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Bangkok State of the Environment 2001


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Foreword

Rapid industrialization and urbanization have caused Bangkok to face the population growth and social problem. The most important problems are environmental degradation related to solid waste, air and water pollution. Increasing intensity of these problems not only causes impact on public livelihood but also causes direct impact to the health of the people.

The Bangkok Metropolitan Administration (BMA), as a local government, is very much concerned on environmental problems. These issues are being addressed when the Bangkok development policies are implemented. However, the BMA administrator still needs precise and accurate information for planning and management of the environment.

"Bangkok State of the Environment Report" is the report for administrators and general public aimed to promote correct understanding and awareness of environmental problem in Bangkok. The report supports future environmental planning and surveillance program.

In preparation of this report, United Nations Environment Programme (UNEP RRC.AP) provided technical and financial support to complement the BMAs efforts. The information in the report was gathered from several agencies including the BMA's. Several stakeholders contributed to the report and validated the information through a consultation process. Even though this is the first Bangkok State of the Environment Report for the BMA, it is expected to pave for better systematic environmental management and BMA will continue to publicize "Bangkok State of the Environment Report" on regular basis as a mean to evaluate environmental management performance of the BMA.

Mr. Samak Sundaravej
Bangkok Governor

Foreword

The Rio Earth Summit in 1992 formulated an action plan, Agenda 21, a multifaceted process to address the full range of development and environmental issues involving participation of governments, international organizations and major groups in the quest for sustainable development.

In response to the requirement under Agenda 21, state of the environment reports (SoE) are being prepared at global, regional, sub-regional, national and provincial or city level at varying frequencies. These SoE reports address a diverse range of environmental problems and concerns with a call for more concrete guidance for policy setting, action planning, and resource allocation for the coming decades to improve the state of the environment at various levels.

The United Nations Environment Programme (UNEP) has been preparing the Global Environment Outlook (GEO) once in every two years since 1997. UN ESACP and Asian Development Bank have been preparing the regional SoE and the environment outlook respectively. Sub-regional intergovernmental organizations such as ASEAN, SACEP, MRC, and SPREP have also been preparing the sub-regional SoE reports. However, at national level while some of the countries in the region have got an official mandate to prepare SoE reports on annual basis, some countries are yet to launch their first state of the environment report. UNEP has been assisting the governments in the region by providing regular training on SoE data collection, assessment and reporting.

The Bangkok City State of the Environment 2001 is the first city based SoE in Thailand and has been jointly prepared by Bangkok Metropolitan Administration (BMA) and UNEP. BMA has played a very crucial role in carrying out the assessment by soliciting input from several government departments, agencies, and institutions. While addressing the key environmental problems in Bangkok City, the report aims to drive appropriate policy setting, environmental action planning, and resource allocation.

Five priority key issues for the state of environment report for Bangkok City have been identified in consultation with BMA and other government agencies and analyzed using the çpressure-state-impact- responseé (PSIR) analytical framework. The five key environmental issues identified for Bangkok City are: air pollution, water pollution, solid and hazardous waste, land subsistence, and noise pollution.

Growing expansion of industry, increased number of vehicles, and construction activities have led to significant deterioration of the air quality as well as increased level of noise pollution in the city. The major pollutants found in the atmosphere of the city are suspended particulate matter (PM-10), sulfur dioxide, nitrogen dioxide, carbon monoxide and ozone. Bangkok residents are prone to the risk of contracting chronic inflammation respiratory diseases and other related health problems. The canals are highly polluted due to direct discharge of wastewater throughout the city area. There are instances of constant exchange of flow between groundwater and the leaching pit wastewater, leading to an increased contamination of ground water. Due to increasing population, consumption pattern and changing lifestyle with economic growth, solid waste generation has become a major issue. Bangkok and surrounding areas are facing considerable land subsidence problems (with subsidence rate up to 10 cm./year in some critical areas) due to large withdrawal of groundwater from the aquifers. The land subsistence phenomenon has also aggravated flooding problems in some part of city during rainy seasons. In order to deal with these problems, the central and local governments, along with BMA, have initiated a number of policy measures and activities to improve environmental conditions in Bangkok City.

UNEP will continue to facilitate and provide required assistance for capacity development to conduct regular environmental assessments in the region.

Klaus Töpfer
Executive Director
United Nations Environment Programme

Acknowledgement

The objective of preparing the first Bangkok State of the Environment Report is achieved due to technical and funding support from United Nations Environment Programme (UNEP RRC.AP) RRC.AP provide training to the Bangkok Metropolitan Administration (BMA) officials on data collection, and report preparation. RRC.AP also provided support for editing and publishing the report. The associated pamphlets, CD-Rom are possible with funding from the BMA. All the stakeholders from government offices, universities, private sectors and NGOs contributed useful data, comments, suggestions, specially through the consultation meeting on Bangkok State of the Environment Report.

The Bangkok Metropolitan Administration would like to thank all mentioned contributors which resulted in accurate and clear assessment of the cities environment in an international standard. The report is a useful reference in planning and operation of environmental affairs as well as for educational and research purposes.

K. Lohachala

Pol. Sub. Lt. Kriengsak Lohachala
Permanent Secretary for the BMA.

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BMA	=	Bangkok Metropolitan Administration
BMA Plan	=	Bangkok Metropolitan Development Plan
BMR	=	Bangkok Metropolitan Region (Bangkok Metropolis, Samut Prakan, Nonthaburi, Pathum Thani, Nakhon Pathom, Samut Sakhon)
BMD Plan	=	Bangkok Metropolitan Development Plan
BOD	=	Biochemical Oxygen Demand
BOD/N Ratio	=	Biochemical Oxygen Demand / Nitrogen Ratio
^{o}C	=	Celsius
CBD	=	Central Business District
cm	=	Centimeter
CO	=	Carbon monoxide
Col/100ml	=	Colony per 100 milliliter
dBA	=	Decibel A
DDS	=	Department of Drainage and Sewerage
DO	=	Dissolved Oxygen
EMS	=	Environmental Management System
EPA	=	Environmental Protection Agency
GENCO	=	General Environment Conservation Public Company Limited
GIS	=	Geographic Information System
HC	=	Hydro Carbon
hr	=	Hour
H_2S	=	Hydrogen sulfide
JICA	=	Japan International Cooperation Agency
km	=	Kilometer
KNITNB	=	King Mongkuts Institute of Technology North Bangkok
Ldn	=	Noise Levels Average over day and night
LNG	=	Liquefied Natural Gas
LPG	=	Liquefied Propane Gas
m	=	Meter
m^3	=	Cubic Meter
mg/l	=	Milligram per liter
mg/m^3	=	Milligram per Cubic Meter
m/sec	=	meter per second
MCMD	=	Million Cubic Meters per Day
MOI	=	Ministry of Industry
MOSTE	=	Ministry of Science, Technology and Environment
MRTA	=	Metropolitan Rapid Transit
MWA	=	Metropolitan Waterworks Authority
NEB	=	National Environment Board
NEPO	=	National Energy Policy Office
NEQA	=	National Environmental Quality Act
NGOs	=	Non-Governmental Organizations
NH_3	=	Ammonia
NHA	=	National Housing Authority
NOx	=	Nitrogenoxide
PCD	=	Pollution Control Department
PM-10	=	Particulate Matter with the Diameter Equal or less than 10 micron
ppb	=	Parts per Billion
Sec.	=	Second
SS	=	Suspended Solids
TDRI	=	Thailand Development Research Institute
Temp.	=	Temperature
TKN	=	Total Kjeldahl Nitrogen
T-P	=	Total Phosphorus
T-coli	=	Total Coliform Bacteria
TSP	=	Total Suspended Particulate
µg	=	Microgram
WHO	=	World Health Organization
WQMD	=	Water Quality Management Division
WWTP	=	Wastewater Treatment Plants

1 Profile of Bangkok City

1.1 Location and Climate

Bangkok, the capital of Thailand is situated on the low flat plain of Chao Phraya River which extends to the Gulf of Thailand. Its latitude is 13 45' North, and the longitude is 100 28' East. The total area of Bangkok is 1,568.737 sq. km.

Bangkok has a monsoon type of climate, which can be classified into three main seasons: rainy (May-October), cool (November- January) and hot (February-April). The average annual temperature was 28.4 °C in 1999. The highest temperature average during the period of 1990-1999 was 33.3 °C and the lowest temperature average was 24.9 °C. The average wind velocity was 1.3 m/sec. The relative humidity is high throughout the year.

The provision of well-developed infrastructures has enabled development of Bangkok as the focal center for economic, culture and administrative activities. Thus, Bangkok is regarded as the growth flagship of the Central Region and the whole country. Figure 1.1 shows the Map of Bangkok City with 50 districts.

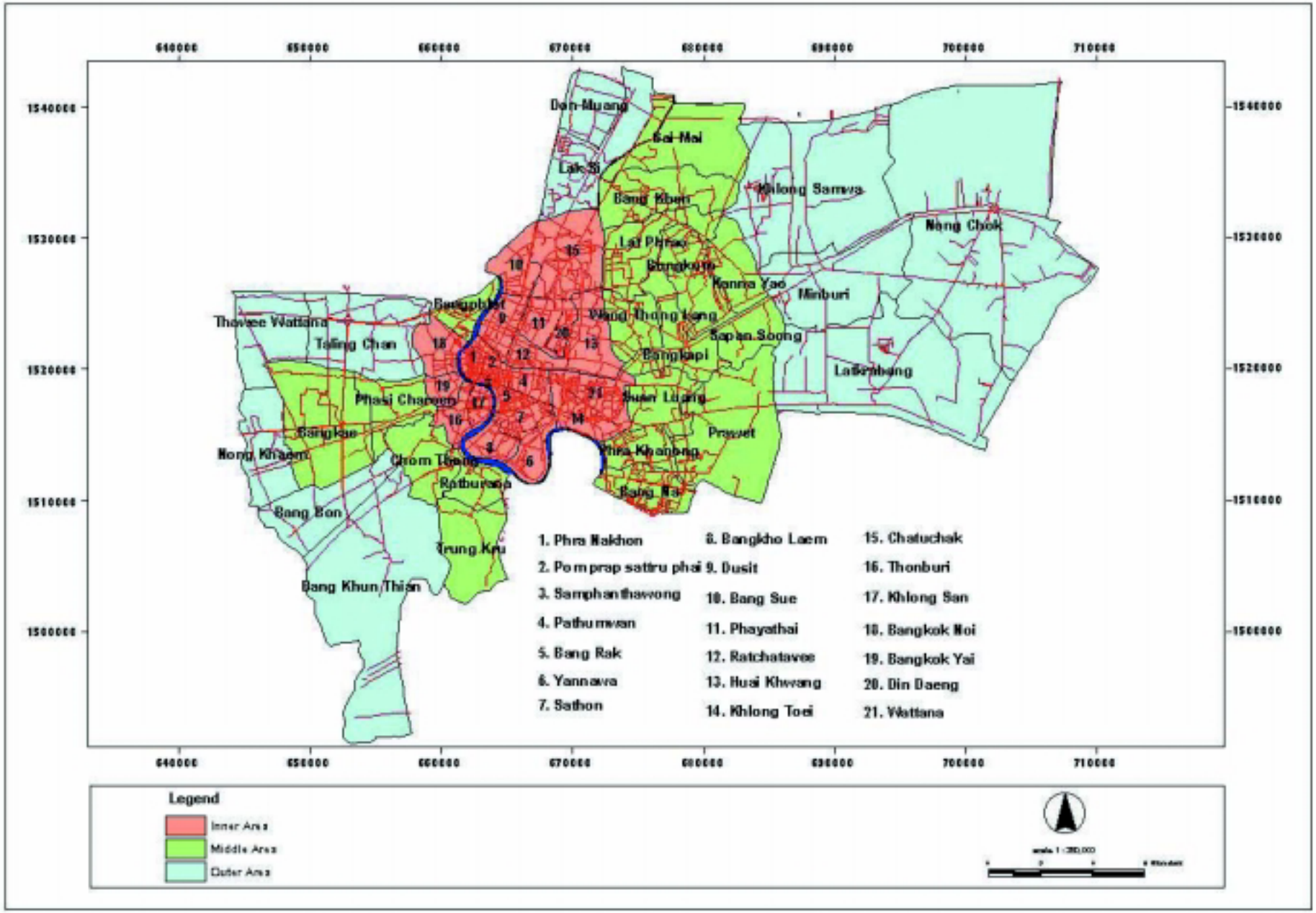


Figure 1.1 Map of Bangkok City with 50 Districts

1.2 Population

The total population of Bangkok in 2000 was 5.68 million, which was 9.18% of the total population of Thailand. Figure 1.2 shows the trend of the population dynamics in the Bangkok city. The trend during 1987-2000 shows the decreasing number of population in the inner area and increasing in the middle area. The population density in the inner area decreased from 15.27 to 11.09 thousand/Sq. Km(that is 3.25 to 2.36 million) during 1987 to 2000 respectively. The outer area shows increase in population density from 0.77 to 1.28 thousand/ Sq.Km(which is 0.67 to 1.12 million) in 1987 to 2000 respectively.

Figure 1.3 shows population migration in and out of Bangkok. In later year (1995-2000) Bangkok seems to lose populations. However, the actual population of city may not be known, as there are people who commute to work in Bangkok or live in the city without registration. They are estimated to be around 3.21 million. Therefore, the actual population of Bangkok in later years was likely around 8.89 million (NIDA, 2000)

1.3 Industrial Activities

During 1987-1996, there was rapid rise in number of factories, but in 1997-2000 number of factories was stable. In 2000, the total number of factories in Bangkok was 21,026 and the capital investment was 261,428 million baht with 608,088 employees. As a result of economic crisis and the Bangkok Comprehensive Plan (1999), factory profile in Bangkok are more likely to be small-scale factories. The trend of capital investment, factories and employees in the Bangkok are shown in Figures 1.4 and 1.5.

The Bangkok Comprehensive Plan defines special zones for industrial estates at Lat Krabang and Bangchan. The total number of factories in 2 Industrial Estates was 221 in 2000. The plan promotes development of non-polluting and nuisance - free industries to improve the urban environment. Therefore new industries and factories have been shifted outside the Bangkok to Samut Prakan and Pathum Thani. Figure 1.6 shows the locations of factories in Bangkok.

As ISO 14001 is gaining popularity as direction for Environmental Management Systems (EMS) certification in Thailand, the concept of this standard has enabled the organizations to continually develop and improve their environmental management systems. In 1999, the number of ISO14001 certified companies was 288.

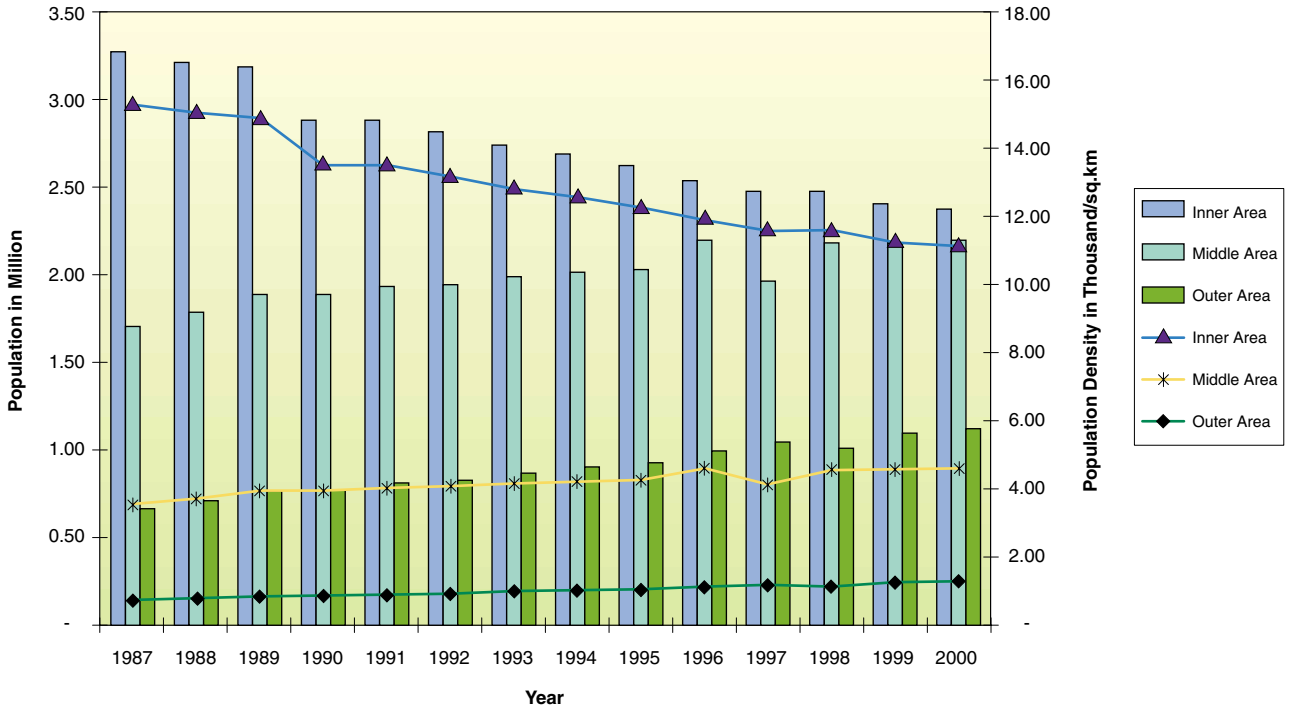


Figure 1.2 Change of population and population density in Bangkok 1987-2000
(Source : BMA. Statistics Report, 2000)

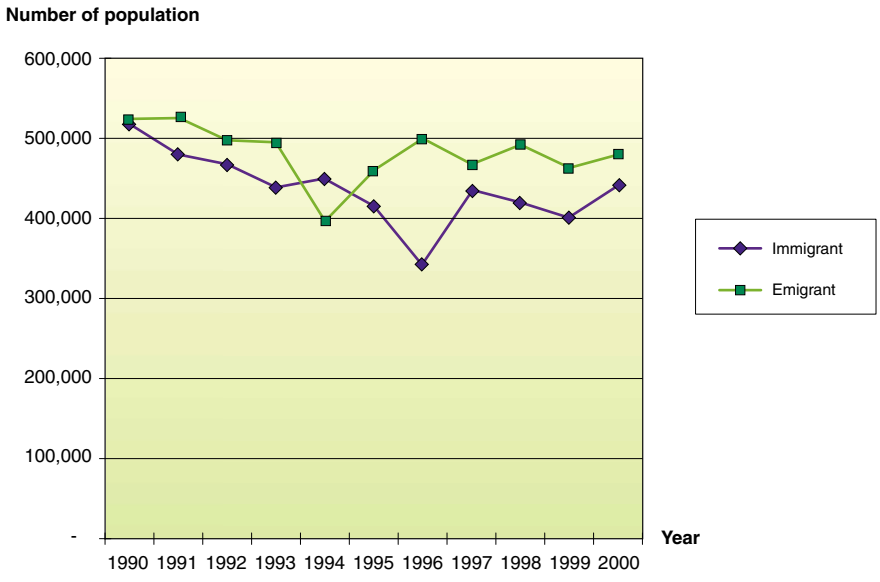


Figure 1.3 Population migration in Bangkok 1990-2000
(Source : BMA. Statistics Report, 2000)

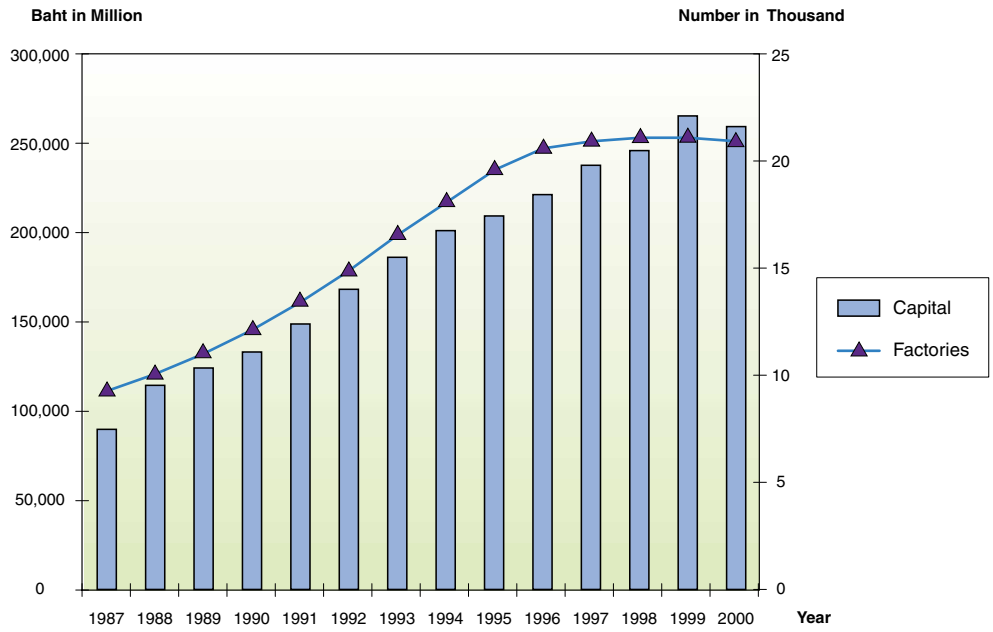


Figure 1.4 Number of total industrial factories and capital investment in Bangkok 1987-2000
(Source: Information Center, Department of Industrial Works, Ministry of Industry, 2000)

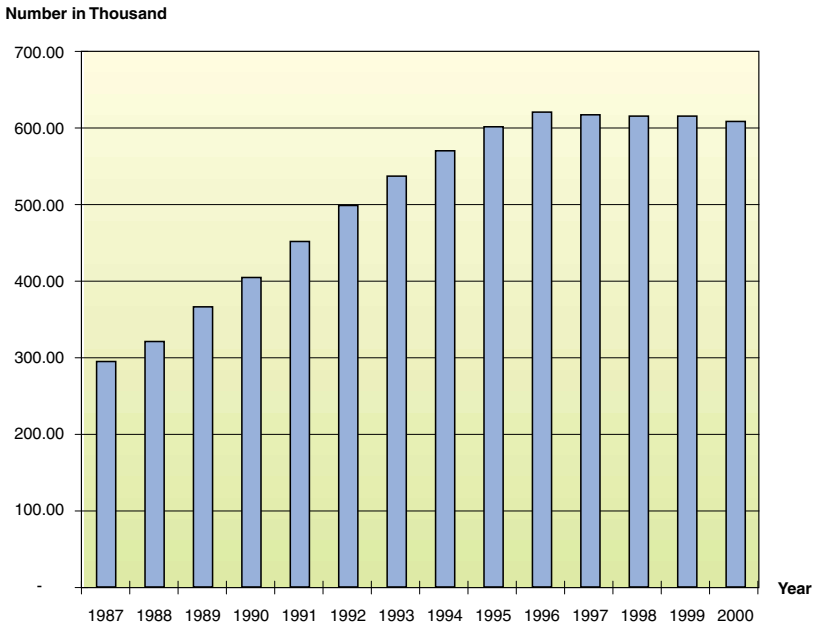


Figure 1.5 Number of total industrial employees in Bangkok 1987-2000
(Source: Information Center, Department of Industrial Works, Ministry of Industry, 2000)

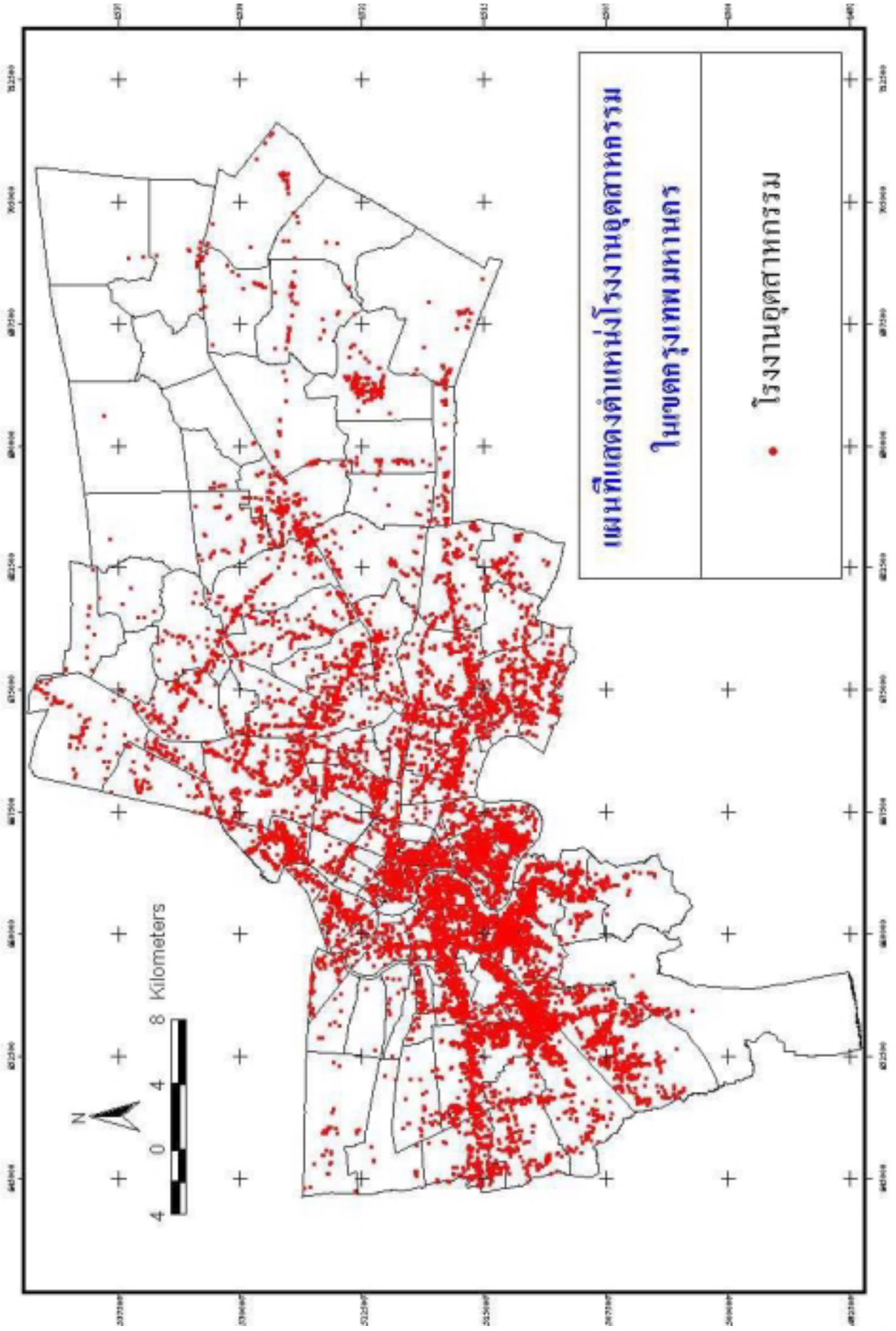


Figure 1.6 Bangkok Factories Location Map

1.4 Infrastructures

Bangkok City has been undergoing rapid urbanization and industrialization since 1960. The increasing population is due to the development of infrastructures such as road networks, real estate developments, land value, public policy as well as advancing economy which resulted in expansion into the surrounding areas.

