its reduction

According to the data specified, the load on surface and underground water supply sources in Karaganda Oblast is assessed as high, including Nura River (44.6 percent) Irtysh-Karaganda Canal (59.1 percent). At the same time, there is a large amount of water losses during the transmission via Irtysh-Karaganda canal - 57 percent of the total amount of water transmitted from Pavlodar Oblast (table a5.7). Further increasing of water consumption in the Oblast is possible only due to the underground sources of water supply the existing load on which is estimated as low (15.3 percent) or due to reduction of the surface water losses.

Main measures for the reduction of the load on water supply sources in Karaganda oblast include:

- Discharge of standard-based pure water back into the sources (rivers);
- Application of the reverse and recycling-successive water supply (158 percent of the total raw water consumption for industrial needs);
- Usage of the water from mines.

Surface water quality

As a whole the surface water in Karaganda Oblast is estimated from moderately polluted (Nura River) to polluted (Balkhash Lake) [3, 9].

MAC excesses were observed for oil products - to 2.8 MAC (0.14 mg/dm^3), iron - to 1.6 MAC (0.16 mg/dm^3), copper – 2.7 MAC (0.0027 mg/dm^3). The first half of the year witnessed increased water salinity– 1.2 MAC (1242 mg/dm^3). By the end of the year, the average salt content was equal to 887 mg/dm^3.

The condition of the water treatment facilities has an impact on water quality. Thus, in Nura River station 1000 meters below the joint wastewater discharge from OJSC Ispat Karmet and Temirtau Chemical-Metallurgical Plant Ltd. the following violations of MAC are observed: iron – up to 2 MAC (0.2 mg/decimeter^3), oil products – up to 1.6 MAC (0.08 mg/decimeter^3), copper – up to 3 MAC (0.003 mg/decimeter^3), ammonia nitrogen – 1.2 MAC (0.44 mg/decimeter^3). Concentration of the suspended particles is 9 mg/decimeter^3, mineralization (1028 mg/decimeter^3). Downstream after discharge from the ineffectively operating treatment facilities of the TransOil Ltd., where treating the wastewaters from Saran City the exceeding of the following MAC is observed: ammonia nitrogen – 7.8 MAC (3.06 mg/decimeter^3), nitrites – 7 MAC (0.558 mg/decimeter^3), BOD_5 – 3 MAC (9.13 mg/decimeter^3), SS – 3.6 MAC (0.36 mg/decimeter^3), oil products – 1.6 MAC (0.08 mg/decimeter^3), iron – 1.5 MAC (0.15 mg/decimeter^3).

The exceeding of MAC was observed in Balkhash Lake: mineralization – 3.3 MAC (5000 mg/decimeter^3), copper – 5.5 MAC (0.022 mg/decimeter^3) oil products – 2.5 MAC (0.125 mg/decimeter^3).

Analysis of the impact of contaminated surface and underground water on the potable water quality and population health, on local economy (agriculture, fishery, manufacturing)

According to the RK Statistics agency [3], situation in Karaganda Oblast in 2001-2003 was as follows:

- share of the population provided with piped water is 87-89 percent, which is 12-14 percent higher than in the country;
- share of the population provided with potable water from decentralized water supply sources constitutes 12 percent;
- specific weight of the water samples that do not correspond to quality standards for sanitary-chemical and microbiological indicators is equal to 4-8 percent for centralized and 20-32 percent for decentralized water supply sources.

South Kazakhstan Oblast

Table A5.8:Water stress indicators for South Kazakhstan Oblast (2002)

	Renewable resources of fresh water, mln.m^3/year	Existing water consumption, million m^3/year	Load on water resources, %*	Main reasons or sources of the load
1. Surface water	12,000 (4,260 – formed at the territory of RK)	3,581.3	30% stressed	Rural farms (96%) and losses (27%)
2. Underground water	1,091.6	196.7	18% Low stress	
3. Other sources of water, including:				
Water of the reverse and successive usage			142.0	

According to the data given, the load on surface water supply sources in South Kazakhstan Oblast is assessed as stressed (29.8 percent), on underground water as low stress (18 percent). Main reasons and sources of load are the use of water for agricultural needs (96 percent of the total water consumption volume in the oblast) and losses due to evaporation and filtration that constitute 27 percent. Main measures for the reduction of the load on water supply sources in South Kazakhstan Oblast include:

- Discharge of standard-based pure water back into the sources (rivers);
- Application of the reverse water supply (222 percent of the total raw water consumption for industrial needs);
- Usage of return water.

Available and forecasted water resources

Surface water resources

The South Kazakhstan Oblast (SKO) is almost completely located within the Aral-Syrdariya River Basin. The surface water include: large rivers - Syrdariya and Chu (undercurrent); 135 small rivers and temporary waterways, 25 lakes, 28 reservoirs, 16.5 thousand km of irrigation systems, 4.3 thousand km of the sewer-drainage network.

