Bangkok
State of Environment
2003
Environmental management is considered as one of many important policy of the Bangkok Metropolitan Administrators. We have been working hard to solve many of the problems of air pollution, water pollution, and solid waste as well as others, with effective planning and measures for the abatement of adverse impacts on quality of life and public health in the City.

The Bangkok State of Environment Report 2003, the 2nd Edition, reports information on environmental situation and management of the environmental problems. The data and information were gathered and compiled from several agencies in charge of environmental management in the past year, such as on air pollution abatement, garbage reduction, and public participation, for example. Bangkok Metropolitan Administration expects this Bangkok State of Environment Report to reflect the situation and our determination to aim for improvement of the environment.

Publication of this year’s State of Environment Report was still supported technically and financially from United Nations Environment Programme-Asia Pacific Region (UNEP RRC.AP) as in the previous year. This Report will be useful for administrators, officials, and the public in general. In addition to the information on the environmental situation trend in the City of Bangkok, it will promote understanding and knowledge as well as awareness for the future cooperation towards the unified goals of better environment for the City.

Mr. Samak Sundaravej
Bangkok Governor
รายงานสถานการณ์คุณภาพสิ่งแวดล้อมของครั้งที่ 2546 ได้รับรายงานที่จัดทำขึ้นเป็นบัตรพื้นที่การที่ครั้งที่ 2546 ได้แสดงว่ามีการจัดทำรายงานสถานการณ์คุณภาพสิ่งแวดล้อมของครั้งที่ 2546 ได้เป็นกระจาย ลำดับเน้น เป็นเรื่องที่น่าจะยิ่งใหญ่ในการเตรียมการให้เกิดการตระหนักถึงสถานการณ์คุณภาพสิ่งแวดล้อม รวมทั้งประสบความ สิ่งแวดล้อมในการให้การตอบแทนของจากที่มีนั้นได้สำเร็จ UNEP มีความยินดีในการช่วยให้สัญญาณการที่ 2546 ได้ใช้ในการจัดทำรายงานที่สำคัญ โดยเริ่มต้นในปี พ.ศ. 2544 กระบวนการเตรียมการในการจัดทำรายงานฉบับที่ 2 ในปี พ.ศ. 2546 นั้นเป็นไปตามขั้นตอนที่กำหนด โดยมีผู้มีส่วนร่วมในการจัดทำรายงานประมาณ 20 หน่วยงาน และมีบุคลากรจ้างงาน 60 ท่าน ได้เข้ามามีส่วนในการจัดทำข้อความและตัวอย่างที่ปรากฏอยู่ในรายงานฉบับนี้ ประกอบไปยุ่นในระหว่างการจัดทำโดย คาดว่าจะจัดพิมพ์ในปี พ.ศ. 2550

รายงานสถานการณ์ฉบับนี้แสดงให้เห็นปัญหาสิ่งแวดล้อมที่เป็นปัญหาหลักของรัฐมนตรีทำ โดยใช้ราย โครงการวิเคราะห์แบบหลัก สถานการณ์ ผลกระทบ - การตอบสนอง (PSIR) ปัญหาสิ่งแวดล้อมหลักของ รัฐมนตรีทำขึ้นเป็นเรื่องของปัญหาคุณภาพอากาศ การจัดการคุณภาพน้ำ การจัดการคุณภาพของอากาศ การจัดการคุณภาพและลดโลกร้อน ผลสัมฤทธิ์ และปัญหาด้านทางทะเล เช่นเดียวกับในรายงานฉบับต้น