The rapid rise in population has caused community number to increase. The BMA has defined communities into 5 categories which are slum community, suburb community, real estates community, urban community and housing community. In 2000, there were a total of 1,596 communities in Bangkok. Figure 1.7 shows the trend of communities in Bangkok which was increasing every year, but population in the communities were slightly decreasing during 1995-1997 and were increasing in 1998. In 2000, population in communities were 1.26 million, and households were 310,490 with 256,489 houses.

Number of canals in Bangkok was 1,357 in 2000. Department of Drainage and Sewerage is responsible for 329 canals and District Offices are responsible for 1,028 canals.

In 2000, the Public Works Department reported that there were 4,076 kilometers of road length in Bangkok, which has total area of 58.45 square kilometers.

The rapid development of Bangkok has led to other environmental problems and created serious environmental degradation such as air pollution, water pollution, solid and hazardous waste problem, land subsidence and noise pollution.

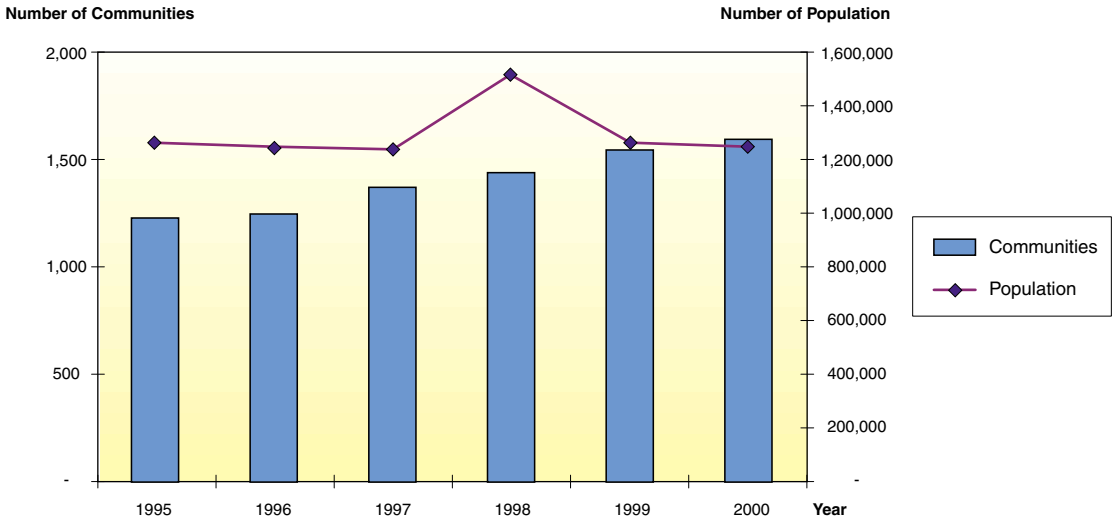


Figure 1.7 Number of communities and population in Bangkok 1995-2000
(Source : BMA. Statistics Report, 2000)

2 Air Pollution

2.1 Present Situation

The major sources of air pollutants in Bangkok are motor vehicles, roads and construction dust, industries and power plants.

2.1.1 Mobile Source

From vehicular registration statistics, it was found that in the year 2000 the number of vehicles registered in Bangkok was 4.5 million (Figure 2.1), increasing of 113% from 1991 and compared to 20 millions for the whole country. The increase of vehicles in Bangkok is not proportionate to the increase of roads and has caused traffic congestion and delay in transportation. Traffic speed survey in 2000 showed that during the rush hour, average speed was 10-12 km./hour in the inner area, whereas it was 19-21 km./hour in outer area. The number of transportation mode in Bangkok was 18.48 million person-trip/day, which was mass transit, 9.47 million person-trip/day (51.2%) and private vehicles 9.01 million person-trip/day (48.8%).

These large numbers of vehicles and traffic congestion have put severe impact on air quality of Bangkok. Figure2.2 shows emissions from mobile, point, and area sources in BMR. Mobile sources are the major emitters of NOx (80%), CO (75%), particulates (54%), and hydrocarbons (close to 100%). Moreover, Land Transport Department reported that among vehicular sources, light duty vehicles were the major sources of CO (79%) and HC (64%). Heavy duty vehicles and motorcycle vehicles were also the significant contributors of NOx (61%) and PM-10 (48%) respectively (Figure 2.3).

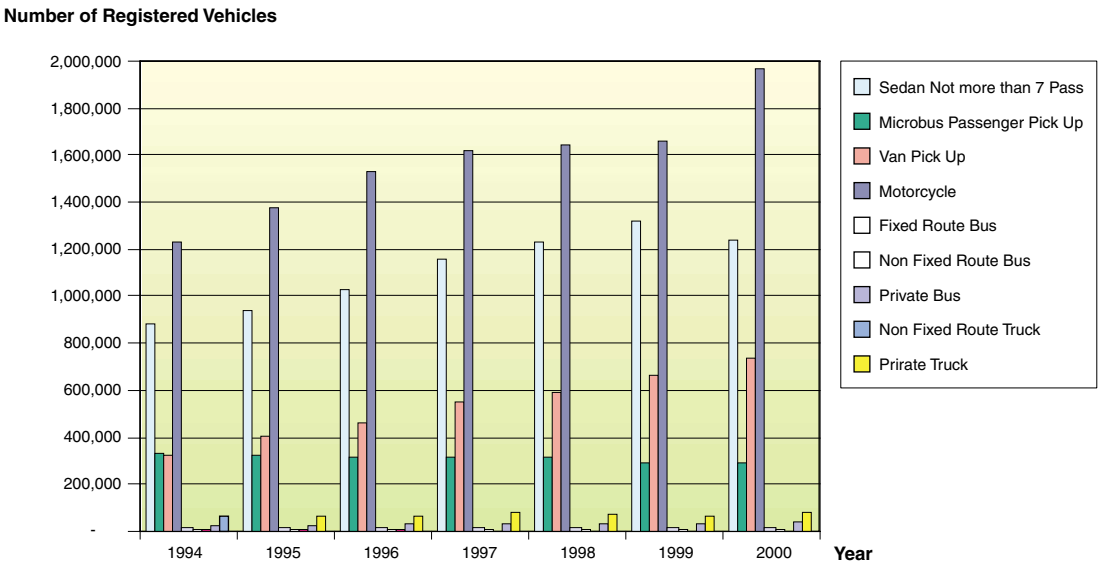


Figure 2.1 Number of Motor Vehicles Registered in Bangkok under Motor Vehicle Act and Land Transportation Act, 1994-2000
(Source: Land Transport Department, Ministry of Transport and Communications, 2000)

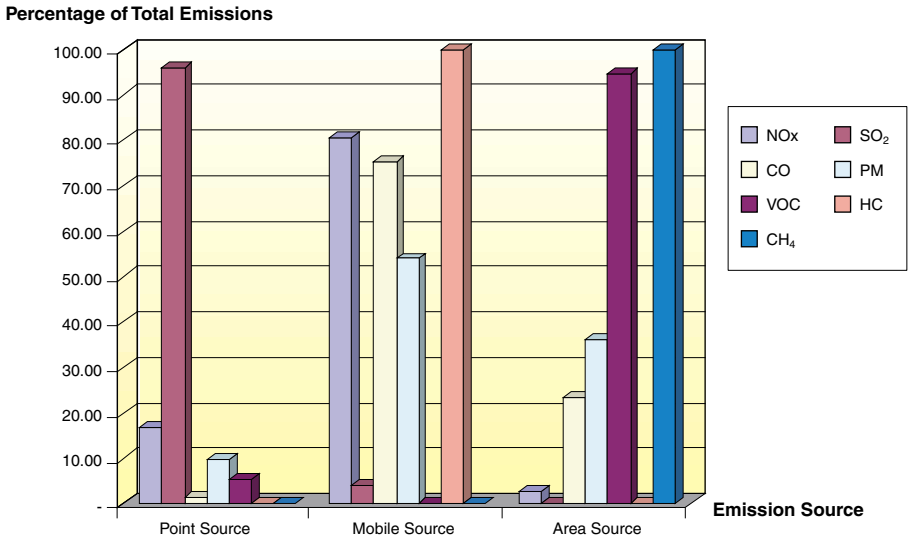


Figure 2.2 Percentage of Emission in BMR, 1997
(Source: Pollution Control Department, Ministry of Science, Technology and Environment,1997)

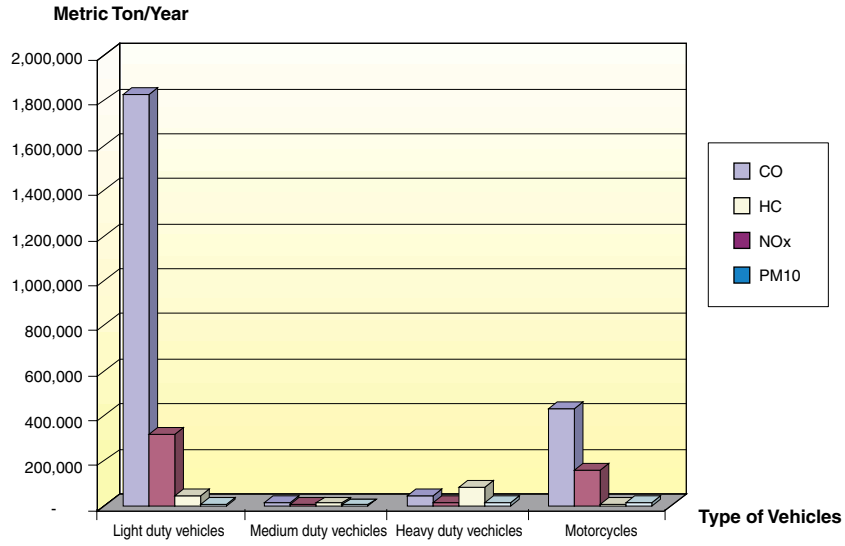


Figure 2.3 Emission Loads of Air Pollutants from Vehicles in Bangkok, 2000
(Source: Land Transport Department, Ministry of Transport and Communications, 2000)

2.1.2 Non-Mobile Source

Crematoriums in Bangkok cause both significant nuisance and air quality problems because of incomplete combustion. The majority (65%) of them burn wood chips and charcoal, while the rest primarily burns diesel fuel. Only a few use liquefied petroleum gas (LPG). Units that burn wood achieve relatively low combustion temperatures in their single combustion chambers. Currently, the BMA's Department of Health is conducting a study of low emission crematorium design by installing 20 new units at various temples. These units feature dual-LPG-fired chambers, high combustion temperatures, multi-point combustion, air injection, and photoelectric opacity sensors to control visible emissions. To date, only six such systems have been installed, and only five operate on a regular basis.

The National Environment Board and BMA's Department of Health have established performance and emission standards for crematoriums. In addition, the Ministry of Public Health has drafted standards for infectious waste incinerators, which are also being considered in reviewing the crematorium standards. These standards differ from one another, as shown in Appendix.

Estimates of the potential emission reduction from retrofitting non-conforming furnaces to BMA standards were prepared based on the current levels of emissions and an assumed distribution of future cremations using various types of equipment. The resulting estimated reductions are shown on Table 2.1.

Table 2.1 Estimated Potential Emissions Reductions (Ton per Year)

Pollutant	Current Emissions from Wood-Fired Facilities	Percent Reduction Required	Potential Emissions Reductions	Total Future Emission[1]
Particulate	1.984	84%	1.666	1.377
SO_2	0.928	53%	0.492	0.936
NO_x	1.515	35%	0.530	1.801
CO	1.260	80%	1.008	0.931

1. Future emissions from 145 converted wood-fired facilities, plus emissions from existing diesel and gas-fueled equipment.
Source: Pollution Control Department, Ministry of Science, Technology and Environment, 2000

The construction of buildings and infrastructures also lead to high level of dust pollution. Lack of proper planning and zoning of housing areas has also aggravated the seriousness of air pollution.

The central government, including the Pollution Control Department, Ministry of Science, Technology and Environment have played a vital role in air quality monitoring. There are seventeen ambient roadside air quality monitoring stations installed in order to monitor the air pollution and provide meteorological data. BMA has one ambient air and noise quality monitoring station at Rajthevi district office along with one mobile unit.

It has been noted that the level of lead in the air has reduced significantly after introduction of unleaded gasoline in 1993. The particulate matter with the diameter less than 10 microns (PM-10) is now considered as the top priority air pollutant, as exceeding of ambient air quality standard are widespread.

The main streets of Bangkok are facing serious problem of dust. In 1993, the level of PM-10 has become a significant problem along roadsides during the traffic congestion periods. In 2000, the 24-hour maximum average concentrations of TSP and PM-10 at roadside stations were about 400 µg/m^3 and 240 µg/m^3 respectively. Whereas the 24-hour maximum average TSP at ambient air stations (at least 50 meter away from main roads) was about 300 µg/m^3. These data are shown in Figures 2.4 and 2.5.

In 2000, one hour average concentration of ground level ozone was 13.9 ppb which was lower than the standard. However there were some peak hours with high concentrations, indicating that ozone may be an emerging problem.

Carbon monoxide, nitrogen dioxide, sulfur dioxide were below their ambient standards, but the carbon monoxide shows rising trend.

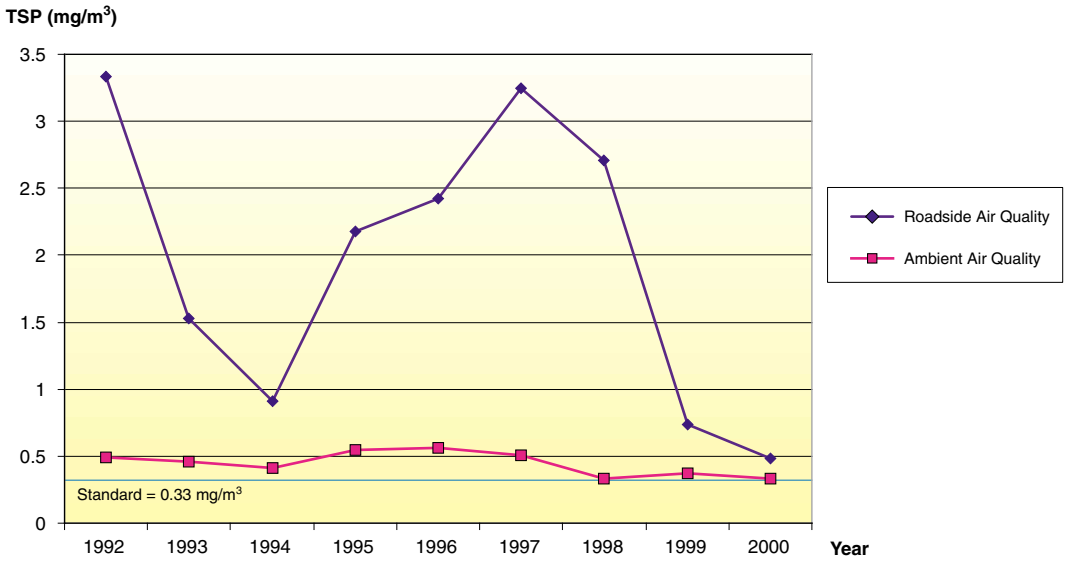


Figure 2.4 Average Bangkok's total suspended particulate (TSP) concentration, 1992-2000
(Source: Pollution Control Department, Ministry of Science, Technology and Environment, 2000)

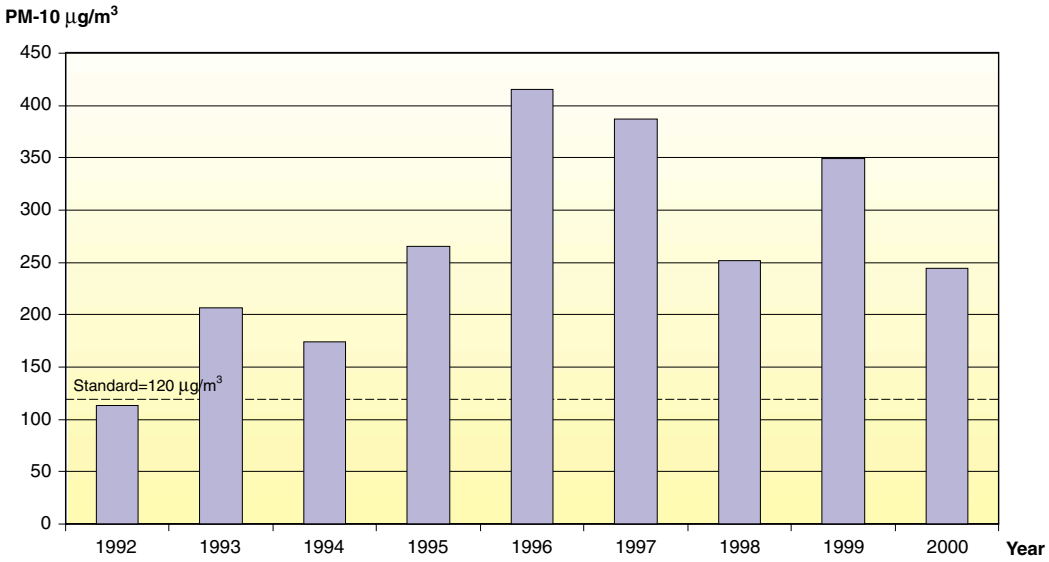


Figure 2.5 Particulate matter less than 10 micron(PM-10) 24 hour average at roadside in Bangkok, 1992-2000 (Source: Pollution Control Department, Ministry of Science, Technology and Environment, 2000)

2.2 Public Health Problems Resulting from Air Pollution

Air pollution has adversely affected the health of Bangkok residents. Bangkok residents are prone at risk of having chronic inflammation respiratory diseases. People suffering from throat irritation of varying degrees of severity are as high as 60 % , a trend which is expected to increase.

Most of the health studies in Bangkok and its surrounding areas focused on three main air pollutants, i.e., airborne particulate matter, lead, and carbon monoxide. The health effects examined were centered on respiratory-related illnesses. Findings from a World Bank funded project demonstrated an association between respiratory symptoms and PM-10. More importantly, this study found percentage changes in daily incidence of upper respiratory symptoms per 30 µg/m^3 increase of PM-10 at 9% for children, and 26% for adults who worked and lived at curbside and were highly exposed to PM-10; and 9% for adults who worked and lived in a more protected environment and were minimally exposed to PM-10. Similar dose-response relationships were found for lower respiratory symptoms; the percentage changes in daily incidence of lower respiratory symptoms per 30 µg/m^3 increase of PM-10 were 7% for children, 20% for highly exposure adults, and 5% for low exposure adults.

The study also found that a 30 µg/m^3 daily increase in PM-10 resulted in a 5.3% to 17.6% daily increases in hospital admissions. (Radian International, 1998)

Evaluating the acute morbidity effects of air pollution in Bangkok mainly involve examining the differences in acute effects between high and low pollution areas. The air pollutants in question were mostly particulate matter and carbon monoxide. Respiratory illnesses were found higher among children living in high pollution areas than children living in low pollution areas. Furthermore, children who might already have existing respiratory conditions were more sensitive to air pollution; their risk of developing respiratory symptoms was 2 to 4 times higher than normal children.

Most studies investigated the effects on groups who are highly exposed to air pollution. They include bus drivers, traffic policemen, and street sweepers. Higher rate of respiratory illnesses and abnormal lung function were observed. Additionally, among bus drivers, higher carboxyhemoglobin levels were found after work than before starting work which suggested effect of carbon monoxide.

The World Bank study determined the economic loss/ gain due to air pollution. The results show that the residents of Bangkok spent about 12.5% of their total medical expenses on respiratory illnesses alone (about 131 baht per family per month).

Economic valuation in terms of benefits from reduction in air pollution shows that 20 $\mu g/m^3$ reduction in annual average PM-10 concentrations in Bangkok would result in an estimated savings of 65 billion to175 billion baht (based on 1995 prices and US to baht exchange rate of $1 per 25 baht). These savings outweigh the costs of mitigation measures used to reduce the particulate matter. (Radian International, 1998)

2.3 Management and Control of Air Pollution

Both the central agencies and local governments such as Bangkok Metropolitan Administration have developed a clear policy to improve air quality. The National Economic and Social Development Plan has identified pollution control and environmental protection as one of the National Agenda items.

Vehicular emissions have been highly improved by controlling fuel quality and establishment of emission standards for the new vehicles. Phasing out of lead in gasoline was completed in 1996, which resulted in phenomenal reduction of lead in air down to approximately 0.22 $\mu g/m^3$, an insignificant level.

Introduction of unleaded gasoline also enabled the use of catalytic converters in gasoline cars and new emission standards led the improvement of diesel vehicles. Most obvious source of air pollutants in Bangkok is the motorcycles, which emit clouds of smoke. Standard for low-smoke lube oil and emission standards are being implemented in stages resulting in gradual conversion from two-stroke engines to four-stroke engines. Much improvement in air quality can be witnessed in Bangkok due to less smoke-belching buses, trucks and motorcycles, comparing to the past decades.