The average annual river basin balance is 17,900 million m^3/year, of which 14,600 million m^3/year are supplied from the neighboring territories and 3,300 million m^3/year are formed within the basin. Taking into account the sanitary-ecological discharges and losses for evaporation and filtration, the available resources are estimated in the volume of 12,000 million m^3/year [1, 3].

Almost all lakes of SKO are stagnant and acute fluctuation of the water level is typical to these lakes. Water in most of thee lakes is saline; besides, most of them are sedimentary and serve for salt production. Lakes are used for water supply and irrigation, as well as for growing the swimming birds.

Artificial water reservoirs were constructed at the territory of South Kazakhstan Oblast, for the purposes of power generation, irrigation of the planted areas and water supply to the industrial centers. The largest reservoir in the oblast is Shardara. It is located in Shardara, Keles and Kirov districts of SKO, in the medium stream of Syrdariya river. It was founded in 1964 by means of the construction of the dam for Sharadara Hydroelectric Power Station (HPS).

Underground water resources

The South Kazakhstan Oblast is well supplied with the underground water and the forecasted regional operational resources of which constitute 8,199 million m^3/year. Approved reserves are equal to 1,091 million m^3/year. The needs in water comprise 4,100 million m^3/year, including:

2,270 million m^3/year for irrigation, 915 million m^3/year for public utility and industrial water supply, 473 million m^3/year for watering the grasslands and 442 million m^3/year for agricultural water supply. Around 4,100 million m^3/year of water might be used for the expansion of the industrial needs.

Water use and discharge (surface and underground water)

About 94.8 percent of water intake in the oblast comes from surface water, while the remaining 5.2 percent comes from the underground sources.

The oblast has the pronounced agricultural orientation: 97.4 percent of all water is used for rural water supply. Water consumption for industrial and domestic needs is equal to 2.4 percent and 1.6 percent, correspondingly. River water plays a significant role for the water supply of the population and settlements. Along with this, the water from the rivers is used for obtaining power. At present, only the part of water systems that belongs to the state and is operated by RSE "Yugvodkhoz" is in adequate condition. There are 1,500 inoperative vertical drainage wells. The sewer-drainage system is in bad condition.

Load on the water supply sources and existing policies and measures for its reduction

According to the data given, the load on surface water supply sources in South Kazakhstan Oblast is assessed as medium (29.8 percent), and on underground water as weak (18 percent). Main reasons and sources of load are the use of water for agricultural needs (96 percent of the total water consumption volume in the oblast) and losses due to evaporation and filtration that constitute 27 percent.

Main measures for the reduction of the load on water supply sources in South Kazakhstan Oblast include:

- Discharge of standard-based pure water back into the sources (rivers);
- Application of the reverse water supply (222 percent of the total raw water consumption for industrial needs);
- Usage of return water.

Quality of the surface and underground water

Hydro-chemical regime of the Syrdariya River is formed mainly under the influence of economy activities (flow regulation, water intake for irrigation and industrial-domestic water supply purposes, inflow of return water into the rivers contaminated by fertilizers, insecticides, discharges of untreated industrial and domestic wastewater into the river). All these resulted in the fact that the water in the river is estimated as moderately polluted [3] and inconsistent with the norms determined for the fishery and household-drinking purposes.

The level of mineralization currently amounted to 2,000-3,000 mg/l. Prior to irrigation activity, water salinity was equal to 500-600 mg/l. According to its chemical content, it was hydrocarbonate calcium; at present, it is sulfate salinity with the majority of natrium and magnesium ions. It is noted that the maximum allowable concentrations (MACs) on sulfates, chlorides, nitrates, DDT, magnesium, copper, iron, phenols, lead and etc., are exceeded

Analysis of the impact of contaminated surface and underground water on the potable water quality and population health, on local economy (agriculture, fishery, manufacturing)

According to the data of RK Statistics agency [3], the situation in SKO in 2001-2003 was as follows:

- share of the population provided with piped water is 61-64 percent, which is 10 percent higher than in the country, but at the same time 10 percent less than the level of 1998. In some regions, this indicator varies from 12 to 92 percent.
- share of the population provided with potable water from decentralized water supply sources increased by 10 percent compared to the level of 1998-2000 and constitutes 29 percent on average;
- specific weight of the water samples that does not correspond to quality standards for sanitary-chemical and microbiological indicators is equal to 4-6 percent for centralized and 7-10 percent for decentralized water supply sources.

Because of the increased mineralization and huge contamination, the water in Syrdariya River is not suitable for use in water supply without preliminary treatment and desalination. Water quality in the river became significantly worse because of the increasing of return contamination and discharge of wastewater that served as the main reason of sanitary-epidemiological catastrophe in the Aral Sea area. Because of significant contamination and deficit of potable water, a high level of disease is observed amongst local residents in the ecologically crisis areas. Diseases that can be caused by potable water (such as hepatitis, typhus, gastrointestinal diseases and other diseases) are widely spreading.