ในรายงานฉบับนี้ได้แสดงให้เห็นการขยายตัวทางเศรษฐกิจได้ก่อให้เกิดผลกระทบอย่างมากต่อการแกร่ง คุณภาพอากาศ และสภาพภูมิอากาศ คุณภาพดินสิ่งแวดล้อมในระดับวิถีชีวิตถึงระดับการแกร่ง คุณภาพของ попуเลชัน มีการระบายน้ำสิ่งแวดล้อม 2.5 ล้านลูกค้าแต่ละเดือนลดลงอย่างมากต่อช่วง 75 ปี พ.ศ. 2545 พบว่ามีการเป็นโรคซึ้งช่วง 39 ราย การสูญหายอากาศ คาดว่าจะต้องเน้นเป็นระยะยาว ที่เกิดจากวัตถุระดับน้ำได้ติด โดยเป็นการเพิ่มความรุนแรงต่อปัญหาแกร่งสิ่งแวดล้อม จำนวนเรื่องที่ เพิ่มขึ้นถึง 0.29 ล้านที่ ในวันที่ พ.ศ. 2543 ถึง พ.ศ. 2545 รวมถึงการใช้บริการแสงเพื่อสิ่งแวดล้อมถึงร้อยละ 39.9 ของวัตถุระดับเพื่อการใช้ในประเทศ ที่เกิดผลกระทบอย่างมากต่อคุณภาพอากาศในเมือง ตัวชี้วัดคุณภาพอากาศ ที่มีค่าติดตามมาตรฐานเรื่อง 青岛 ซึ่งเคยเป็นไปได้ดีในปี 2000 และในช่วงที่ผ่านมาผ่านขั้นตอนการพัฒนา การพัฒนาด้านคุณภาพอากาศ ภายในตัวชี้วัดคุณภาพอากาศ ร่างสิ่งแวดล้อม ตามแนวสิ่งแวดล้อมเกิดขึ้นมาหลายครั้ง โดยแสดงถึงการรักษาอย่างที่ดีในสิ่งแวดล้อมที่มีค่า เสียที่น้อยที่สุดในระดับที่ และในช่วงการพัฒนาที่ผ่านมาผ่านขั้นตอนการพัฒนา ปัญหาเรื่องคุณภาพได้จัดเป็นปัญหาหลักในการ ทรัพยากรที่มีภายในจังหวัดร่วมกับนักแสดงช่วงต่อจากจังหวัดมีอยู่ ไม่ว่าจะใช้ในทางการ ภายในตัวชี้วัดการพัฒนา และรายได้เช่นช่วงระยะเวลาที่มีอยู่เพิ่มขึ้นจาก 3,260 ตันต่อวัน ในปี พ.ศ. 2528 เป็น 9,472 ตันต่อวัน ในปี พ.ศ. 2547

UNEP หวังว่ากระบวนการจัดทำรายงานฉบับนี้จะเป็นการช่วยเพิ่มความระดับความรู้ให้กับรัฐมนตรีทำควบคู่กับการ ช่วยในการทำให้รัฐมนตรีทำเป็นมิตรกับสิ่งแวดล้อม และรายงานฉบับนี้จะมีส่วนช่วยเสริมสร้างในการจัดทำแผนปฏิบัติในการ จัดการภัยพิบัติสิ่งแวดล้อม การจัดทำนโยบาย การจัดทำทรัพยากร รวมทั้งช่วยในการตัดสินใจ

UNEP จะยังคงเป็นบูรณาการให้ความช่วยเหลือในการเสริมสร้างสมรรถนะในการประเมินผลด้านสิ่งแวดล้อม ในภูมิภาคต่อไป

Klaus Töpfer
Under-Secretary General United Nations and Executive Director, United Nations Environment Program
June 2004
The Bangkok City State of the Environment (SoE) 2003 is the second report of its series. The decision of the Bangkok Metropolitan Administration (BMA) to publish SoE reports on a regular periodic basis is an exemplary step towards creating awareness about the prevailing environmental situations and achieving the required response from stakeholders. UNEP is pleased to assist BMA in the preparation process of both reports, the first being on year 2001. The participatory process followed in the preparation of the Bangkok City SoE 2003, is the same as that of the first report. Around 20 agencies and 60 individuals were involved in the process. Data and indicators presented in this report will serve as a quantitative base for UNEP Global Environment Outlook 4 report, which is under preparation and is to be published in 2007.

This SoE report presents the key priority issues of Bangkok, which are analyzed following the "pressure-state-impact-response" (PSIR) framework. The key environmental issues of Bangkok City continue to be air quality, water quality management, solid and hazardous waste management, land subsidence, and noise pollution, as with the first report.

This report states that the increase in economic activities and growth has contributed significant pressure on land, quality of water and air, level of noise and status of solid waste generation. Surface water quality is found to be at a critical level in comparison to the national standard. Around 2.5 million cubic meter of effluents is discharged per day in the canals and river; Households and communities generate 75 percent of this waste. Around 39 cases of acute diarrhea have been reported in 2002. Over use of ground water for a long time has adversely effected the level of the ground water table, subsequently intensifying the land subsidence problem. Increase of 0.29 million number of land transportation vehicles between 2000 and 2002 in Bangkok and consumption of 39.9 percent of total fuel used in Thailand have put additional pressure on the quality of city air. Some of the indicators of air quality have been occasionally found to exceed the standards. There has also been an increase of ozone, nitrogen dioxide and sulfur dioxide levels in few places. The increase in respiratory diseases has been evident especially during dry season. Solid waste remains a major issue for Bangkok city. Electronic wastes from computers, mobile phones and electronic appliances, and infectious waste from hospital show a rising trend. Solid waste (garbage) generation trend is found to be increasing from 3,260 tons to 9,472 tons per day between 1985 and 2002 respectively.