Figure 2.6 Cloulds of Smoke from Motorcycles

Figure 2.7 Black Smoke Inspection

BMA earmarked 1999 as the Air Pollution Mitigation Year and implemented the following 13 measures.

1. Providing free car engine tune-up service stations for the public.
2. Publishing car engine maintenance manuals for public distribution
3. Setting up black smoke inspection points in 50 districts jointly with the traffic police.
4. Setting up six mobile black-smoke inspection units in 6 areas.
5. Setting up motorcycle white smoke and noise level inspection units in the inner area of Bangkok.
6. Reporting about air pollution in critical areas in cooperation with Pollution Control Department through the display boards and air quality reports to promote pollution-free streets.
7. Designating pollution-free streets, which prohibited single occupant-vehicles. Originally, there were 3 streets, later increased to 8 streets.
8. Paving road shoulders to reduce dust.
9. Enforcing windscreens for buildings which were under construction.
10. Enforcing dust controls for trucks by covering loads and cleaning wheels.
11. Putting up campaign boards to inform the public on various measures being implemented.
12. Designating car-free streets to reduce air pollution.
13. Improving fuel quality by joint efforts to reduce air pollution.

Thai Government has developed mass transit projects for solving transportation problem, particularly rail transport system. BTS, the electric train, started operation in December 1999, there are 2 lines of this system, Sukumwit and Silom line with total distance of 23.5 km. The number of population using the electric train is about 300,000 per/day. Metropolitan Rapid Transit (MRTA) is under construction with the distance from Hua Lampong to Bang Sue at 20 km., extended blue line at 26 km. and orange line at 35 km. The first line of MRTA is scheduled to operate by the end of 2003. These mass transit projects can reduce private car and traffic congestion, and also reduce air pollution.

2.4 Future Plan

2.4.1 Land Development Project

After implementing 3 measures (pave street shoulder, enforce dust curtain for buildings during construction and dust control for construction material handling trucks) since 1997 to present, the Department of Public Works, BMA also supports improvement of air quality in Bangkok by introducing following future projects.

Railway Park Project:

Department of Public Welfare supports in renovation and construction of walkways and buildings in the newly established park which was formerly a golf course. Growing new trees in this park helps to reduce the air pollution of the Northern CBD of Bangkok.

Bang Khunthien Natural Center Project:

Introducing new natural center with camping area and observation deck in the southeastern area of Bangkok is another project to preserve coastal forest and provide clean air for the puplic.

Ta Thian Land Development Project:

Department of Public Welfare is working with Department of City Planning in the old city center to preserve valued buildings, piers, walkways and public facilities.

Rattanakosin Project:

This project is situated in the old city center to initiate car-free street not only for environmental benefits but also for tourism. The project includes provision of walking facilities, car parking and pubic transport interchange facilities within the area.

These projects are to be proposed in the Sixth Bangkok Metropolitan Development Plan (2002-2006) in addition to the traffic projects such as new road/bridge construction, road improvement, intersection improvement and superblock/bottleneck elimination projects.

Pollution-Free Streets

1. Ratchapralop	Ratchatavee District
2. Silom	Bangrak District
3. Phahonyothin	Phaya Thai District
4. Ardnarong	Khlong Toei District
5. Rama 9	Huai Khang District
6. Phetburi	Ratchatavee District
7. Ramkhamhaeng	Bang Kapi District
8. Sri Praya	Bangrak District

Figure 2.8 Pollution-Free Streets

2.4.2 Air Pollution Management Plan

The Objectives of Air Pollution Management Plan 2002-2006 proposed by Environmental Quality Control and Management Division of BMA are as follows:

1. Control and reduce emission of particulate matter from the sources to the standard levels.
2. Reduce emission level from vehicles through strict enforcement of inspection at roadsides.
3. Oversee and improve the licensing procedure of industrial operation in order to control industrial emission .
4. Raise public awareness on air pollution problems including the impact and promote public participation.
5. Monitor air pollution and evaluate its impacts.
6. Capacity building for BMA officials and provide equipment for measuring air pollution .
7. Support and encourage study and research on air quality.

2.4.3 Green Fleets Project

Green Fleets Project is an BMA's initiative in reducing pollution from BMA fleets. The objectives of Green Fleets Project are to reduce air pollution from motor vehicles by establishing incentive to get private sector involved, to raise public awareness, as well as to formulate policies.

The Green Fleets Project has the following strategies:

- Reduction of vehicle size to increase fuel efficiency
- Inspection and maintenance program support
- Switching to cleaner technology vehicles and cleaner fuels
- Retrofitting diesel vehicles with diesel catalytic converters
- Replacement of current vehicles with newer and less polluting ones
- Such as replacing 2 stroke motorcycles with cleaner 4 stroke ones)

2.4.4 Green Area Project

At present, 1,168 of public parks with the area of 9.134 million sq.m. have been established by Office of Public Park, Social Welfare Department, BMA. It has future plan to increase green area in Bangkok as recreation area and improve air quality. There are many projects which BMA has planned for the future, which are as follows:

1. Main Public Park Project: 5 sites with the total area of 172 rai(69 acres).
2. Road Park Project: Target: establish parks in the inner area with the distance of 20 km./year.
3. Community Mini Park: Target : 2 mini parks/district/year.
4. Perennial Growing Project: Target:growing 120,000 perennials/year.
5. Manage to procure public parks by purchasing, renting land or request for lands from sponsors.

3 Water Pollution in Bangkok]

3.1 Present Situation

3.1.1 Surface Water Contamination

The canals are presently highly polluted due to direct discharge of wastewater throughout the city area. Although large buildings are required to have some form of wastewater treatment, and also small private houses are required to have at least septic tanks to receive toilet wastes, domestic wastewater are mostly discharged to public drains without treatment. The septic tanks generally have outlets to public drains or canals. The study of Thailand Development Research Institute (TDRI) in 1988 showed that domestic sources account for 75 % of the wastewater generated in Bangkok while industrial sources account for the remaining 25 %. Later in 1996, the Pollution Control Department (PCD) estimated industrial wastewater in Bangkok region to be lesser than those estimated by the earlier plan (475,980 m^3/day in 2000 and 167,410 m^3/day in 2016). This is because the government encourages industries to be relocated outside of Bangkok area by using tax brakes and duty exemption (The Study for the Master Plan on Sewage Sludge Treatment/Disposal and Reclaimed Wastewater Reuse in Bangkok, 1999). The main source of water pollution in Bangkok is obviously the domestic sector.

In accordance to its role and responsibility, the Department of Drainage and Sewerage (DDS), BMA has operated a monitoring program for more than 20 years. The most recent survey, as presented on Figure 3.1-3.2 and Table 3.1, shows that water quality in Bangkok is critical in comparison to the surface water standards set by the National Environment Board (NEB). The summary of surface water standards is presented in appendix III.

3.1.2 Groundwater Contamination

Households in BMR use indoor pour flush latrines connected to septic tanks or leaching pits. Septic tanks are to allow the liquid effluents to percolate into the ground, while the accumulated sludge is collected by vacuum truck and disposed of at nightsoil treatment plants. Since septic tank cannot provide treatment efficiencies higher than 30-40 %, the discharge of the effluents created environmental problem to receiving surface water. The soil in BMR is clay in nature with low permeability value of the order of 10×10^{-7} cm/sec. The groundwater table is high and as a result, the leaching pits do not work properly. There is a possibility of constant exchange of flow between

groundwater and the leaching pit wastewater, leading to an increased probability of groundwater contamination and higher water levels in the pits.

3.1.3 Drinking Water Supply and Management

At present, the Metropolitan Waterworks Authority (MWA) produces water supply based on the demand, at the average of 3.8 million cubic meters per day (MCMD, 1991-2000). Almost 85% within the service areas under the responsibility of MWA are accessible to water supply although the authority has to face problems of fresh water shortage and deterioration of water quality in the drought period. Improper wastewater treatment and disposal of domestic, agriculture and industrial wastewaters at the upstream of Chao Phraya River cause these problems.

MWA water supply depends solely on the main surface water sources which are the Chao Phraya and Mae Klong rivers. The new fresh water canal for conveying fresh water from Mae Klong river to MWA's Mahasawat Water Treatment Plant is still under construction and will start its operation by the end of year 2002. At present, fresh water from Tajin River is being used as temporary source.

MWA's obligation to maintain tap water quality in accordance with WHO's standard is always being achieved. At present, tap water distributed by all 13-branch offices is absolutely safe for drinking.

Fresh water is a limited natural resources whilst there are various water users such as agriculture, navigation, and water supply. No doubt that the crisis on competing for water is getting more and more serious. Therefore, the enforcement of proper wastewater treatment before discharging into natural receiving bodies should be strictly controlled by the authorized agencies along with promotion of the campaign for efficient uses of water in the development of water resources conservation and sustainable water supply.

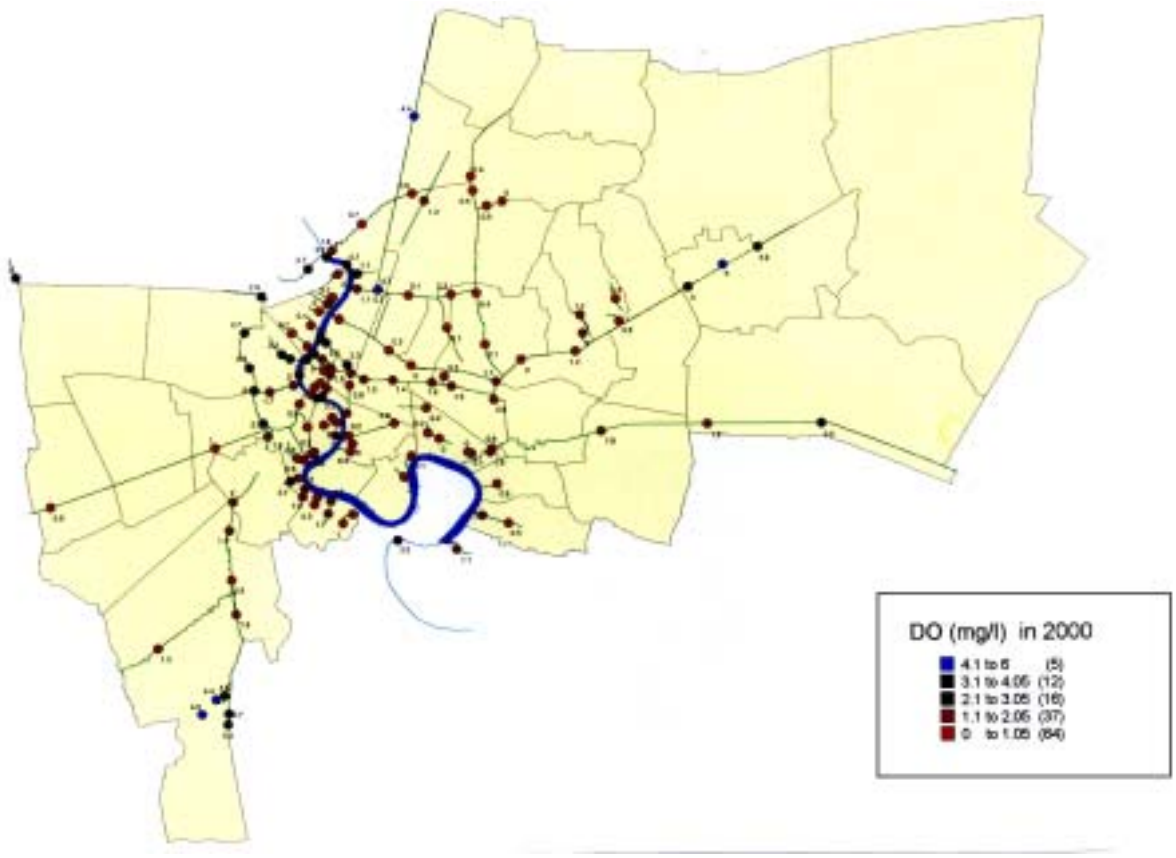


Figure 3.1 Water Quality in Bangkok in Canals (BOD) 2000
Source: Department of Drainage and Sewerage, BMA, 2000

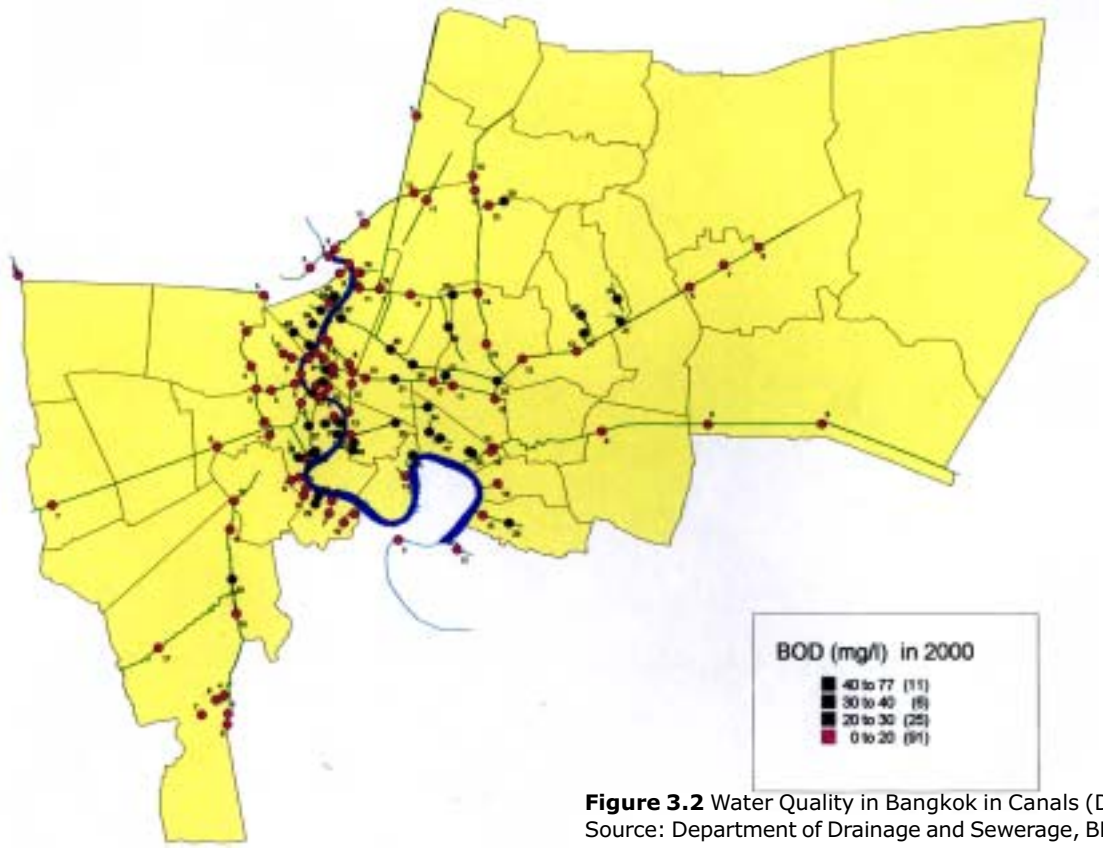


Figure 3.2 Water Quality in Bangkok in Canals (DO) 2000
Source: Department of Drainage and Sewerage, BMA, 2000

Table 3.1 2000 Chao Phraya River Water Quality

Sampling Point	Temp. °C	pH	DO mg/l	BOD mg/l	SS mg/l
Nonthaburi Pier	27.8	7.3	3.9	3	69
Rama VI Bridge	27.9	7.32	3.7	3	67
Chang Pier	27.9	7.34	3.9	3	88
Memorial Birdge	28.6	7.31	3.4	4	69
Supphanava-navy Pier	28.7	7.26	3.5	3	54

Source: Department of Drainage and Sewerage, BMA, 2001

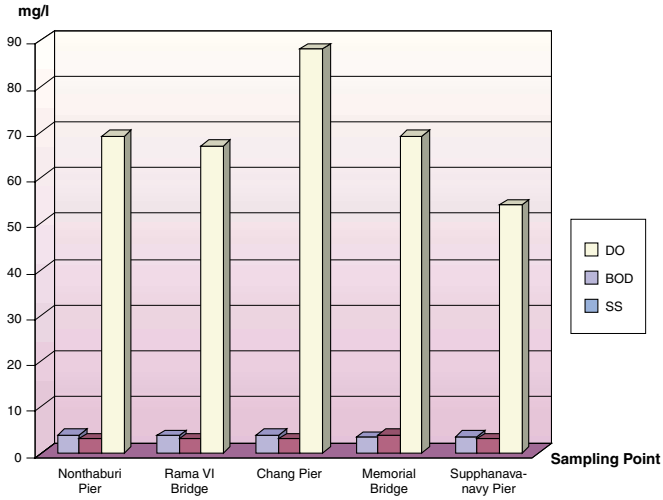


Figure 3.3 DO, BOD, and SS Observation in the Chao Phraya River Stretch 2001
(Source: Department of Drainage and Sewerage, BMA, 2001)

3.2 Impact of Water Pollution

3.2.1 Impact to Tourism Activities

Bangkok is the capital city and the center of tourism. Therefore, deterioration of canal water directly has impact to the tourism activity. As pollution in canals is in inner area of Bangkok, it certainly gives negative impression to the tourists who travel and stay in Bangkok.

3.2.2 Impact to Aquatic Life

Basically, water pollution causes deaths of aquatic creatures either by its toxicity or reducing dissolved oxygen concentration. The toxicity may come from high concentration of sulfide or ammonia. It is observed that when water is polluted there are usually

(1) A fall in the total number of species of organisms which are generally more sensitive than fishes ;
(2) A change in the type of species present;
(3) A change in the numbers of individuals of each species in the water.

In severe cases, where dissolved oxygen concentration becomes zero, all aquatic creatures died and this occurs in the highly polluted canals in Bangkok. In Chao Phraya River, even so me species of fish and plant cannot survive, or the number of the survivors is reduced.

3.2.3 Impact to Public Health

Poor sanitary conditions prevail in many parts of Bangkok. Records of some water related diseases generally associated with sanitary conditions in the Annual Epidemiological Surveillance Report of the Epidemiological Subdivision, Disease Control Division, Department of Health, BMA are illustrated in Figure 3.4 and Appendix V. In case of acute diarrhea, about 45,000 and 40,000 cases were found in 1994 and 1995 respectively. The figures were even higher in 1997. These, however, might not represent the true extent of waterborne diseases, as most cases were not recorded.

3.3 Water Pollution Countermeasures

3.3.1 Implementation of Central Wastewater Treatment Projects

The first Bangkok Sewerage System Master Plan was drafted in 1968. Then, the JICA's supported Master Plan was established in 1981. The Master Plan introduced the implementation of the Central Wastewater Treatment Projects to tackle water pollution. Since 1990, BMA has initiated a major program of central wastewater treatment schemes to improve water quality in the canals and in the Chao Phraya River. The seven areas, six large-scale wastewater treatment projects have been undertaken. These are all expected to be completed by 2005 and will provide service area over a total of 191.7 km^2 . Table 3.2 provides the status and detail of each project and Figure 3.5 shows Bangkok wastewater treatment project sites.

3.3.2 Improvement of the Community Wastewater Treatment Plants

In 1990, BMA and the National Housing Authority (NHA) have an agreement to transfer the NHA community wastewater treatment plants to BMA. The 12 community wastewater treatment plants are now being operated by BMA with total capacity of 25,700 m^3/day. At first, many of them were in poor condition but BMA has undertaken the repairs and renovation of these treatment plants to be in good operational condition, thus increasing their treatment efficiencies. This resulted in treating wastewater to meet the building effluent standards.

3.3.3 Canal Water Improvements

A canal water improvement project was initiated by JICA in 1990. The project provided re-circulation of cleaner water to the canals and to oxygenate canal water with aerators. During the dry season from December to April, river water is pumped from the Chao Phraya River to the

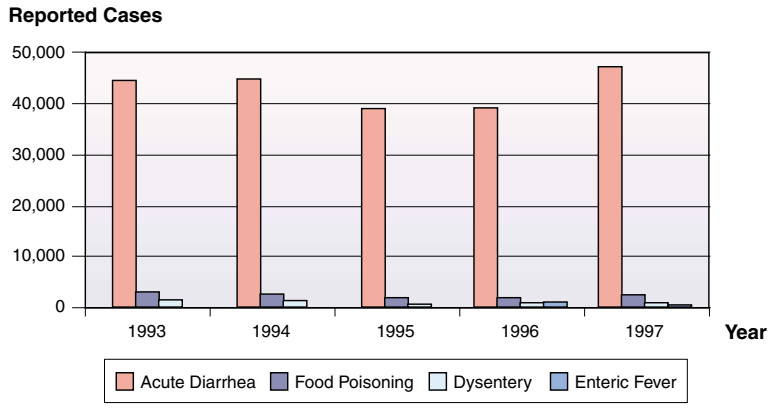


Figure 3.4 Reported cases of selected water-related diseases
Source: Department of Health, BMA, 1997

Table 3.2 Ongoing Wastewater Treatment Projects Status in 2002

Wastewater Treatment Project	Service Area (km^2)	Capacity (m^3/day)	Status
1. Si Phraya	2.7	30,000	Operation
2. Rattanakosin	4.1	40,000	Operation
3. BMA-1	37.0	350,000	Under construction
4. Chongnonsi	28.5	200,000	Operation
5. Nong Khaem-Phasicharoen Ratburana	44.0 42.0	157,000 65,000	Construction Completed, Operation Test
6. BMA-4	33.4	150,000	Under contruction
Total	**191.7**	**992,000**	

Source : Department of Drainage and Sewerage, BMA, 2002

canals. On the other hand, polluted canal water is pumped back to the river at an average of 2,083 m^3/min from Phra Khanong Pumping Station, located at downstream of the Chao Phraya River. This system includes water gates on the canals, which are needed to prevent salt water entering the canals at high tide, but despite of this, some canals have become saline. Several aeration systems have been installed in the canals and there is also a boat-mounted mobile aerator. There are also three aerated lagoons systems : the Makkason Pond is to improve Sam Sen Canal, the Rama IX Pond is to improve Lat Phrao Canal and the Buddamonthon Sai 2 Pond is to improve Bang Jak canal.

3.3.4 Legislation Measures

There are many effluent standards applied in Bangkok by the BMA offices such as the Building Effluent Standards formulated by the National Environment Board (NEB) and standards under the Public Health Act (1992). The effluent from municipal wastewater treatment plants which are operated by the Water Quality Management Division (WQMD), DDS, must meet the building effluent standards as show in Table 3.3 set by NEB. In addition, the WQMD and the District Offices are responsible for monitoring effluent generated from private buildings in Bangkok. The BMA has authority to enforce the Building Effluent Standards, the Public Health Act's standards and other related ones.

BMA established its effluent standards called "BMA Requirements" in effort to improve quality of surface water in Bangkok and also downstream of the Chao Phraya River, which is outskirt Bangkok. The requirements are more stringent than the Building Effluent Standards and are being applied to the BMA Central Wastewater Treatment Projects that control not only BOD and SS but also nutrients as total nitrogen and total phosphorus. To meet the requirements, the activated sludge biological nutrient removal treatment process has been selected. The aim is to reduce eutrophication in the receiving surface water. Moreover, to improve water quality in the receiving surface water, dissolved oxygen concentration standards in effluent has been set.

Table 3.3 Comparison of Significant Parameters Between the Building Effluent Standards (Type A) and BMA Requirements.

Parameter	Unit	Building Effluent Standards	BMA Requirements
1. pH	-	5-9	5-9
2. BOD	mg/l	< 20	< 20
3. SS	mg/l	< 30	< 30
4. Nitrogen (Ammonia)	mg/l	-	< 5
5. Total Nitrogen*	mg/l	-	< 10
6. Total Phosphorus	mg/l	-	< 2
7. Dissolved Oxygen	mg/l	-	> 5

Note: * only applicable when the BOD/N ratio in the incoming wastewater is 4 or higher.
Source : Department of Drainage and Sewerage, BMA, 2001

3.3.5 Public Relation Measures

In order to implement Central Wastewater Treatment Projects, public acceptance is necessary. Accordingly, BMA has to carry out public relation and information campaign. For examples: (1) conduct educational program in school and community; (2) organize training programs for BMA staff who monitor building effluent and for operators who are responsible for private wastewater treatment plants; (3) conduct public exhibitions and (4) provide more pubic information via meetings, brochures or media.

The objectives of such public relation and information campaigns are as follows:

(1) To ensure that public get knowledge about wastewater treatment projects including its progress, the benefits and impacts of such projects.
(2) To explain to the public that everyone produces wastewater from their daily activities and to convince them that everyone has the responsibility and should contribute toward the cost of treating wastewater. BMA, therefore, provides information with regards to the system of treating wastewater, the cost of treating wastewater and the procedure in collecting fees to the public. It is also important that the public be informed when the collection of fees will be initiated.
(3) To increase public awareness that improving the water quality will not be achieved without everyone's help. Individual can contribute by minimizing wastewater generation or avoiding any activity that would cause excessive wastewater from their daily life.
(4) To give knowledge and understanding of wastewater management, BMA educates or distributes technical information to the public.

3.4 Future Plan

3.4.1 Construction Measures

In the 5th Bangkok Metropolitan Development Plan from 1997 to 2001, the plan clearly describes that the construction of unfinished wastewater treatment plants (as listed in Table 3.4) be continued so as to enable them to operate in full capacity. In addition, the plan mentions that three new wastewater treatment plants are to be constructed. The wastewater related projects listed in sub work plan are:

Currently, 4 projects that BMA will include in the 6th Bangkok Metropolitan Development Plan (Draft) are Klong Toei (same as Phrakanong-Klong Toei in the 5th Bangkok Metropolitan Development Plan), Thonburi, Huai Khwang and Wang Tong Lang Projects. The 6th Bangkok Metropolitan Development Plan delays Nong Bon Project. Among those 4 projects, Klong Toei is the only project that its feasibility study was completed.

3.4.2 Sludge Management Project

The Sludge Treatment Center is under construction at Nong Khaem site. Anaerobic Digestion system has been employed with full capacity of 120 ton dry sludge/day. Sludge will be collected from Si Phraya, Ratanakosin, Stage 1 ,2 and 3 plants and transported to Sludge Treatment Center. The sludge from Stage 4 may be excluded from the plan and uses on- site anaerobic digestion system.

In addition, the Master Plan study on Sewage Sludge Treatment/Disposal and Reclaimed Wastewater Reuse in Bangkok was conducted and completed in October 1999. The Master Plan propose the sludge management in Bangkok for future management of sludge from wastewater and nightsoil treatment plant and its safe disposal for better environment.

3.4.3 Non-Construction Measures

3.4.3.1 Legislation Measures

To improve surface water quality, the next Central Wastewater Treatment Projects listed in the 6th Bangkok Metropolitan Development Plan will continue to follow the BMA's requirements. For the effluent generated by

Table 3.4 Listing of the Future Wastewater Treatment Project

Wastewater Treatment Project	Service Area (km^2)	Capacity (m^3/day)	Status
1. Thonburi	51	520,000	Preparation for the Feasibility Study
2. Phrakanong - Klong Toei	71	480,000	Completion of Feasibility Study
3. Nong Bon	55	125,000	Listed in the 5th BMD Plan
Total	**177**	**1,125,000**	

Source : Department of Drainage and Sewerage, BMA, 2001

private buildings, besides inspection and enforcment through related laws and regulations, BMA prepares to establish new regulation concerning the wastewater user charge in Bangkok area. Currently, BMA has set up the committee to work on the legislation aspect of wastewater user charge.

3.4.3.2 Public Relation Measures

The future plan of public relation measure is focused not only to provide knowledge and information but also to promote people participation in various activities. The Water Quality Management Division (WQMD) will continue carrying out the public relation activities of previous plan. From the experience of some wastewater treatment projects in Thailand, social acceptability and awareness is necessary for preventing local people to be against the project. It is obvious that if there is more public awareness, the more public cooperation will be given to the agencies responsible for water quality management.

3.4.3.3 Wastewater User Charge

The wastewater user charge will be implemented in the near future. Co-operation among agencies are needed such as Metropolitan Waterworks Authority and private sectors. Some strategies for collecting fee will be established including the rate of wastewater user charge. Only the residents in the service area will be charged.

3.4.3.4 Private Sector Participation

The private sector participation was not stated in the original plan. BMA generally implements Turnkey construction with one-year operation . In the future BMA has to consider the methodology of private sector participation that may also be applied to Wastewater Treatment Project Management. Regarding to the Feasibility Study of the Klong Toei Wastewater Treatment Project, the turnkey strategy is recommended. However, BMA may consider increasing the operation period from one year to 3-5 years. A longer operations period would encourage wastewater system developer to optimize the design, not only for capital costs, but also for operations costs.

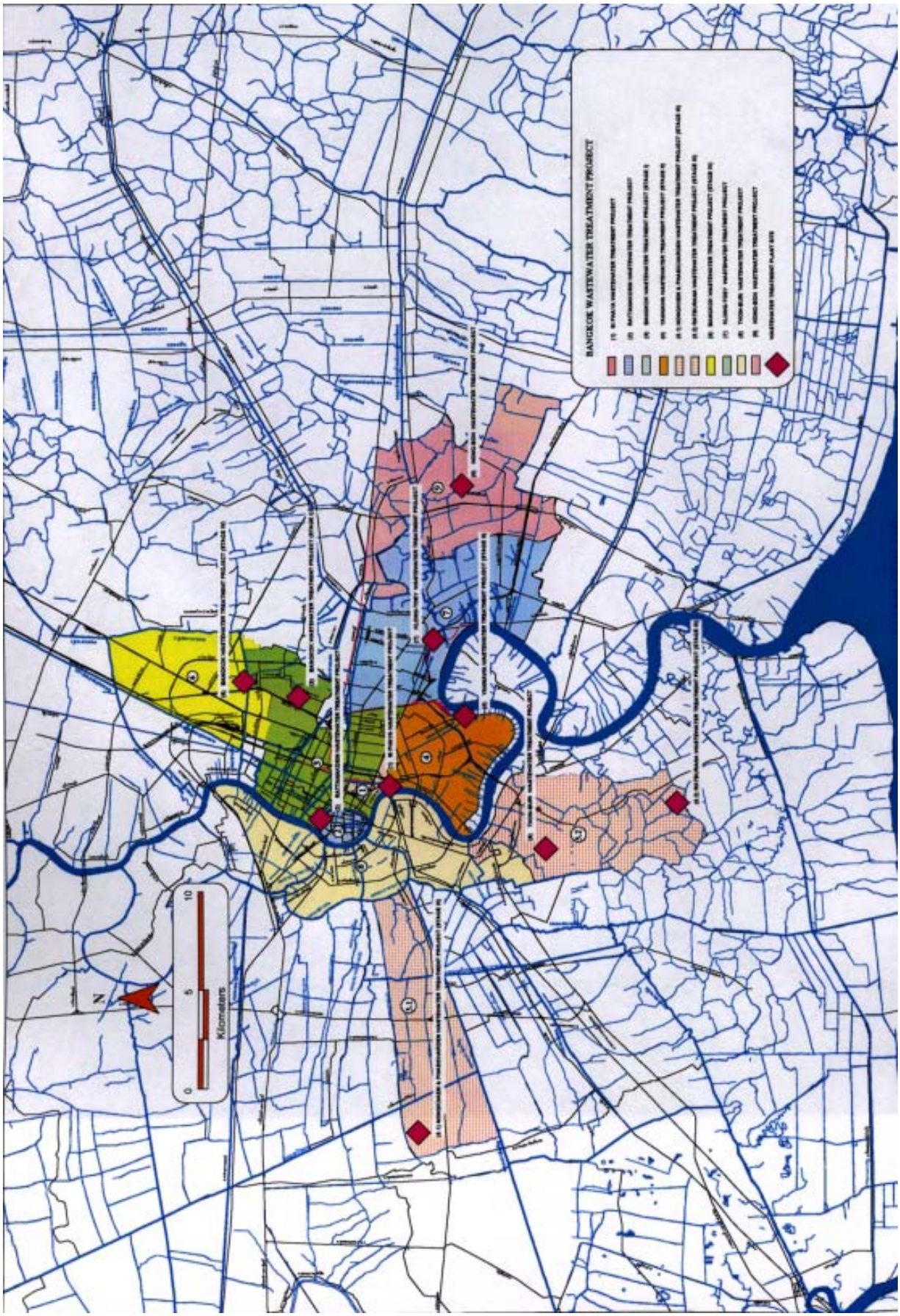


Figure 3.5 Wastewater Treatment Plant Sites
Source: Department of Drainage and Sewerage, BMA, 2000

4 Solid and Hazardous Waste

4.1 Present Situation

In Bangkok, the average solid waste generation per day has doubled from 3,260 tons/day in 1985 to 6,633 tons/day in 1995. In 2001, approximately 9,173 tons/day of solid waste were generated. Each year, solid waste generation has increased as shown in Figure 4.1. This increase is due to various factors such as increasing population, consumption pattern and changing lifestyle. Thus along with the economic growth of the city solid waste management is the essential component which needs to be seriously considered.

At present BMA is responsible for collecting hazardous and infectious wastes from households and hospitals. The Ministry of Industry is responsible for hazardous wastes from industrial sources.

4.2 Hazardous Materials

Hazardous materials are extensively used in the households, factories and in agricultural sector. The consumption and impact of hazardous materials has increased rapidly since 1988. In factories, in creasing use of hazardous materials and lack of effective controls lead to increased injuries and loss from accidents as well as vulnerability to chronic diseases for the employees . The explosion at Khlong Toei port in 1997 was one of the worst event revealing the widespread unsafe storage and use of hazardous materials. The improper disposal of hazardous wastes pollutes the environment as well as endangers human health.

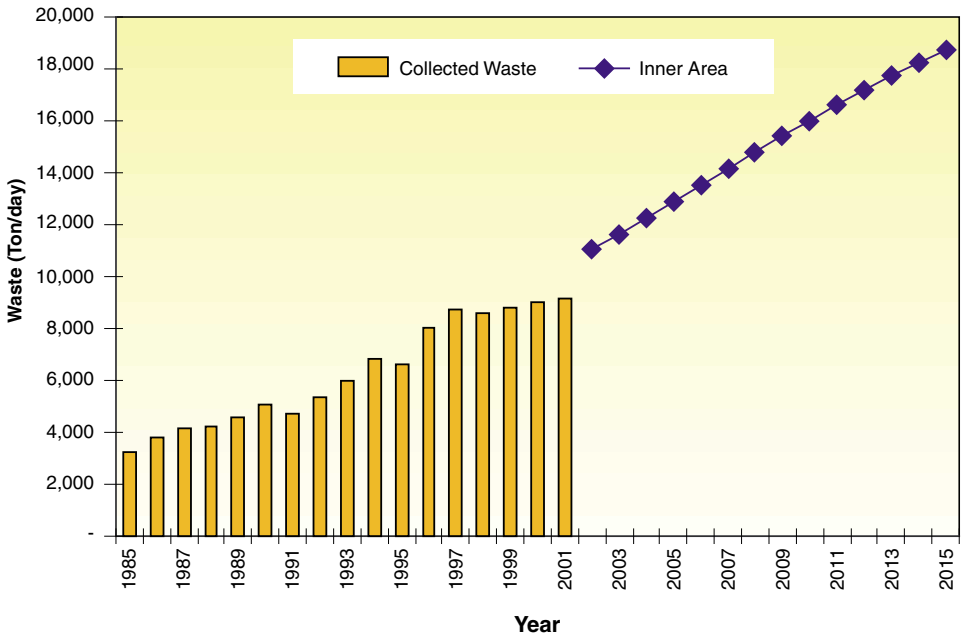


Figure 4.1 The Quantity of Collected Solid Wastes in Bangkok 1985-2001 and the Estimated Solid Wastes Generated in 2002-2015 (Source: Department of Public Cleansing, BMA, 2001)

4.3 Solid and Hazardous Waste Management

4.3.1 Hazardous Waste Management by BMA

BMA collects household hazardous waste such as batteries, fluorescent light bulbs, insecticide cans, herbicide cans, etc. by placing bins (grey bin with red lid) at appropriate places in the city. These hazardous wastes are collected by Public Cleansing and Public Parks Section of each district and stored at three transfer station sites before transporting to General Environmental Conservation Public Company Limited (GENCO) for disposal. Infectious waste from hospitals and clinics are collected and disposed by 2 incinerators at On-nuch site. Each incinerator has the capacity of 10 tons per day.

BMA hazardous waste management process is shown in Figure 4.2.

4.3.2 Solid Waste Management by BMA

BMA operates 3 transfer stations at On-Nuch, Nong Khaem and Tha Raeng. The wastes are transferred to sanitary landfills at Kumpaeng Saen district at Nakhon Phathom province and Bang Plee district at Samut-Prakarn province.

The process of solid waste management in Bangkok is shown in Figure 4.3.

Solid Waste Collection

The Public Cleansing and Public Park Section of 50 district offices and the Public Cleansing Service Division of Public Cleansing Department, BMA are responsible for the collection of solid waste in Bangkok. The quantities of solid waste collected in Bangkok are shown in Figure 4.4. Present waste stream model of BMA is shown in Figure 4.5. The physical composition of collected solid waste in 1991-2000 is shown in Table 4.1, Figures 4.6 and 4.7.

BMA has applied direct and indirect methods for collecting solid waste :

1. For direct collection method the waste is collected by vehicles or boats. In this method collection is from house to house in various areas where accessible. If not then the residents need to carry the waste to the waste collecting vehicles.

2. Indirect collection is a system in which BMA provides containers for collecting waste at various sources such as markets, department stores, and pedestrian walkways. The containers are placed along the roads or in the designated areas.

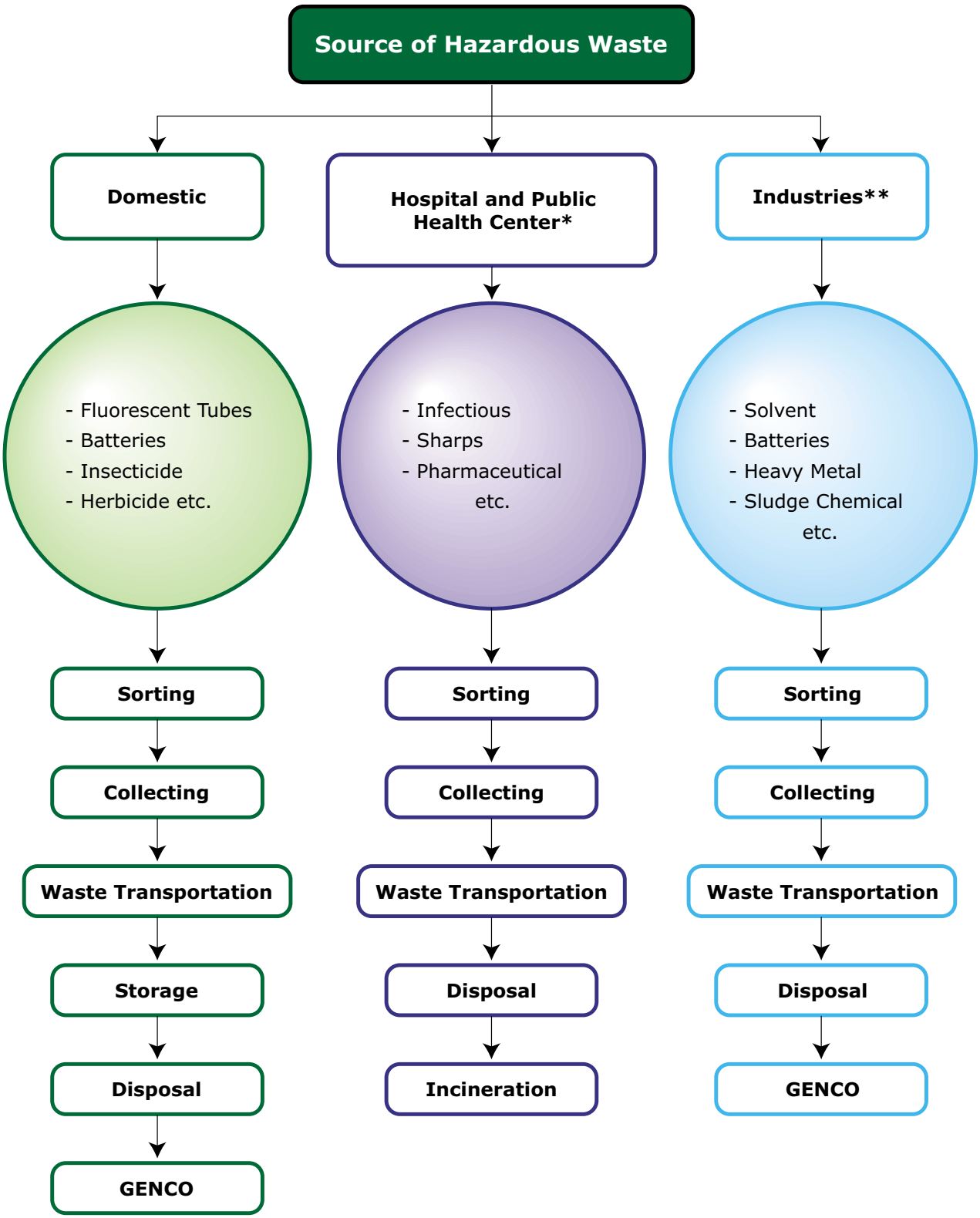


Figure 4.2 The BMA's Hazardous Waste Management Process
(Source: Department of Public Cleansing, BMA, 2001)
* Infectious and radioactive wastes are collected and disposed separately.
** Industrial waste is managed by Ministry of Industry.

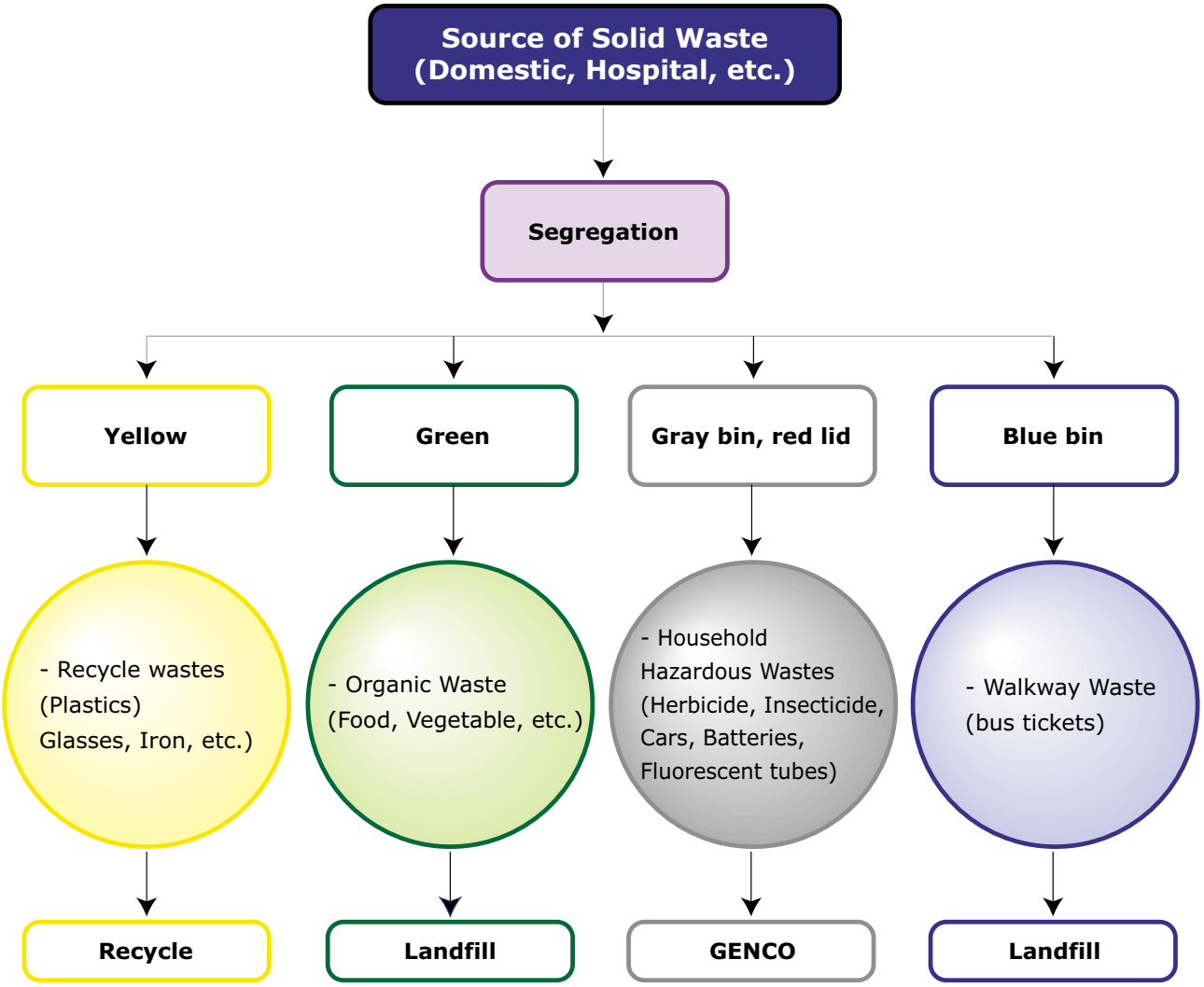


Figure 4.3 The Process of Solid Waste Management of BMA.
Source: Department of Public Cleansing, BMA, 2001

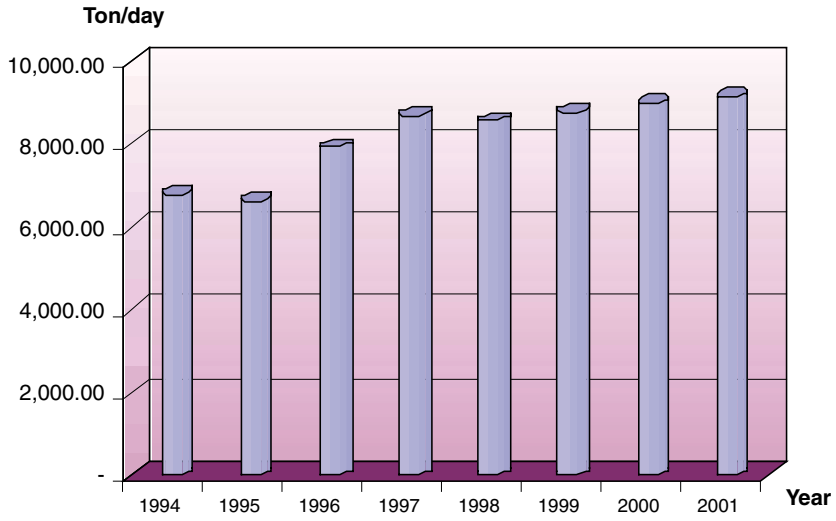


Figure 4.4 The Solid Waste Collection by BMA in 1994-2001
Source : Department of Public Cleansing, BMA, 2001

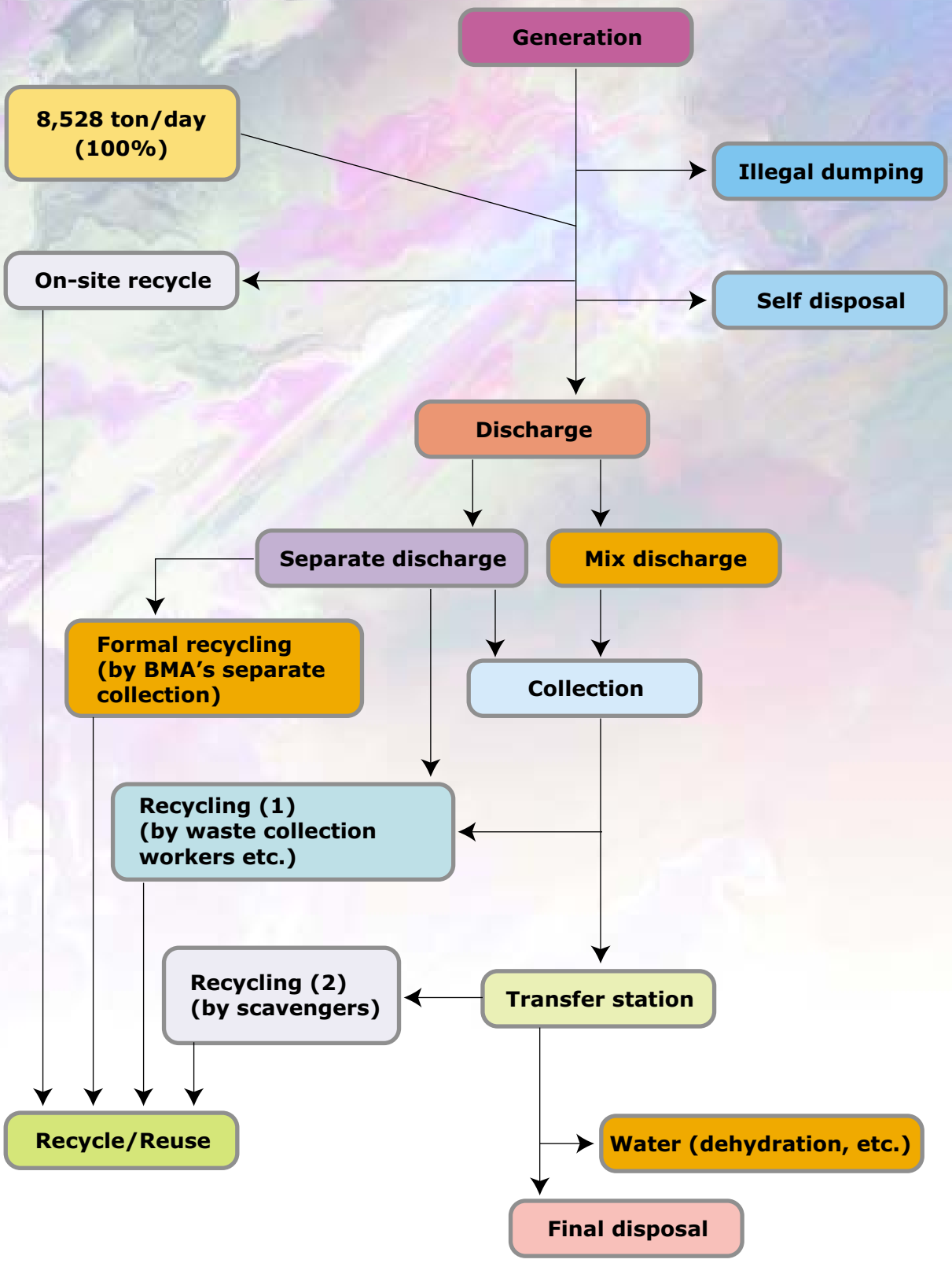


Figure 4.5 Bangkok Solid Waste Stream Model
Source : Department of Public Cleansing, BMA, 2001

Table 4.1 Physical Composition of Solid Waste 1991-2000

Type of solid waste	Composition (% by weight)									
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Combustible	**81.03**	**83.80**	**91.01**	**91.63**	**92.31**	**89.67**	**93.23**	**93.94**	**97.37**	**95.08**
Paper	19.23	10.80	15.40	13.99	14.49	11.25	11.39	11.58	9.57	8.66
Textile	5.53	4.15	4.50	3.49	1.95	7.34	6.17	3.71	11.01	6.43
Plastic&Foam	16.22	19.10	16.02	20.66	18.72	19.06	17.43	19.80	25.84	19.47
Wood and leaves	4.78	7.06	4.24	5.89	5.39	2.98	5.77	14.51	7.89	6.77
Garbage	8.10	18.94	15.76	14.72	20.72	28.74	44.28	35.54	35.41	46.88
Leather	5.28	1.66	2.17	0.15	0.82	2.36	0.62	0.82	2.15	0.11
Unclassified	21.69	22.09	32.92	32.73	30.22	17.93	7.57	7.87	5.50	6.76
Non-combustible	**19.17**	**16.20**	**8.99**	**8.37**	**7.69**	**10.34**	**6.77**	**6.17**	**2.63**	**4.92**
Metals	4.98	1.66	2.52	2.00	1.28	2.76	2.30	2.00	0.96	1.49
Glasses	4.52	10.80	4.65	4.64	3.86	6.72	4.47	4.17	1.67	2.57
Stones&Ceramic	4.70	2.08	0.61	1.11	1.77	0.46	0.00	0.00	0.00	0.51
Bones&Shells	4.97	1.66	1.21	0.62	0.78	0.40	0.00	0.00	0.00	0.35
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Department of Public Cleansing, BMA, 2000

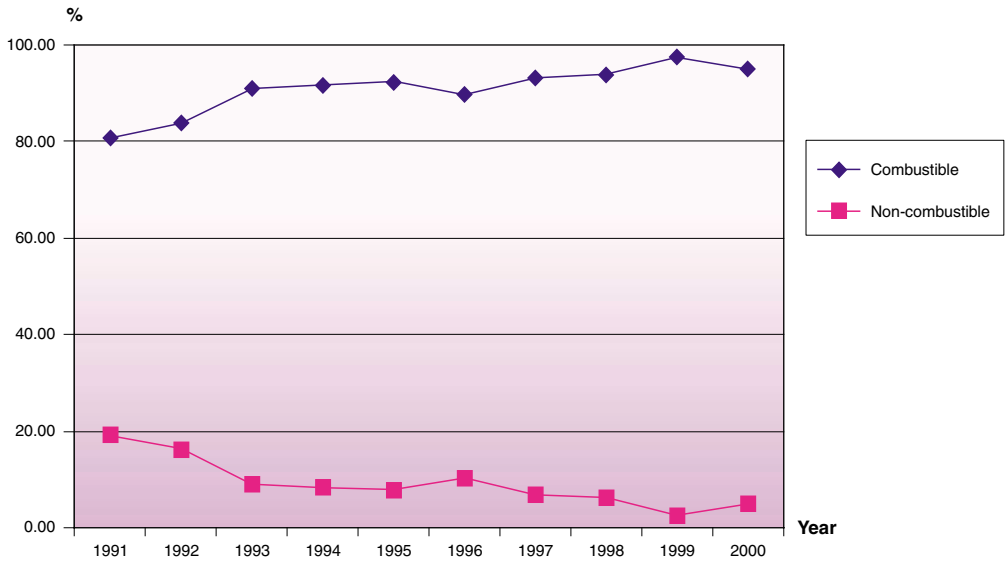


Figure 4.7 Combustion Characteristics of Solid Waste 1991-2000
(Source: Department of Public Cleansing, the BMA, 2000)

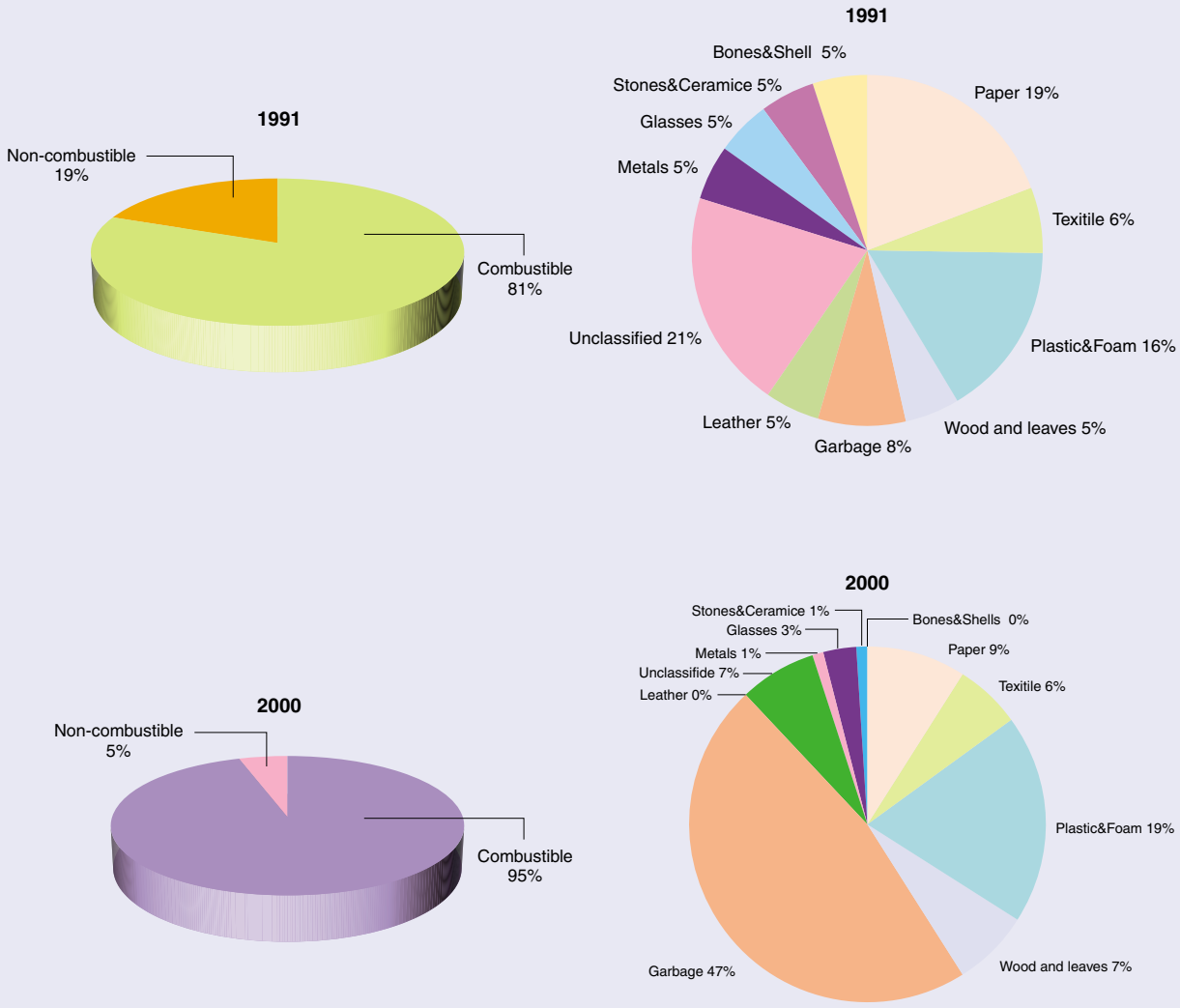


Figure 4.6 Type of Solid Waste composition 1991 and 2000
(Source : Department of Public Cleansing, BMA,2000)

4.4 Solid and Hazardous Waste Control Measures

4.4.1 Public Participation

1. Good Looking Home Front Project : To foster people's sense of responsibility on their own homes, society and environment, BMA supports public participation in cleaning their communities, by encouraging row houses, schools, shops and others situated along main streets to join in keeping their compound, public sidewalks clear and clean.

2. Appointed Waste Collection Time Project : BMA schedules for improving waste collection system according to the public convenience. So the time period for daily garbage collection is fixed from 18.00 to 03.00 hour. The green or yellow waste containers according to the category of waste are placed according to the population density

3. Waste Minimization Project : To decrease the amount of solid waste by urging people to reduce and separate wastes before disposal, encouragement on "Waste Minimization" is carried out by involving public participation by "Thinking Over and Saving Resources". For this, people are given suggestions on how to reuse, repair , recycle

and reduce excessive use in order to reduce the waste generation.

4. Community in Your Hands Project : To draw public attention on waste minimization

5. District Offices and Build up of Public Awareness Project : To conduct pilot project to generate public awareness on waste, BMA targeted on six groups of educational institutes, medical centers, enterprises, department stores, organizations and communities in four districts of Bang Sue, Khlong Toei, Rat Burana and Laksi.

4.4.2 Improvement of Waste Collection

In order to improve the waste collection, the new waste collection systems are introduced for the waste which are as follows

- BMA's Database of Waste Collection Vehicles Project
- Setting Containers for Pedestrians Project
- Vehicle Supply for Retaining Waste Collection Efficiency Project
- Waste Collection Truck Care Project
- Improvement of Collection Routes Project
- Waterway Waste Collection Project

4.4.3 Improvement of Waste Disposal

- Private Contractors for Transferring Waste from BMA's Waste Transfer Stations to Landfill Sites Project
- Private Contractors for Old Waste at On-Nuch Solid Waste Treatment Plant Project
- Private Contractors for Old Waste at Nong Khaem Solid Waste Treatment Plant Project
- Private Contractors for Infectious Waste Collection Project
- Private Contractors for Compost Plant Improvement at On-Nuch Project

4.4.4. Improvement of Nightsoil Management

- Public Toilet Service
- Mobile Toilet Care and Temporary Toilet Service
- Grease and Oil Wastes Transfer from Restaurants, Food Stalls and Gas Stations Project
- Nightsoil Vacuum Boat Project
- Supply of Nightsoil Vacuum Trucks for District Offices
- Private Contracting for Operating Nightsoil Treatment Project
- Private Contracting for Mobile Toilet Service Project

4.5 Policies and Regulations

4.5.1 The Public Health Act, B.E. 2535 (1992)

The Chapter 3 of this Act is relevant to the solid waste disposal which indicates that the local government should be responsible for disposal of solid waste in the respective area.

For maintaining cleanliness and establishment of orderliness in collecting, transporting, and disposing of solid waste the local governments have powers to establish local provisions issues as follows:

(1) forbidding the discharge of the solid waste in public place. It also indicates that the waste should not be mismanaged in any areas except in the places provided by the local government.




(2) prescribing means of collecting, transporting, and disposing of solid waste. The owners or occupants of any building or areas are required to manage properly for the hygienic purpose.

(3) prescribing rate of fees for service charges provided by the local government for collection and transportation of solid waste which should not exceed those prescribed in the ministerial regulation;

(4) Prescribing any other requirements necessary for hygienic practice.

4.5.2 The Public Cleanliness and Orderliness, Act B.E.2535 (1992)

According to this Act, it is prohibited to deposit solid waste in public places or outside the containers or areas set up by the local authority. Violators will be fined up to the maximum amount designated by the Act.

4.5.3 The Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 (NEQA 1992)

The major sections of NEQA includes Pollution Control Areas in which formulation and establishment of pollution control standards from sources, categorization of pollution control source as controlled emissions, effluent or waste disposal, to set up the Pollution Control Committee to formulate policies and plans, to coordinate re-mediation of pollution problems and to prescribe the possible pollution prevention measures. This has been chaired by the Permanent Secretary of Ministry of Science, Technology and Environment (MOSTE). Pursuant to NEQA, Pollution Control Department (PCD), stipulates the criteria, methods and conditions of pollution management, assigns Pollution Control Officers to establish Fees and Fines and Civil Liability and provision of penalty in case of violation or refuse to comply with the rules and regulation.

4.5.4 The Factory Act, B.E. 2535 (1992)

To prevent the environment from any discharge of pollutants by the factories, the provision in section 8 empowers the Ministry of Industry to enact the ministerial regulations. These regulations control the industrial environment as well as guide the way of controlling the waste discharges, or any other pollutants from the factories which might cause the adverse impact on the environment.

4.5.5 The Hazardous Substances Act, B.E. 2535 (1992)

This Act controls 4 types of designated hazardous substances in terms of (1) production, (2) import, (3) export and (4) possession of hazardous substances in order to prevent from causing impact to the person, animals, plants or to the environment.

4.5.6 The Atomic Energy for Peace Act B.E. 2504 (1961)

It is the primary law governed to control and manage the import, export, manufacturing, possession and disposal of radioactive substance from the waste stream.

4.5.7 The Fifth Bangkok Metropolitan Development Plan (1997 - 2001)

The disposal of solid waste, night soil and hazardous waste is one of the work plans in the Fifth Bangkok Metropolitan Development Plan (1997-2001). In order to protect the public health and environment from solid and hazardous waste, many improvement activities have been specified such as the application of technically sound solid waste disposal systems, public awareness campaign on solid waste disposal, the improvement of solid waste collection, the priority on solid waste reduction at the source and provision of infectious waste collection and disposal.

4.6 Future Plan

4.6.1 Public Participation
- Encouragement of Waste Minimization and Separation Project
- Good Looking Home Front Project
- Encouraging Household Hazardous Waste Separation Project
- Reprocessing Fresh Garbage into "Odorless Garbage" Project

4.6.2 Improvement of Waste Collection
- Development of Efficient Waste Collection by Geographic Information System (GIS)
- Development and Management of a Fee Collection System
- Encouraging Household Hazardous Waste Collection and Transfer by Separate Trucks
- Private Contracting for Business Waste Collection Project

4.6.3 Improvement of Waste Disposal
- Integrated Solid Waste Disposal Project consisted of sorting, composting and incineration Systems
- Preparation of a Master Plan for Land Use for BMA's Solid Waste Disposal Plants
- Upgrading Sanitary Landfills to comply with international standards
- Installation of machines to dispose of construction and demolition waste
- Preparation of a preliminary hazardous waste storage and treatment system project for communities
- Contractors from private sector for Solid Waste Disposal and Nightsoil Treatment Project

4.6.4 Improvement of Nightsoil Management
- Provision of Public, Temporary and Mobile Toilet Services
- Private Contracting for Nightsoil Transfer Project
- Construction Project of a Compacted-Fertilizer Plant from Nightsoil Sludge

5 Land Subsidence

5.1 Background

BMR are facing considerable land subsidence problems resulting from overuse of groundwater. Subsidence occurred at rates up to 10 cm./year in critical areas. The crisis has worsened flood conditions and caused damage to buildings and infrastructures. Since 1983, government agencies have monitored subsidence and groundwater levels, and implemented several measures to mitigate the problem.

5.2 Demand on Groundwater Resources

The reason for the extensive use of groundwater in Bangkok prior to 1990 was due to the lack of Metropolitan Waterworks Authority's services to the outlying areas of the city. Until 1987, the tap water services were made available in both level I and level II critical areas. (Level I Covers areas of land subsidence greater than 10 centimeters/year, Level II Covers areas of land subsidence from 5-10 centimeters/year).

Figure 5.1 Land subsidence causes damage to the several building and infrastructure in Bangkok

Therefore, groundwater consumption in the critical areas was reduced. In 1994, the price of groundwater was raised in order to reduce groundwater consumption. However, the rate of groundwater consumption in Bangkok is 567,935 m^3/day in 2001, which is about two fold of 1995. The rates of groundwater production and consumption in Bangkok from1995-2001 are shown in Table 5.1.

5.2.1 Land Subsidence Crisis

At present, the average land subsidence rate in Bangkok is about 1.5-2.2 cm./year which is much lower than the past decade (5-10 cm./year during 1980-1990) (Department of Mineral Resources, Ministry of Industry). However, subsidence is increasing in the provinces around Bangkok. Therefore mitigation measures are extended to cover those affected areas.

5.2.2 Change in Groundwater Levels

The country is facing severe problem to maintain the ground water level. Groundwater levels in provinces situated outside Bangkok have lowered significantly in conjunction with land subsidence. The water level of the Nakorn Luang aquifer lowered from 54 to 68 m., and the shallower Nonthaburi aquifer from 38 to 64 m. (Department of Mineral Resources, Ministry of Industry).

5.2.3 Groundwater Monitoring in Bangkok

Groundwater monitoring in Bangkok has been conducted since 1965. The program collects information regarding groundwater level, the current state and long-term trend of groundwater quantity and quality.

Out of total of 117 groundwater monitoring stations, there are 78 complete stations where each station consists of 3 monitoring wells penetrating three different aquifers: Phra-Pradaeng, Nakhon Luang and Nonthaburi; 12 stations of 2 wells and 27 stations of one well or the wells drilling in the other aquifer. Figure 5.2 shows the locations of the 117-groundwater monitoring stations (Department of Mineral Resources, Ministry of Industry).

5.3 Land Subsidence in Bangkok City and its Impact

Geographically, the critical areas of land subsidence are in the Southern and Eastern parts of the city. Since Bangkok is at almost sea level, the most serious impact is flooding during the end of the rainy season. Notable floods occurred in 1983, 1995, and 1996 which costs billions of baht . In addition to the flood, Land subsidence also causes many problems including:

(1) changes in elevation and slope of streams, canals, and drains;

(2) damage to bridges, road, railroad, storm drains, sanitary sewers, canals, and levees;

(3) damage to private and public buildings; and

(4) failure of well casings from forces generated by compaction of fine-grained materials in aquifer systems:

(5) in some southern coastal areas, subsidence has resulted in tides moving into low-lying areas that were previously above high-tide levels;

(6) cost of pumping stromwater and sewage out to Chao Phraya river and Gulf of Thailand.

Table 5.1 Groundwater Production and Consumption in Bangkok, 1995-2001

Year	Total		Consumtion		Commercial Industry		Agriculture		Government	
	Wells	Quuantity (m^3/day)	Wells	Quuantity (m^3/day)	Wells	Quuantity (m^3/day)	Wells	Quuantity (m^3/day)	Wells	Quuantity (m^3/day)
1995	1,313	307,739	630	123,301	651	181,180	32	2,258	-	-
1996	1,422	503,048	675	150,527	637	176,923	33	3,395	52	170,328
1997	1,375	402,940	696	155,536	618	176,461	32	3,260	4	65,808
1998	1,384	411,372	712	157,323	612	183,166	31	3,200	29	67,683
1999	1,440	491,317	742	159,445	638	189,014	31	3,175	29	67,683
2000	1,641	573,008	830	159,306	697	329,112	31	2,030	83	82,560
2001	1,879	567,935	902	19,323	857	290,625	37	1,417	83	82,560

Source: Department of Mineral Resources, Ministry of Industry, 2001

5.4 Policy and Regulation

The National Environment Board has designated Bangkok City and the surrounding provinces as a critical area with respect to groundwater and subsidence for which series of policies have been formulated. These include expansion of water work service to cover the area, using pricing system to discourage groundwater use, to study groundwater recharging, and promotion of public information on water saving. These measures for groundwater management were implemented by the Department of Mineral Resources with Groundwater Act, B.E.2520, amended B.E.2525. Ministry of Industry formulated the price for groundwater use in the Ministerial Regulation No. 8, B.E. 2543 under Groundwater Act, B.E. 2520.

5.5 Future Plan

Recharging of the aquifers will require appropriate technology for which Department of Mineral Resources and relevant agencies were instructed to study. Higher prices for groundwater and Groundwater Conservation Trust Fund have also been proposed.

A draft BMA Regulation entitled "Administration and Management of Groundwater Wells" was proposed by the Department of Community Development, BMA to guide communities who are relying on groundwater due to lack of public water supply. It has also formulate a regulation for group of groundwater users for well administration and maintenance. A district groundwater well administrative committee should be formed to supervise and provide technical support. This enables consistent well administration and management to save BMA's well maintenance cost. According to the draft regulation, the groundwater users should administer and manage the wells and be responsible for any cost by themselves . The government will provide support only if it is beyond their capacity. The draft was approved in principle on January 24, 2001.

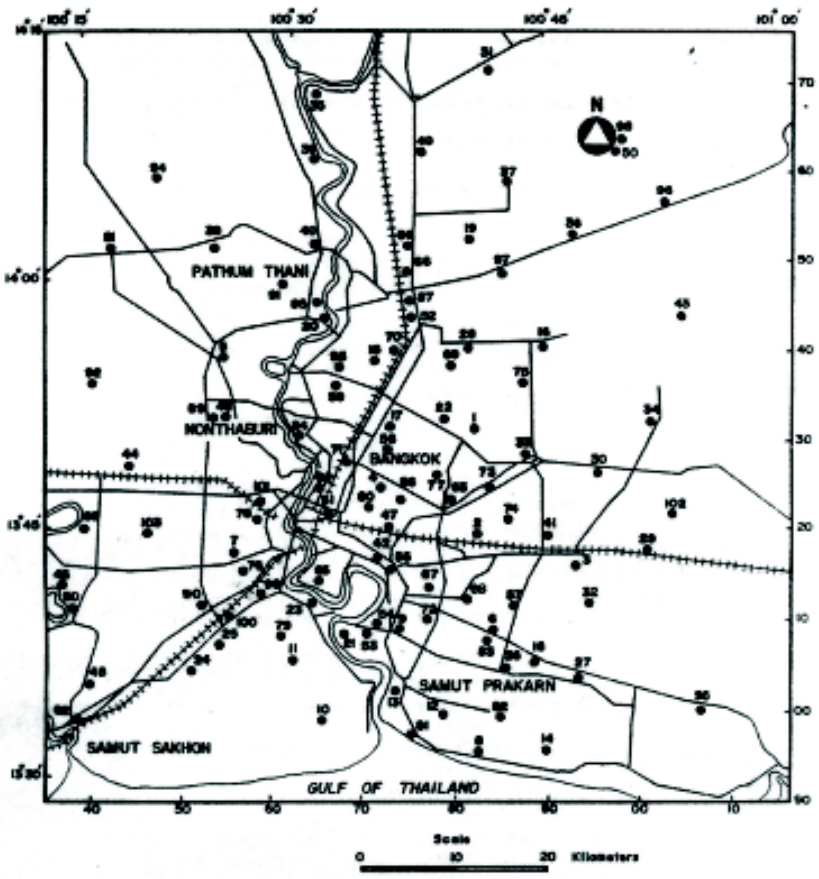


Figure 5.2 Groundwater Monitoring Stations in Bangkok and Adjacent Provinces
Source: Department of Mineral Resources, Ministry of Industry, 1999

6 Noise Pollution

6.1 Present Situation

Pollution Control Department monitors both ambient and roadside noise levels of Bangkok. During 1996-2000, 6 monitoring stations along the major roads recorded that 24-hr average noise level exceeded the ambient noise level of the 70 dBA standard in which noise levels ranged from 73.9-79.7 dBA (Figure 6.2). These noise levels could affect the long term hearing of those living nearby. Day-Night Average Sound Level (Ldn) could cause severe discomfort to 40-70% of the population living nearby.

On the secondary roads, 20% of noise level data exceeded the testing days but the overall level was lower than that of the main roads with maximum ranging from 74.3-76.7 dBA. For general areas, which are more than 50 meters away from the major roads the noise levels were lower than the roadside as shown in Figure 6.3. However, 12% of noise level data were still found to exceed the standard level, ranging from 64.2-87.8 dBA. It is obvious that the major source of noise pollution is traffic, the other sources are construction activities and industry .

The 24-hr average noise levels from boats, 57.5-69.1 dBA, along the canal sides did not exceed the standard level . However, the noise level during the rush hour(6.00-10.00 am.) is about 10 decibel higher than the normal level. Such high noise level causes a great annoyance to people who live nearby the canals.

It is essential to continue to monitor the noise level in order to prevent the people exposed for long period from being affected to their hearing.

6.2 Noise Pollution Control Measures

According to Enhancement and Conservation of National Environmental Quality Act, B.E.2535 (1992), noise standards and methods of measurement have been prescribed in order to control noise pollution from the sources such as motor vehicles, factories and power boats.

BMA controls noise from motor vehicles with the cooperation of Traffic Police, Pollution Control Department, and Land Transport Department. On the expressways, sound-proof walls have been installed in areas where the noise levels are high.

Regarding noise pollution in communities along the canals, the Harbour Department prohibits boats which generates noise levels above the standard and all boats in service along the canals and the Chao Praya River must check and maintain their engines regularly to reduce the noise level.

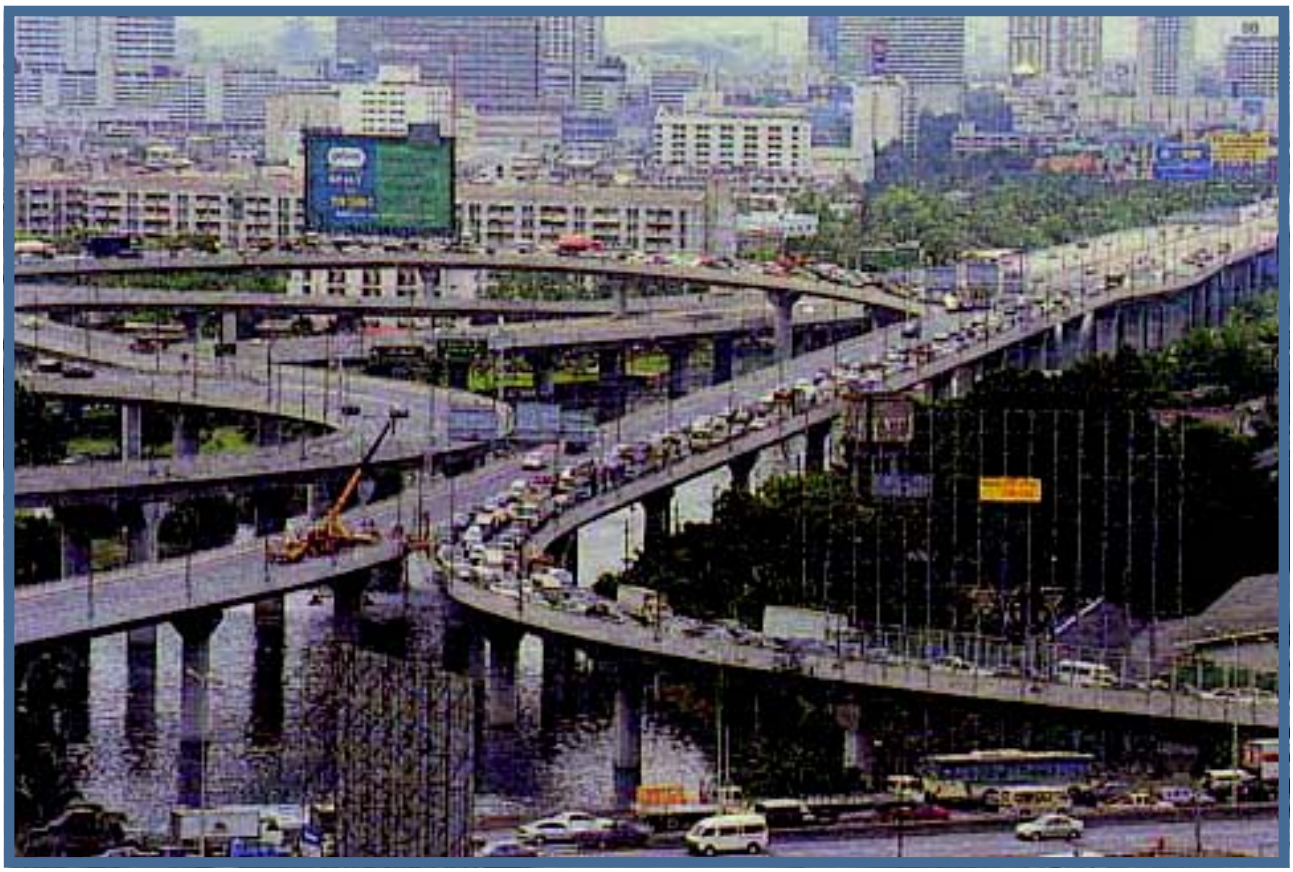
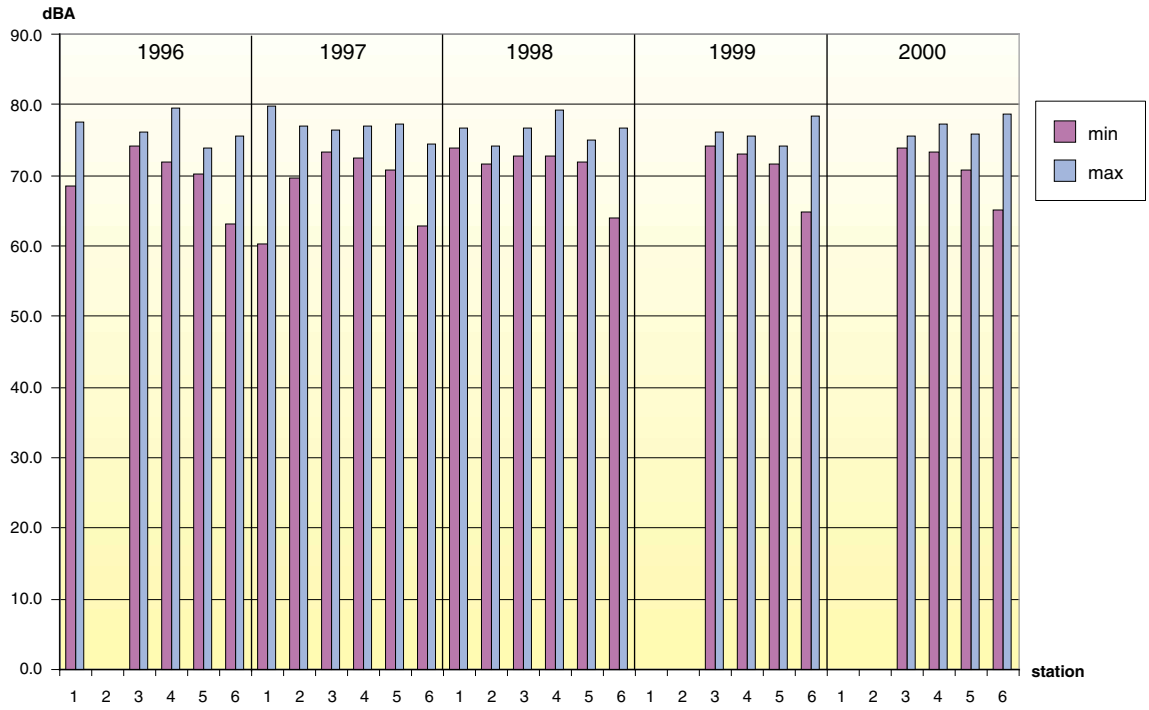
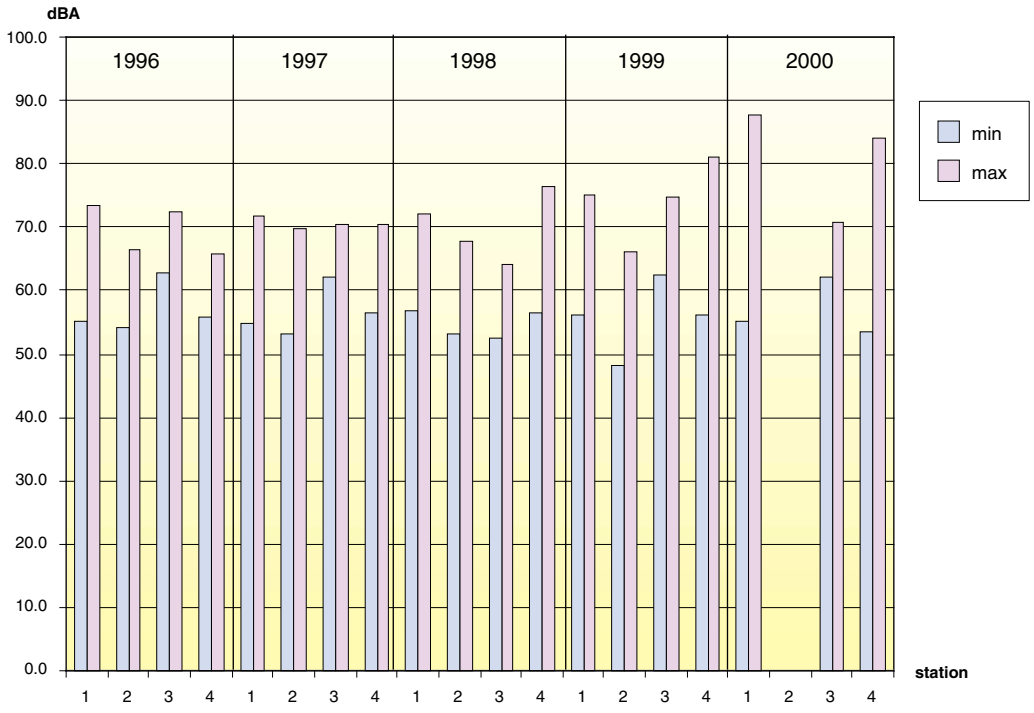


Figure 6.1 Transportation and Construction in Bangkok



1. Rama VI Rd. 2. Paholyothin 3. Ladprao Rd. 4.Dindang Rd. 5. Intarapitak Rd. 6. Prachasongkroa Rd.

Figure 6.2 Roadside Noise Levels in Bangkok, 1996-2000
(Source: Pollution Control Department, Ministry of Science Technology and Environment, 2000)



1. Ramkamhang University 2. Klongjan Community 3. Singharajpittacom School 4. Nontriwittaya School

Figure 6.3 Noise Levels in General Sites of Bangkok in 1996-2000
(Source: Pollution Control Department, Ministry of Science Technology and Environment,2000)

6.3. Future Plan

BMA has implemented many projects aimed at solving noise pollution problems from potential sources. BMA, via Health Department with King Mongkut's Institute of Technology North Bangkok (KMITNB), has implemented a project aimed at reducing noise pollution from the passenger boats travelling in the canals. The efficiency of this project will be evaluated after the completion of the project in 2002 by assessing from people living along the canals and transport operators.

Apart from vehicle noise, other potential sources such as entertainment noise and industrial noise have increasingly become major complaints. Noise from small and medium enterprises commonly found in Bangkok has always caused as nuisance. The recently promulgated Notification of National Environment Board No.17 B.E.2543 (2000) clearly stipulates procedures in helping determine noise complaint caused by various sources.

Environmental Health Division, BMA has constantly organized training courses for personnel working at every district offices to make them aware about the noise hazard. The content of courses cover various aspects of environmental health tasks including noise pollution measurement and abatement.

7 พลังงาน

7.1 Energy Situation

Energy is a crucial fundamental production factor; a sufficient supply of energy to meet the demand in various economic activities is essential in order to develop the international competitiveness of the country. The supply of energy must be at reasonable prices with sufficiently high quality consistent with consumer requirements. At the same time, production activities must utilize energy in efficient and economical manner.

In 1997, the major energy consumption in Thailand was oil (42%). The other sources were renewable energy (26%), natural gas (17%), lignite (9%), imported coal (3%), and imported electricity (3%). The proportion of energy consumption in 1997 is shown in Figure 7.1.

7.1.1 Electricity Consumption in Bangkok

The highest figure of electricity consumption is from industrial sector, which was 38.77% of the total electricity consumption of Bangkok in 2000. The others were 34.23% from business, 21.42% from residential and 5.57% from other sectors. The electricity consumption in Bangkok during 1996-2000 is shown in Figure 7.2.

7.1.2 Fuel Consumption in Bangkok

Fuel consumption of Bangkok in 2000 was 12,219.44 million liters, which was 35.3% of total consumption of Thailand. It comprised of diesel (29.49%), aviation fuel (26.83%), fuel oil (20.74%), unleaded gasoline (20%), LPG (2.69%) and Illuminating and Kerosene (0.24%). as shown in Figure 7.3.

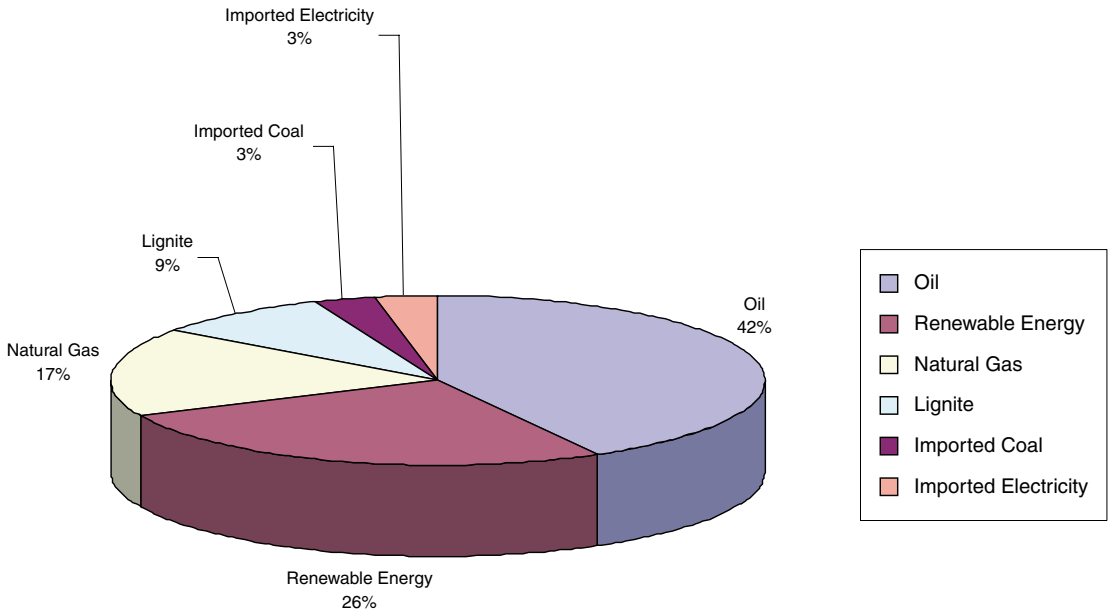


Figure 7.1 Energy Consumption in Thailand 1997
Source: National Energy Policy Office, 1997

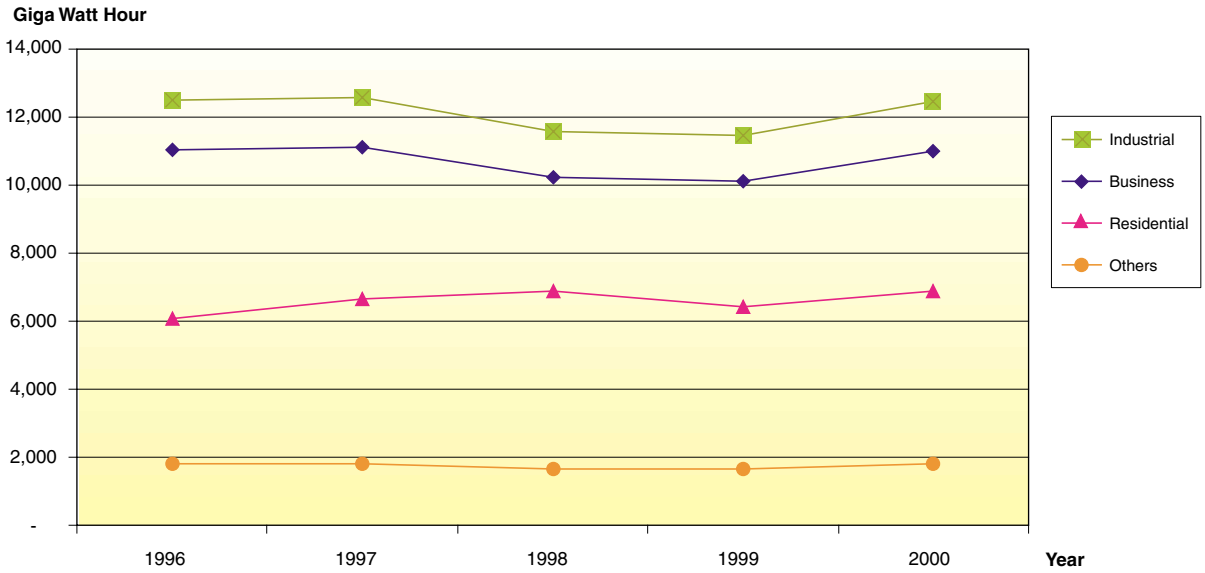


Figure 7.2 Electricity Consumption in Bangkok 1996-2000
Source: National Energy Policy Office, 2000

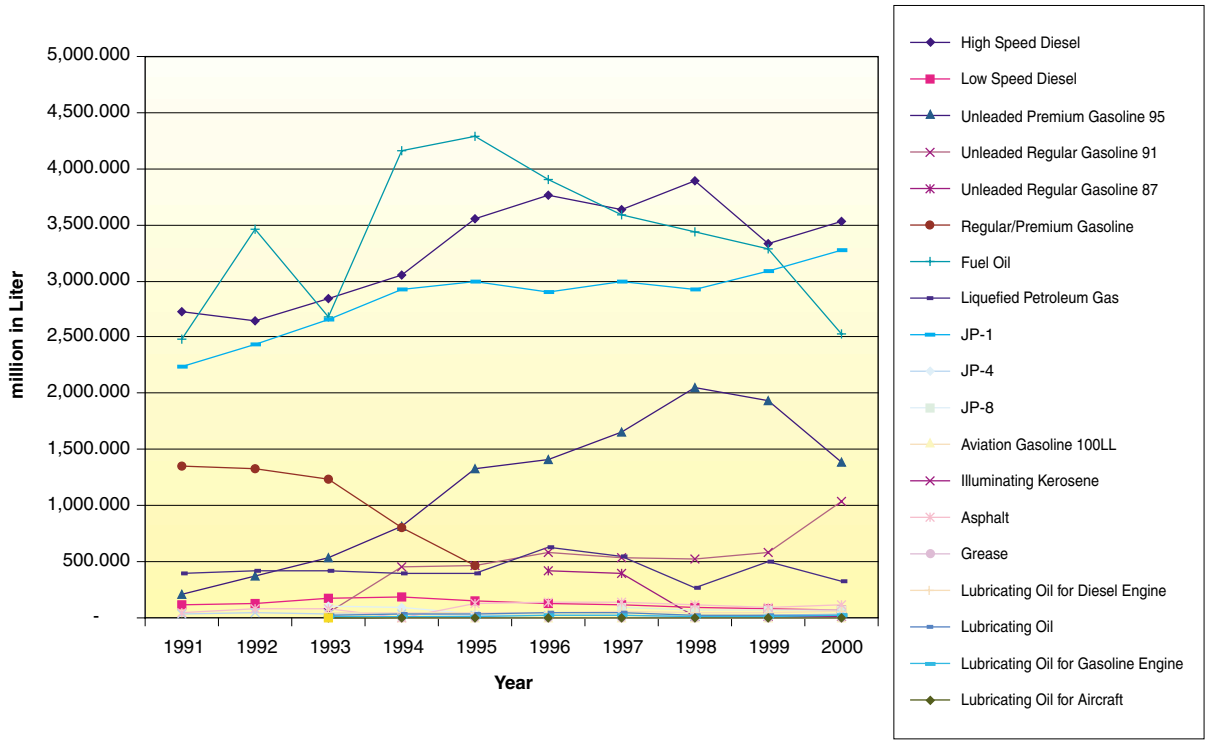


Figure 7.3 Number of Fuel Sales in Bangkok 1991-2000
Source: Bureau of Fuel and Oil, Department of Commercial Registration, Ministry of Commerce, 2000

7.2 Strategies for Energy Sector Development

The National Energy Policy Office (NEPO) has established strategies for the energy development during the Eighth National Economic and Social Development Plan (1997-2001), being a part of the Eighth National Economic and Social Development Plan (1997-2001). NEPO, a national policy agency for energy, is responsible for coordinating the formulation of an operational framework to be a guideline for individual energy-related agencies and to incorporate into their respective operational plans. The strategies for energy development (NEPO, 2001) are as follow;

7.2.1 Provide adequate energy and supply security

This main activities are as follows:

1. Speed up exploration and development of petroleum and coal resources.
2. Speed up negotiations and energy development with neighboring countries.
3. Consider the feasibilities and determine regulatory framework for the use of nuclear energy for electricity generation and speed up energy procurement from foreign sources, in particular that of liquefied natural gas (LNG), orimulsion and coal.

4. Invest to increase reserve capacity for power generation and improve the power transmission and distribution system to ensure reliability of the power system.
5. Establish the customer-service quality standards of the electricity supply to industry.

7.2.2 Promote efficient and economical use of energy

Efficient and economical use of energy will help reduce not only investment requirements in energy supply but also fuel costs in various production processes. Consequently, efficient use of energy will increase the country's competitiveness in the international arena. In this regard, basic policy measures to be implemented are pricing measures which will induce efficient use of energy; provision of additional incentives, raising of the general public's awareness, and compulsory measures. These can be elaborated as follows:

1. Revise the petroleum pricing structure so that it truly reflects the economic costs of supply, and maintain the current price setting mechanism

2. Improve the electricity tariff for both retail and wholesale levels

3. Set guidelines in determining prices of natural gas and pipeline tariff, and develop a clear and transparent regulatory system.

4. Speed up the implementation of the Demand Side Management program and the energy conservation program to be implemented under the framework of the Energy Conservation Promotion Act, B.E. 2535 (1992),

5. Speed up the establishment of the testing standards and the minimum energy efficiency standards of electrical appliances and equipment

6. Promote the establishment of the Energy Efficiency Technology Information Center in major urban centers

7. Implement public relations work to raise the general public's awareness in energy conservation

7.2.3 Promote competition in energy supply industry and increase private sector role

The increase of competition in energy supply industry and the promotion of a greater private sector role will lead to efficient utilization, procurement and distribution of energy as well as a reduction in investment burden of the government. This will also enhance capital market development and savings mobilization from the private sector, and enable the public to participate in energy development.

7.2.4 Prevent and solve environmental problems resulting from energy development

1. Study the feasibility on the extension of the mandatory requirement for sale of fuel oil grades 1 - 4 (with no more than 2.0% of sulfur content) and grade 5 (with no more than 0.5% of sulfur content), which currently covers only the Bangkok Metropolis and Samut Prakarn province, to other provinces where industrial factories are located.

2. Advance the date for the mandatory sale of the low sulfur diesel oil with 0.05% by weight of sulfur to 1 January 1999 in order to correspond with the vehicle emission standards to be enforced and consider further improvement of quality specifications of gasoline and high speed diesel in order to reduce pollution.

3. Control and monitor the storage and disposal of lube oil residue and used lube oils, and promote investment in technically sound recycling system for used lube oil.

4. Install vapor recovery systems in oil depots, oil trucks and petroleum service stations in the Bangkok Metropolis and major urban centers.

5. Promote substitution of fuel oil by clean fuels, such as natural gas and LPG, in power plants and in industrial factories, in particular in the areas where a large number of industrial factories are located, as well as speed up the application of natural gas in commercial vehicles in order to reduce air pollution, especially in the Bangkok.

6. Improve the standards and regulations on safety in energy transportation, storage and utilization, in particular oil trucks, oil tankers, and LPG utilization, and ensure strict enforcement of such standards and regulations.

7. Encourage garbage disposal projects which yield energy as a by-product in order to reduce environmental problems in large communities.

7.2.5 Develop Legislation related to energy administration mechanism

1. Accelerate the proclamation of the Oil Control Act to replace the Oil Storage Act, B.E. 2474 (1931) which is obsolete, and amend the Fuel Oil Act, B.E. 2521 (1978) which has already been approved by the cabinet.

2. Amend the Revolutionary Decree No. 28, legislation and regulations related to LPG to ensure that the LPG business would be safe, organized and fair for all parties.

3. Consider the appropriateness of establishing an Independent Regulatory Body to independently regulate energy-related activities in order to provide assurance for investors and at the same time to ensure fairness for energy consumers.

7.3 Policy of the Government

The Government (The Government of H.E. Prime Minister Thaksin Shinawatra Delivered to the National Assembly on Monday, 26 February 2001) has the policy to conserve and develop energy as well as promote the efficient use of energy in balance with the country's environment and natural resources. Efforts will be made to reduce dependency on energy sources from foreign countries. Towards this end, the following policies will be pursued:

(1) Promote the combined use of energy by further developing the use and exploitation of Thailand's natural gas, which is a domestic resource, as the country's major source of energy.

(2) Promote the efficient procurement and use of alternative energy sources by expediting the survey, development and procurement of alternative energy sources as well as by promoting research and development of innovative energy sources for the purpose of energy conservation.

(3) Emphasize energy management to increase the competitiveness of Thailand's production sector and to enhance the stability of energy prices through appropriate monetary, fiscal and managerial measures.

7.4 BMA's Energy Conservation Policy

To be in line with the government's energy conservation policy, the Bangkok Metropolitan Administration has issued the executive order with the following activities.

1. Energy saving by
   - setting the turn on and off time for electricity, no electricity turned on during lunch time except the necessary areas
   - setting the air conditioning temperature to be 25 Degree Celsius as well as setting the switching on and off time
   - setting the servicing time for escalator, starting from 06.00 to 18.00 except the escalator in front of the General Affair Division
2. Tap Water saving
   - maintain the tap water pipeline and relevant equipment to ensure well functioning of water supply
   - closing water tap properly after use
3. Fuel and lubricating oil
   - regularly maintain the fleet vehicles as recommended by the vehicle manual
   - switching off engines while parking
   - minimize use of vehicles and promote telecommunication uses
   - establish more efficient routing of vehicles by introducing the GIS map
   - promote carpooling between BMA offices
4. Office paper
   - back to back photocopy (both sides of paper)

8 Environmental Nuisance Control in BangkokÕ

Bangkok, the capital city of Thailand, has been urbanized rapidly over the past few decades, making it the most important city of the nation. With this economic and industrial growth, consumption and demand for production has expanded. The industrial sector has shown the biggest growth, and between 1960 and 1994 rose by 27 percent. In 1999, there were 128,350 factories throughout Thailand with 16.49 percent located in Bangkok and the remainder located in the regions. Statistics compiled by Bangkok Metropolitan Administration (BMA) showed that the total number of businesses detrimental to health in Bangkok in 2000 as defined in the Public Health Act, B.E.2535 (1992) stood at 42,347. This rapid growth has caused environmental degradation, resulting in health hazards to community surrounding those factories and businesses.

To minimize the risks and to safeguard the health of the population, the Public Health, Act B.E 2535(1992) was revised and amended from the previous one which was in use since B.E.2484(1941). These amendments placed the major sources of public annoyance into the following five categories;

(1) Water resource, gutter, shower room, latrine, dung or ash pit or any other place which is unsuitably situated, dirty or accumulated or piled up with any waste and may:

- cause foul odour or toxic particle.
- become or likely to become a breeding place for carriers of disease.
- cause impairment or be harmful to health.

(2) The raising of animals in a place or by any method or in an excessive number causing impairment or maybe harmful to health.

(3) Any building which is a dwelling of human or animals, factory or business establishment without air ventilation, water drainage, sewage disposal or toxic substance control to prevent foul odour or toxic substance, thereby causing impairment or likely being harmful to health.

(4) Any action causing odour, light, ray, noise, heat, toxic matter, vibration, dust, powder, soot, ash or any other to the extent that causes impairment or harm to health.

(5) Any other sources prescribed by the Public Health Minister and published in the Royal Government Gazzette.

8.1 The Current Situation in Bangkok

During the period of 1997-2000, the Environmental Health Division, Health Department, BMA. together with 50 district offices collected data throughout Bangkok. The total number of complaints concerning environmental health nuisance are as follows:

The major causes of nuisance include noise, air pollution, offensive odour, dust and particulate, wastewater, animal raising, latrines, solid waste, breeding place and vibration.

Table 8.1 The total Number of Complaints Concerning Environmental Health Nuisance 1997-2000

Year	Complaints
1997	3,501
1998	2,993
1999	3,498
2000	3,967

Source: Environmental Health Division, Health Department, BMA, 2000

Table 8.2 shows the percentage of environmental health complaints causing nuisance. Noise was the most common cause of complaint accounting for between 31.6 and 39.7 percent of the total complaints during 1997-2000 followed by odour, particulate, wastewater, animal raising, respectively. The proportion of nuisance is categorized by causes in 2000 are illustrated in Figure 8.2

It was found that the operation of certain kinds of business detrimental to health prescribed under the Public Health Act pose an adverse effect on health of people living nearby those enterprises. Those responsible for the largest proportion of environmental nuisances include:

- Entertainment venue such as karaoke, pub
- Manufacture of utensils and appliances from metal
- Garage and automotive repair shop
- Animal raising especially pet raising
- Printing by machines
- Manufacture of plastic, celluloid, bakelite or similar material
- Melting and moulding of metal

Table 8.2 Percentage of Environmental Health Complaints Causing Nuisance

Year	Complaints (%)									
	Noise	Odour	Animal Raising	Particulate	Wastewater	Latrine	Solid Waste	Breeding	Vibration	Miscellaneous
2000	39.7	29.9	8.4	5.9	4.8	1.8	1.4	0.7	0.7	6.3
1999	35.3	30.3	5	6.3	6.1	1.7	2	2.1	0.8	9.9
1998	31.6	30.9	3.4	9.7	8.6	1.2	2.1	4.9	0.2	7.2
1997	33.7	31.6	3.8	12.1	9.3	1.3	2.3	2.1	0.3	7.1

Source: Environmental Health Division, Health Department, BMA, 2000

8.2 BMA's Strategies and Implementation

BMA, via Environment and Sanitation Section of District Offices and Environmental Health Division of Health Department, has carried out various measures aimed at reducing and mitigating environmental nuisances caused by the operation of business detrimental to health. These measures are as follows:

- Giving suggestion and recommendation
- Ordering entrepreneur to make improvement or correction
- Penalty or fine
- Temporary shutdown of operating units/premises

8.3 Recommendations

Nuisance problems in Bangkok are increasingly becoming more prevalent and complicated requiring collaborative effort from all government units concerned. There is a need both from the central and local government to study and set up nuisance standards and guidelines for businesses detrimental to health and their health effects to improve and control such nuisance. Knowledge and experience of the past and existing practices in both developed and developing countries is important to develop local appropriate strategies to deal with these nuisances. Community participation should also be encouraged for better control of environmental nuisance.

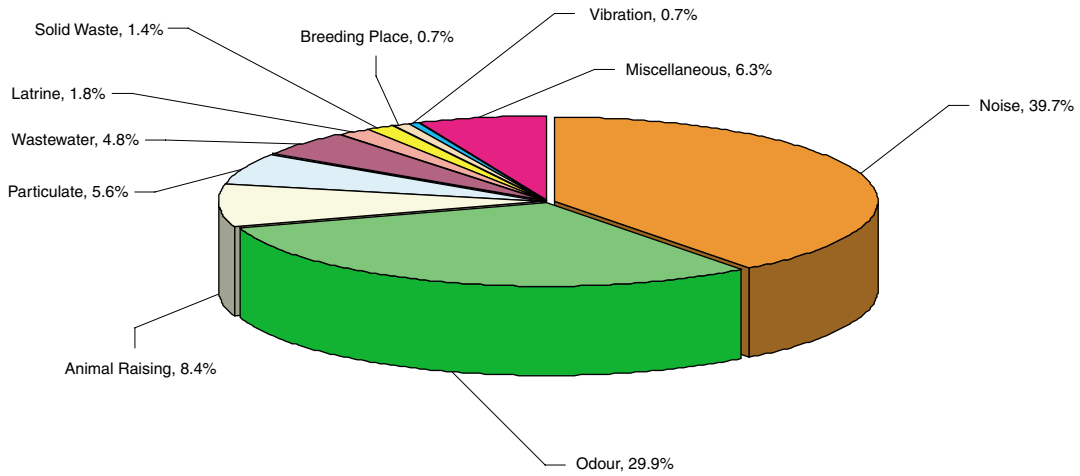


Figure 8.1 Proportion of Nuisance Categorized by Causes in 2000
Source: Environmental Health Division, Health Department, BMA, 2000

9 Environmental Promotion and Education

In recent years, relevant agencies including the central and local governments, along with non-governmental organizations, have contributed greatly to environmental promotion and public information. For example, the recent successful campaign to correct the widespread misconception that high octane gasoline was somehow " more powerful" or "better" than lower octane gasoline in automobiles designed to use. It illustrates how environmental promotion can influence the behavior of the general public. The multimedia campaign resulted in the reduction in the proportion of high-octane gasoline use from 73% in 1997 to 52.4% in 2000. In addition to major savings for the motoring public, the campaign improved the environment by reducing refinery emissions and demand for crude oil. It serves as a model for other public environmental activities.

Many public awareness campaigns have been carried out by MOSTE, Royal Thai Police, Ministry of Public Health, and other. The Bangkok Metropolitan Administration has played an active role in involving the public in environmental protection. In order to improve the living conditions of Bangkok residents, air pollution abatement has a top priority. The Air Pollution Mitigation Campaign Year 1999 has been announced, and many pollution reduction measures have been taken. Although the success of this campaign is difficult to quantify, there is increasing cooperation from the drivers in avoiding the eight critical air pollution roads announced by the Bangkok Metropolitan Administration. Moreover, the street pollution level especially the fine dust with the diameter

Figure 9.1 Brochures on Vihicle Maintenance

Figure 9.2 Environmental Awareness Promotion for Schoolchildren

equal or less than 10 micrometer (PM-10) has dropped to or below the standards for some time. (Standard 120 micrometer/m^3)

The campaign to increase public participation in environmental protection also focuses on solid waste management. The littering prohibition campaign was implemented followed by the enforcement. This is a very prominent and successful environmental protection campaign which is making Bangkok a clean city again. The local governments in the Bangkok vicinity have followed this campaign. The reduction of solid waste generation is targeted at households and a campaign has been launched to promote the 5 R strategy (Reduce, Reuse, Reject, Repair and Recycle). The concept promotes a simple life style by reducing consumption and purchasing only necessary things; reusing items when possible, rejecting household hazardous waste by discarding them separately from the other solid waste; repairing broken items to make them functional again, and recycling solid waste to be made into new useful items.

The 430 BMA primary schools in Bangkok are part of the environmental promotion and education program. Many activities have been initiated in order to encourage students to participate in environmental protection. Green school program such as planting more trees, environmental camp and competition for the best environmental composition are some of the activities. Teaching materials such as books, and videos for environmental classes have been developed and provided to all BMA schools to help raise awareness of environmental protection among pupils.

The Environmental Protection Volunteer Project is another activity initiated by the BMA to promote the environmental protection and conservation. The first volunteer group was students from universities in Bangkok. Two seminars were held by BMA with the participation of about 120 students. The most recent seminar were held on 4 - 6 August, 2000. During the seminars, students were gathered to discuss and brainstorm. The outcome showed the strong potential for environmental solutions developed by students. The students will disseminate environmental knowledge and ideas to encourage people near their homes, their relatives and friends to be active in environmental protection and conservation and take part in the BMA activities, those of the universities, and their own initiatives.

BMA also developed a web page for Environmental Protection Volunteers as a channel for communication among volunteers and dissemination of volunteer's activities. By October 2000, the volunteer group expanded to the community, BMA primary and secondary schools of the Ministry of Education.

The NGOs for example Magic Eye, and Thai Environment Institute, also joined the public awareness raising campaign on prohibition of littering, promotion of waste recycling and protection of watercourses and the environment.

Figure 9.3 Black Smoke Inspection

Figure 9.4 Single-Occuppant Vehicles Cooperating to Avoid Polluted Roads

Environmental campaigns or activities achieve success only in short periods . In order to sustain achievements, the responsible agencies must work to maintain continuity. Dissemination of environmental information and news to public need to be promoted by all relevant agencies. The education programs for effective understanding of and cooperation on the environment need to be provided. The partnership among all levels of government, NGOs, the private sector and local residents in the environmental programs needs to be effectively established and sustainably maintained.

10 แผนปฏิบัติการ 21-วาระแห่งกรุงเทพมหานคร

BMA has worked out an Agenda-AGENDA 21- for what has to be done in the next 20 years in order to improve the city, the environment and the quality of living for the Bangkok people.

The Bangkok Agenda has been subject for debate and discussion among the BMA staff. Representatives from the citizens of Bangkok have debated and commented on the Agenda in the Bangkok Strategic Forum. The Bangkok Agenda is presented in 10 chapters, which together cover all BMA duties, what must be done if Bangkok shall improve. The following is an outline of each of the ten chapters;

1. THE STRATEGY FOR A SUSTAINABLE BANGKOK AS A SAFE CITY WITH HIGH QUALITY OF LIVING STANDARD

The Bangkok Agenda will

1. Guide and coordinate all plans, activities and projects in BMA.
2. Link economy, development and environment in BMA decision making.
3. Ensure that BMA will use up-to-date urban planning tools to lead urban development and redevelopment.
4. Ensure that air quality is raised and traffic congestion reduced by the use of efficient transport systems.
5. Increase the supply of green areas.
6. Reduce problems from solid waste, wastewater and flooding.
7. Develop the BMA organization to meet the new challenges.
8. Increase public awareness and responsibility through public involvement.
9. Secure open access to information.

2. WE WILL LEAD URBAN ECONOMY TOWARD SUSTAINABILITY

Chapter 2 states that "There is more to economy than money" and focus on efficient economical management, increase in revenues and transparency in the BMA economy. The need to link plans with budgets and to monitor department performance is emphasized and tools presented.

An important part of the urban economy is the environment, which can either be an economical burden or a benefit for the city. The attention is drawn to the fact that Bangkok can only attract serious investors if the city can offer good environment as well as efficient and sufficient infrastructure.

3. WE WILL USE URBAN PLANNING TO IMPROVE QUALITY OF LIFE

To plan is to prepare for the future.

Modern urban planning instruments are necessary for the decision-makers to influence and control the urban development.

The modern urban planning tools and procedures are at the same time preconditions for public participation.

The chapter presents a variety of tools that BMA will use to coordinate and interrelate the urban functions and infrastructures.

Increased attention is paid to urban renewal, protection of cultural heritage, green areas and provision of alternatives to existing slum areas.

The plans will serve as memory for citizens and decision-makers.

4. WE WILL REORGANIZE TRAFFIC AND TRANSPORT TO RAISE QUALITY OF AIR AND NEIGHBORHOODS

It is well known that cars, trucks, buses and motorcycles are the main sources of air pollution and noise.

The chapter is consequently focusing on improvement of traffic planning, management and control systems.

The chapter is also focusing on how to provide alternatives to the private cars in the form of increased coverage of rail bound transport systems and other measures supporting public mass transport systems.

Other measures are mentioned on how to improve air quality.

5. WE WILL INVEST IN GREEN URBAN AREAS

Public space green and recreational areas are of importance for health, wellbeing and social life in a city.

Chapter 5 is listing a number of ways to increase green areas and public meeting places.

The involvement of the citizens to plant more trees and plants is maybe among the most important initiatives to be taken.

6. WE WILL MAKE BANGKOK A CLEAN CITY

Human activities are creating a number of problems in the form of solid waste and wastewater.

It is often left to the city administration to clean up after the citizens.

The chapter is focusing on how to reduce these problems, how to mobilize the citizens to share the responsibility and how to handle those tasks that will after all be left for the administration to take care of.

The chapter looks into alternative ways to organize for improved handling of these tasks.

Flood prevention measures are presented and energy conservation is introduced in the chapter.

7. WE WILL FOCUS ON GOOD GOVERNANCE IN BMA TO MEET THE CHALLENGES OF THE FUTURE

A city can never improve or function effectively unless the city administration is well organized, professional and efficient.

BMA is in this chapter focusing on how they will develop staff, organization and procedures to meet the new challenges.

BMA will use plans, information technology and human resources development as vehicles in the improvement of the city administration towards good governance.

8. WE WILL SECURE EASY ACCESS TO INFORMATION IN BMA

Knowledge and information are determining factors for good administrative performance and for public participation.

The activities concerning information and knowledge may be the most crucial tasks in the Bangkok Agenda. Simply because the right and relevant information is directly influencing the quality of the decisions.

Focus is not only on hardware and software. How to organize the collection of data, how to disseminate and maintain data and information has a high priority in the Agenda.

9. WE WILL USE HUMAN RESOURCES AS A STRATEGIC TOOL IN SOCIAL AND ECONOMIC DEVELOPMENT

It is human behavior that directs the development of society as well as of the city and the community. The way people act is determining quality of society.

It is a main objective of the Agenda to enable the citizens to take care of themselves and of their fellow citizens.

The Agenda lines up a number of action plans to be made to empower the citizens to make a good living.

Better education, health and social development are focal points as are the fighting of poverty, slum, drugs and aids.

Culture, tourism and improvement of the environment are other subjects of importance.

10. WE WILL INVOLVE THE CITIZENS IN THE DEVELOPMENT OF A BETTER BANGKOK

Citizens are the key players in the city.

The chapter describes how citizens will be mobilized and involved in decision making and in the efforts to improve Bangkok.

Public participation in the decision-making processes is a newly introduced issue in Thai Democracy.

It will take some time before public participation is well established.

Public participation can be either prevented or promoted by the public administration.

BMA has decided to promote public participation actively and this chapter lists a number of activities that will involve the citizens in the efforts to improve quality of life.

The Bangkok Agenda is a long-term plan serving as the umbrella for all plans and activities in BMA.

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APPENDICES

Appendix I List of Districts in Bangkok

1. Inner Area 21 District

1.	PHRA NAKHON
2.	POM PRAP SATTRU PHAI
3.	SAMPHANTHAWONG
4.	PATHUMWAN
5.	BANG RAK
6.	YAN NAWA
7.	SATHON
8.	BANGKHO LAEM
9.	DUSIT
10.	BANG SUE
11.	PHAYA THAI
12.	RATCHATAVEE
13.	HUAI KHWANG
14.	KHLONG TOEI
15.	CHATUCHAK
16.	THON BURI
17.	KHLONG SAN
18.	BANGKOK NOI
19.	BNAGKOK YAI
20.	DIN DAENG
21.	WATTHANA

2. Middle Area 18 District

1.	PHRA KHANONG
2.	PRA VET
3.	BANG KHEN
4.	BNAG KAPI
5.	LAT PHRAO
6.	BUNG KUM
7.	BANG PHLAD
8.	PHASI CHAROEN
9.	CHOM TONG
10.	RAT BURANA

11.	SUAN LUANG
12.	BANG NA
13.	THUNG KHRU
14.	BANG KHAE
15.	WANG THONGLANG
16.	KANNA YAO
17.	SAPHAN SUNG
18.	SAI MAI

3. Outer Area 11 District

1.	MIN BURI
2.	DON MUANG
3.	NONG CHOK
4.	LAT KRABANG
5.	TALING CHAN
6.	NONG KHAEM
7.	BANG KHUNTHIAN
8.	LAK SI
9.	KLONG SAM WA
10.	BANG BON
11.	THAVEE WATTHANA

The total number of districts in Bangkok is 50 districts.

Appendix II List of Environmental Organizations and Foundations

Ministry of Defence
Ministry of Finance
Ministry of Foreign affairs
Ministry of Transport and communication
Ministry of Commerce
Ministry of Education
Ministry of Public Health
Ministry of Science, Technology and Environment
Ministry of University affairs
Ministry of Interior
Ministry of Justice
Royal Forest Department
Royal Irrigation Department
Department of Land development
Department of Land Transport
Department of Agriculture
Department of Agricultural Extension
Department of Local Administration
Department of Town & Country Planning
Department of Mineral Resources
Pollution Control Department
Department of Energy development and Promotion
Department of Environmental Quality Promotion
Thai Meteorological Department
The Council of State of Thailand
National Information Technology Committee
Thai Chamber of Commerce
The Secretariat of the Prime Minister
The Secretariat of the Cabinet
Office of The Attorney General
National Economic and social Development Board
National Statistical Office

National Research Council of Thailand
Office of Atomic Energy for Peace
Thailand's National Science and Technology Development Agency
Office of Science and Technology Brussels, Belgium
Office of Agricultural Economics
Thailand Institute of Scientific and Technological Research
Asian Institute of Technology
The National Electronics and Computer Technology Center
National Synchrotron Research Center
Wastewater Management Authority
Electricity Generating Authority of Thailand
Tourism Authority of Thailand
Industrial Estate Authority of Thailand
Petroleum Authority of Thailand
Thailand Board of Investment
Ramsar Convention on Wetlands
Ramsar Database
THE FOUNDATION OF EDUCATION FOR LIFE AND SOCIETY
WILDLIFE FUND THAILAND UNDER THE ROYAL PATRONAGE OF H.M.THE QUEEN
RAJCHAPRUCK PROJECT FOUNDTION
LOCAL DEVELOPMENT FOUNDATION
MACRO BIO PSYCHE FOUNDATION
THE WILD ANIMAL RESCUE FOUNDATION OF THAILAND
FOUNDATION FOR ANTI AIR POLLUTION AND ENVIRONMENTAL PROTECTION
FOUNDATION FOR WOMEN
HILL AREA DEVELOPMENT FOUNDATION
SUWANNAPHUM HUMAN RESOURCE DEVELOPMENT FOUNDATION
FOUNDATION FOR THE PROTECTION OF ENVIRONMENT AND TOURISM
FOUNDATION FOR LIFE-LONG EDUCATION

Appendix II List of Environmental Organizations and Foundations (Contd..)

FOUNDATION FOR ENVIRONMENTAL PRESERVATION
MAE FAH LUANG FOUNDATION
GREEN WORLD FOUNDATION
THAILAND DEVELOPMENT RESEARCH INSTITUTE FOUNDATION
FOUNDATION OF SIAMESE ASSOCIATION OF UNIVERSITY WOMEN UNDER THE PATRONAGE OF HER ROYAL HIGHNESS PRINESS GALYANIVADGNA
THAILAND ENVIRONMENT FOUNDATION
SEUB NAKHASATHIEN FOUNDATION
PROMOTION OF HUMAN RESOURCES FOR COMMUNITY DEVELOPMENT FOUNDATION
THAI YUWA DASERKORN PROMOTION UNDER THE ROYAL PATRONAGE OF HRH PRINCESSMAHACHAKRI SIRIDHORN
WORD VISION FOUNDATION OF THAILAND
VILLAGE FOUNDATION
NATIONAL COUNCIL ON SOCIAL WELFARE OF THAILAND
APPROPRIATE TECHNOLOGY ASSOCIATION
THINK EARTH ASSOCIATION
SERVING FOR THE POPLE ASSOCIATION
NORTHEAST RURAL DEVELOPMENT ASSOCIATION
POPULATION AND COMMUNITY DEVELOPMENT ASSOCIATION
THE PLANNED PARENHOOD ASSOCIATION OF THAILAND UNDER THE PATRONAGE OF H.R.H. THE PRINCESS MOTHER
MARINE SCIENCE ASSOCIATION OF THAILAND
BANGKOK Y.M.C.A.
ENVIRONMENTAL ENGINEERS ASSOCIATION OF THAILAND
THE ENVIRONMENTAL AND COMMUNITY DEVELOPMENT ASSOCIATION
YADFON ASSOCIATION
SOCIETY FOR THE CONSERVATION OF NATIONAL TREASURE AND ENVIRONMENT
CARE INTERNATION THAILAND
PROGRAM FOR APPROPRIATE TECHNOLOGY IN HEALTH

ESAAN COMMUNITY FOUNDATION
THE Y.M.C.A. FOR NORRTHERN DEVELOPMENT FOUNDATION
HEALTH DEVELOPMENT AND RESEARCH FOUNDATION
FRIEND OF THE ASIAN ELEPHANT
ADULT EDUCATION LABORATORY
WORD ENVIRONMENT CENTER FOUNDATION
BICENTENNIAL VOLUNTEERS INCORPORATED (BVI)
THE THAI PAYAP DEVELOPMENT ASSOCIATION
HAI VOLUNTEER SERVICE
THE PHUKIEW SANCTUARY CONSERVATION
FOUNDATION FOR AGRICULTURAL AND RURAL MANAGEMENT
FOUNDATION FOR QUALITY OF LIFE DEVELOPMENT
TECHNOLOGICAL PROMOTION ASSOCIATION THAI-JAPAN
NORTHERN DELELOPMENT FOUNDATION
RURAL VIVES DEVELOPMENT FOUNDATION
THAI ASSOCIATION FOR VOLONTARY STERILIZATION (T.A.V.S.)
IMPECT ASSOCIATION
SAVE THE CHILDREN
ASSOCIATION OF EARTH ISLAND INSTITUTE
HUMAN AND NATURAL RESOURCES DEVELOPMENT INSTITUTE ASSOCIATION
Green Leaf Foundation
National Center of Genetic Engineering and Biotechnology

Appendix III Technical References

1.1 Water Quality Standards

Table 1.1.a Surface Water Quality Standards

Parameter	Units	Statistics	Class 1	Class 2	Class 3	Class 4	Class 5	Methods for Examination
1. Color, odor, taste	-	-	n	n	n	n	-	-
2. Temperature	°C	-	n'	n'	n'	n'	-	Thermometer
3. pH	-	-	n	5-9	5-9	5-9	-	Electrometric pH Meter
4. Dissolved Oxygen	mg/l	P20	n	6	4	2	-	Azide Modification
5. BOD (5 days, 20 °C)	mg/l	P80	n	1.5	2	4	-	Azide Modification at 20 °C, 5 days
6. Coliform bacteria								Multiple Fermentation
- Total coliform	MPN/100 ml	P80	n	5,000	20,000	-	-	Technique
- Fecal coliform	MPN/100 ml	P80	n	1,000	4,000	-	-	
7. NO_3-N	mg/l	Max Allowance	n		0.5		-	Cadmiun Reduction
8. NH_3-N	mg/l	-	n		0.5		-	Distillation Nesslerization
9. Phenols	mg/l	-	n		0.005		-	Distillation, 4-Amino antipyrene
10. Copper(Cu)	mg/l	-	n		0.1		-	Atomic Absorption Direct Aspiration
11. Nickle (Ni)	mg/l	-	n		0.1		-	Atomic Absorption Direct Aspiration
12. Manganese (Mn)	mg/l	-	n		1.0		-	Atomic Absorption Direct Aspiration
13. Zinc (Zn)	mg/l	-	n		1.0		-	Atomic Absorption Direct Aspiration
14. Cadmium (Cd)	mg/l	-	n		0.005*		-	Atomic Absorption Direct Aspiration
15. Chromium Hexavalent	mg/l	-	n		0.05		-	Atomic Absorption Direct Aspiration
16. Lead (Pb)	mg/l	-	n		0.05		-	Atomic Absorption Direct Aspiration
17. Total Mercury	mg/l	-	n		0.002		-	Atomic Absorption Cold Vapour Technique
18. Arsenic (As)	mg/l	-	n		0.01		-	Atomic Absorption Gaseous Hydride
19. Cyanide (CN)	mg/l	-	n		0.005		-	Pyridine-Barbituric Acid
20. Radioactivity								Low Background
- Alpha	Becqurel/l	-	n		0.1		-	Proportional Counter
- Beta	Becqurel/l	-	n		1.0		-	
21. Total Organochlorine Pesticides	mg/l	-	n		0.05		-	Gas-Chromatography
22. DDT	µg/l	-	n		1.0		-	Gas-Chromatography
23. Alpha-BHC	µg/l	-	n		0.02		-	Gas-Chromatography
24. Dieldrin	µg/l	-	n		0.1		-	Gas-Chromatography

Parameter	Units	Statistics	Class 1	Class 2	Class 3	Class 4	Class 5	Methods for Examination
25. Aldrin	µg/l	-	n		0.1		-	Gas-Chromatography
26. Heptachlor& Heptachlorepoxide	µg/l	-	n		0.2		-	Gas-Chromatography
27. Endrin	µg/l	-	n		none		-	Gas-Chromatography

Remark:
- P Percentile Value
- n naturally
- n' naturally but changing not more than 3 °C
- * when water hardness not more than 100 mg/l as $CaCO_3$
- ** When water hardness more than 100 mg/l as $CaCO_3$

Source : Notification of the National Environmental Board, No. 8, B.E. 2537 (1994), issued under the Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992), published in the Royal Government Gazette, Vol. 111, Part 16, dated February 24, B.E2537 (1994).

Table 1.1.b Surface Water Classification

Water Quality Class	Description
Class 1:	Extra clean fresh surface water resources used for: 1) conservation, not necessarily pass through water treatment process, require only ordinary process for pathogenic destruction; 2) ecosystem conservaton where basic organisms can breed naturally; 3) conservation of ecosystem for water sources.
Class 2:	Very clean fresh surface water resources used for: 1) consumption which require ordinary water treatment process before use; 2) aquatic orgaism conservation; 3) fisheries; 4) recreation.
Class 3:	Medium clean fresh surface water resources used for: 1) consumption. But passing through an ordinary treatment process before use; 2) agriculture.
Class 4:	Fairly clean fresh surface water resources used for: 1) consumption, but requires special treatment process before use; 2) industry
Class 5:	The resources that are not classified in class 1-4 and used for navigation.

Table 1.1.C The Chao Phraya River Water Quality Standards

Control Areas (Km. From River mount)	Water Quality Standards (Same as Standard of Water Classification)
7-62 (lower part of the Chao Phraya River including Bangkok area)	Class 4
62-142 (Middle part of the Chao Phraya River)	Class3
142-379 (Upper part of the Chao Phraya River)	Class 2

Source : Notification of the National Environmental Board (January 17, B.E.2529 (1986)), published in the Royal Government Gazette, Vol. 103, No. 60. Dated April 15 B.E.2529 (1986)1.2 Building Effluent Standards

1.2 Building Effluent Standards

Table 1.2.a Building Effluent Standards (Standard Values)

Parameters	Units	Range or Maximum Permitted Value for These Categories				
		A	B	C	D	E
1. pH	-	5-9	5-9	5-9	5-9	5-9
2. BOD	mg/l	20	30	40	50	200
3. Solids						
3.1 Suspended solids	mg/l	30	40	50	50	60
3.2 Settleable Solids	mg/l	0.5	0.5	0.5	0.5	-
3.3 TDS*	mg/l	500	500	500	500	-
4. Sulfide	mg/l	1	1	3	4	-
5. TKN	mg/l	35	35	40	40	-
6. Fat, Oil & Grease (FOD)	mg/l	20	20	20	20	100

* These values are in addition to the TDS of the water used.

Source : Notification of the Ministry of Science, Technology and Environment issued under the Enhancement and conservation of the National Environmental Quality Act, B.E. 2535 (1992), published in the Royal Government Gazette, Vol. 111 special part 9, dated February 4, B.E. 2537.

Table 1.2.b Building Effluent Standards (Types and sizes of Buildings Subject to Effluent Control)

Building Type	Size	Level of Standard*	Remark
1. Condominium	Less than 100 units	C	
	100 but not more than 500 units	B	
	500 units or more	A**	
2. Hotels	Less than 60 rooms	C	
	60 but not more than 200 rooms	B	
	200 rooms or more	A**	
3. Dormitories	From 10 to not greater than 50 rooms	D	
	From 50 to 250 rooms	C	
	250 rooms or more B		
4. Massage Parlors	From 1,000 m^2 to not greater than 5,000 m^2 (or equivalent)	C	
	5,000 m^2 or more	B	
5. Hospitals	From 10 to not greater than 30 beds B		
	30 beds or more	A**	
6. Schools, Colleges, Universities or Institutes	From 5,000 m^2 to not greater than 25,000 m^2	B	
	25,000 m^2 or more	A**	
7. Government offices, state enterprises, International agencies, Banks, Office buildings	From 5,000 m^2 to not greater than 10,000 m^2	C	working area only (excluding central service area)
	10,000 m^2 to not greater than 55,000 m^2	B	
	55,000 m^2 or more	A**	
8. Department Stores	From 5,000 m^2 to not greater than 25,000 m^2	B	
	25,000 m^2 or more	A**	
9. Fresh-food markets	From 500 m^2 to not greater than 1,000 m^2	D	
	From 1,000 m^2 to not greater than 1,500 m^2	C	
	From 1,500 m^2 to not greater than 2,500 m^2	B	
	2,500 m^2 or more	A**	
10. Restaurant and food shops or food centers	Less than 100 m^2	E	dining area
	From 100 m^2 to not greater than 250 m^2	D	
	Frome 250 m^2 to not greater than 500 m^2	C	
	From 500 m^2 to not greater than 2,500 m^2	B	
	2,500 m^2 or more	A**	

Note:

* Level of standard refers to the 6 parameters listed in standard value-Building Effluent Standards (Table 1.2.a)

** This type and size of building will be controlled by the Pollution Control Officer, as specified in Section 69 of the Act

Source : Notification of the Ministry of Science, Technology and Environment issued under the Enhancement and conservation of the National Environmental Quality Act, B.E. 2535 (1992).

Appendix IV Criteria Design for Bangkok Wastewater Treatment Plants

Parameter	Unit	Influent	Effuent
BOD	mg/l	150	20 (Carbonaceaus BOD_5, max)
SS	mg/l	150	30 (max)
Ammonia Nitrogen	mg/l (as N)	-	5 (max)
Total Nitrogen (total N)	mg/l (as N)	30	10 (max)
Total Phosphorus	mg/l (as P)	8	2 (max)
Dissolved Oxygen (DO)	mg/l	-	5 (min)
Temperature	mg/l	28	-

Appendix V Reported Cases of Some Water - Related Diseases

Intestinal Tract Diseases	1993		1994		1995		1996		1997	
	C	D	C	D	C	D	C	D	C	D
1. Acute Diarrhea	44,749	-	44,492	10	39,307	5	39,313	-	46,169	-
2. Food Poisoning	2,178	-	1,924	-	1,300	-	1,523	-	2,054	-
3. Dysentery-Total	1,170	-	930	-	613	-	676	-	599	-
- Bacillary	194	-	128	-	112	-	138	-	67	-
- Amoebic	49	-	26	-	26	-	36	-	33	-
- Unspecified	927	-	776	-	475	-	502	-	499	-
4. Enteric Fever-Total	217	-	147	-	143	-	807	-	218	-
- Typhoid	62	-	65	-	60	-	244	-	105	-
- Paratyphoid	4	-	9	-	18	-	445	-	54	-
- Unspecified	151	-	73	-	67	-	118	-	59	-

Note: C means cases and D means Deaths

Source: The Study for the Master Plan on Sewage Sludge Treatment/Disposal and Reclaimed Wastewater reuse in Bangkok

Appendix VI Comparison of Crematory Standards in Thailand

PARAMETER	BMA Standards	National Standards	Infectious Waste Incinerator Standards
Number of Chambers	2	2	-
Standard O_2 (dry) %	11%	-	-
Secondary Combustion Chamber	850 °C	1,000 °C	-
Secondary Chamber Residence Time	1 second	1 second	
Fuel Type	LPG	Gas or diesel	-
Fuel and Emissions Controls	Yes	Yes	-
TSP Limit	100 mg/m^3	-	400 mg/m^3
SO_2 Limit	100 mg/m^3	-	140 mg/m^3
NO_x Limit	100 mg/m^3	-	470 mg/m^3
Opacity Standard	-	10%	-
CO Limit	100 mg/m^3	-	1,000 ppm
HCl Limit	-	-	200 mg/m^3

Source: NEPO, 1999 and BMA, 2000b

Appendix VII Ambient Air Quality Standards (1995)

Pollutants*	1 hour Average		8 hour Average		24 hour Average		1 month Average		1 year Average		Measurement Method
	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	ppm	
Carbon monoxide (CO)	34.2	30	10.26	9	-	-	-	-	-	-	Non-Dispersive Infrared Detection
Nitrogen dioxide (NO_2)	0.32	0.17	-	-	-	-	-	-	-	-	Chemilumine-Sence
Sulfur dioxide/a (SO_2)	0.78**	0.3	-	-	0.3	0.12	-	-	0.1	0.04***	UV-Fluorescence
Total Suspended Particulate (TSP)	-	-	-	-	0.33	-	-	-	0.1	-	Gravimetric High Volume
Particulate matter (PM-10)	-	-	-	-	0.12	-	-	-	0.05	-	Gravimetric High Volume
Ozone (O_3)	0.2	0.1	-	-	-	-	-	-	-	-	Chemilumine-Sence
Lead (Pb)	-	-	-	-	-	-	1.5**	-	-	-	Atomic Absorption Spectrometer

*** : Concentration Calculated at 1 Atmospheric Pressure and 25 °C
** : Microgram/Cubic Meters
* : Geometric Mean
/a : 1 hour Average SO_2 Standard
780 µg/m^3 in Ambient besides Mae Moe District
1,300 µg/m^3 at Mae Moe District, Lampang Province

Source: Notification of National Environment Board No. 10 (1992) under the Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992) published in the Royal Government Gazette No. 112 Part 52 dated May 25, B.E. 2538 (1995)

Appendix VIII Emission Standards for New Vehicles in Thailand

1. Emission Standards for Gasoline Vehicle

No.	TIS	Level	Reference	Effective	Type	Emission			Idle	Crankcase	SHED
						CO	HC+NOx	NOx			
1	1085-2538(1995)	1	ECE R 15-04		Passenger	58-110g/test	19-28g/test	-	3.5%	None	-
					Others	Multiply by 1.25	Multiply by 1.25	-			-
2	1120-2535(1992)	2	ECE R 83	30-Mar-95	Passenger	45-25g/test	15-6.5g/test	6-3.5g/test	3.5%	None	-
					Others	58-110g/test	19-28g/test	-		-	
3	1280-2538(1995)	3	ECE R 83-01	24-Mar-96	Passenger	2.72 g/km	0.97 g/km	-	-	None	2 g/test
					Others	58-110g/test	19-28g/test	-	3.5%	None	-
4	1365-2539(1996)	4	93/59/EEC	1-Jan-97	Passenger	2.72 g/km	0.97 g/km	-	-	None	2 g/test
					Others	2.72-6.9g/km	0.97-1.7g/km	-	-		
5	1440-2540(1997)	5	94/12/EEC	1-Jan-99	Passenger	2.2 g/km	0.5 g/km	-	-	None	2 g/test
					Others	2.72-6.9g/km	0.97-1.7g/km	-	-		
6	1870-2542(1999)	6	96/69/EEC	25-Aug-01	Passenger	2.2 g/km	0.5 g/km	-	-	None	2 g/test
					Others	2.2-5.0g/km	0.5-0.7g/km	-	-		

Source: Land Transportation Department, Ministry of Transport and Communications.

2. Emission Standards for Light Duty-Diesel Vehicle

No.	TIS	Level	Reference	Effective	Type	Emission			Particulate	Remark
						CO	HC+NOx	NOx		
1	1140-2536(1993)	1	ECE R 83	29-Jan-95	Passenger	45-30g/test	15-8g/test	6- -g/test	-	
					Others	58-110g/test	19-28g/test	-	-	
2	1285-2538(1995)	2	ECE R 83-01	23-Feb-96	Passenger	2.72 g/km	0.97 g/km	-	0.14 g/km	
					Others	58-110g/test	19-28g/test	-	-	
3	1370-2539(1996)	3	93/59/EEC	1-Jan-97	Passenger	2.72 g/km	0.97 g/km	-	0.14 g/km	
					Others	2.72-6.9g/km	0.97-1.7g/km	-	0.14-0.25 g/km	
4	1435-2540(1997)	4	94/12/EEC	1-Jan-99	Passenger	1.0 g/km	0.7(0.9) g/km	-	0.08(0.1) g/km	(..) for DI engine
					Others	2.72-6.9g/km	0.97-1.7g/km	-	0.14-0.25 g/km	until 30 Sep. 44
5	1875-2542(1999)	5	96/69/EEC	25-Aug-	Passenger	1.0 g/km	0.7(0.9) g/km	-	0.08(0.1) g/km	(..) for DI engine
					Others	1.0-1.5g/km	0.7-1.2g/km (0.9-1.6)g/km	-	0.08-0.17 g/km (0.10-0.20) g/km	until 31 Dec. 45

Source: Land Transportation Department, Ministry of Transport and Communications.

3. Emission Standards for Motorcycle

No.	TIS	Level	Reference	Effective	Engine Type	Emission			Idle	
						CO	HC	HC+NOx	CO	HC
1	1105-2535(1992)	1	ECE R 40-00	10-Aug-93	2-T	16.0-40.0 g/km	10.0-15.0 g/km	-	3.5%	-
					4-T	25.0-50.0 g/km	7.0-10.0 g/km	-		
2	1185-2536(1993)	2	ECE R 40-01	15-Mar-95	2-T	12.8-32.0 g/km	8.0-12.0 g/km	-	4.5%	-
					4-T	17.5-35.0 g/km	4.2-6.0 g/km	-		
3	1305-2538(1995) (Less than 110 cc)	3	TIS 1105	1-Jul-95		13.0 g/km	5.0 g/km	-	4.5%	10000 ppm
4	1355-2539(1996) (Less than 125 cc)	3	TIS 1105	1-Jul-96		13.0 g/km	5.0 g/km	-	4.5%	10000 ppm
5	1360-2539(1996)	3	TIS 1105	1-Jul-97		13.0 g/km	5.0 g/km	-	4.5%	10000 ppm
6	1650-2541(1998)	4	All sizes	30-Jul-01		4.5 g/km	-	3.0 g/km	4.5%	10000 ppm
			125 cc up	1-Jul-01						

Source: Land Transportation Department, Ministry of Transport and Communications.

4. Emission Standards for a Heavy Duty-Diesel Vehicle

No.	TIS	Level	Reference	Effective	Emission			Particulate
					CO	HC	NO_x	
1	1180-2536(1993)	1	ECE R 49-01		11.2 g/kWh	2.4 g/kWh	14.4 g/kWh	-
2	1290-2538(1995)	2	91/542(A)/EEC (EURO 1)	12-May-98	4.5 g/kWh	1.1 g/kWh	8.0 g/kWh	0.36 g/kWh
3	1295-2541(1998)	3	91/542(B)/EEC (EURO 2)	23-May-00	4.0 g/kWh	1.1 g/kWh	7.0 g/kWh	0.15 g/kWh

Source: Land Transportation Department, Ministry of Transport and Communications.

Appendix IX (Ambient Noise and Vehicles Noise Standards)

Ambient Noise Standards

Standard	Sound Level Calculation Method
1. A-weighted Equivalent Continuous Sound Level (L_{eq}) 24 hours should not exceed 70 dB (A)	Fluctuating Noise
2. Maximum Sound Level (L_{max}) should not exceed 115 dB(A)	Steady Noise

Source : - Notification of environmental Board No. 15 B.E.2540(1997) under the Conservation and Enhancement of National Environmental Quality Act B.E.2535 (1992) dated March 12, B.E.2540 (1997)

Vehicles Noise Standard

Vehicle Type	Standard	Testing Method	Remark
Motorcycle	Not exceeding 100 decibels A (dBA)	Measuring while park in the motorcycle at no load by acceleration the engine to 1/2 and 3/4 of maximum rpm. (rounds per minute) if the engines have maximum rpm. over 5,000 rpm. and less than 5,000 rpm., respectively; the position of microphone is 45 degree at 0.5 meter from the end of exhaust pipe. *Conduct the test twice and use the highest standard measured. If the difference is higher than 2 decibels, perform the test again.	-
Gasoline Vehicle	Not exceeding 100 decibels A (dBA)	Measuring while park in the car at no load by acceleration the engine to 3/4 of maximum rpm. (rounds per minute), the microphone position is 45 degree at 0.5 meter from the end of exhaust pipe.	
Diesel Vehicle	Not exceeding 100 decibels A (dBA)	Accelerate until the engine reaches maximum speed, the position of microphone is 45 degree at point 0.5 meter from the end of the exhaust pipe.	
Motor Boats	100 decibels at 0.5 meters from the boat's exhaust pipe	Diesel engines: accelerate until the engine reaches its highest rounds per minute.	Conduct the test twice and use the highest standard measured. If the difference is higher than 2 decibels, perform the test again.

Source : - Notification of Ministry of Science, Technology and Environment B.E.2535 (1992)dated August 28, B.E. 2535 (1992), published in the Royal Government Gazette Vol. 109 Part 119 dated September 17, B.E.2535 (1992)
- Notification of Ministry of Science, Technology and Environment B.E.2537 (1994) dated June 14, B.E.2537 (1994), published in the Royal Government Gazette Vol. 109 Part 119 dated September 20, B.E.2537 (1994)