UNEP hopes that this reporting process will enrich the awareness of the Bangkok city dwellers to act at the individual level to make Bangkok a pollution free city. The report will also be helpful in formulating environmental action plan, policy setting, resource allocation and decision making.

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

Klaus Töpfer
Under-Secretary General United Nations and
Executive Director, United Nations Environment Program
June 2004
The Bangkok State of Environment Report 2003, the 2nd Edition, has received cooperation and assistance from several environmental agencies to identify the Bangkok Metropolitan’s environmental problems and the present measures to solve them as well as the planning for the environmental management for the future. At the present, Bangkok Metropolitan Administration is implementing action plan according to Agenda 21, the Bangkok Agenda, by identifying actions to be performed in the next 20 years, such as improvement of the City of Bangkok towards the safe city with high standards of living, city planning for better quality of life, improvement of traffic and transportation, air quality management, cleanliness, and encouragement of public participation in the development of the City of Bangkok. The improvement in the environment will sustain the good quality of life for the population.

The Bangkok State of Environment Report presents the progresses on environmental management of the Bangkok Metropolitan Administration, in order to compare with the goals and objectives which have been set, and will be used for planning by administrators and officials as well as for reference document for students and public on the environment issues.

Khunying Nathanon Thavisin
Permanent Secretary for the BMA
Table of Contents

บทที่ 1 โครงสร้างของเมืองกรุงเทพมหานคร (Profile of Bangkok City)
1.1 ภูมิอากาศและที่ตั้ง (Location and Climate) 11
1.2 ประชากร (Population) 13
1.3 กิจกรรมด้านอุตสาหกรรม (Industrial activities) 14
1.4 กิจกรรมด้านพาณิชย์และบริการ (Commercial and Service Sectors) 14
1.5 โครงสร้างพื้นฐาน (Infrastructures) 15

บทที่ 2 คุณภาพอากาศ (Air Quality)
2.1 ปัญหาคุณภาพอากาศในกรุงเทพมหานคร (Air Quality Problem in Bangkok Metropolis) 21
2.2 สถานการณ์ปัจจุบัน (Present Situation) 22
2.2.1 คุณภาพอากาศในเวลากลางวันทั่วไป (Ambient Air Quality) 22
2.2.2 คุณภาพอากาศในเวลารถจราจร (Roadside Air Quality) 23
2.2.3 คุณภาพอากาศในเวลารถไฟสีน้ำเงิน (Air Quality under BTS Elevated Commuter Train Platforms) 24
2.3 ผลกระทบของคุณภาพอากาศที่มีต่อสุขภาพ (Health Impacts of Air Pollutants) 25
2.4 มาตรการเพื่อควบคุมคุณภาพอากาศ (Measures on Air Pollution Control) 25
2.4.1 การใช้กฎหมายด้านคุณภาพอากาศในกรุงเทพมหานคร (BMA and other Agencies’ Measures) 25
2.4.2 กิจกรรมเพื่อบรรลุแผนทางด้านการจัดการคุณภาพอากาศ (Other Actions Supporting Air Quality Management) 28
2.4.3 กิจกรรมความร่วมมือระหว่างประเทศเพื่อลดการระดมมิ่งทางอากาศ (International Cooperation on Air Pollution Abatement) 29
2.5 แผนการเพื่อการจัดการมิ่งทางอากาศ (Air Pollution Abatement Planning) 30

บทที่ 3 คุณภาพน้ำและการจัดการน้ำ (Water Quality Management)
3.1 คุณภาพน้ำ (Water Quality) 31
3.1.1 ปัญหาคุณภาพน้ำในกรุงเทพมหานคร (Water Quality Problem in Bangkok Metropolis) 31
3.1.2 สถานการณ์ปัจจุบัน (Present Situation) 32
3.1.2.1 การปนเปื้อนของน้ำเสีย (Surface Water Contamination) 32
3.1.2.2 การปนเปื้อนของน้ำใต้ดิน (Groundwater Contamination) 35
3.1.2.3 น้ำประปาและการจัดการน้ำ (Water Supply Management) 35
3.1.3 ผลกระทบของปัญหาคุณภาพน้ำ (Impact of Water Pollution) 37
3.1.3.1 ผลกระทบต่อการท่องเที่ยว (Impact to Tourism Activities) 37
3.1.3.2 ผลกระทบต่อชีวิตน้ำ (Impact to Aquatic Life) 37
3.1.3.3 ผลกระทบต่อสาธารณะสุข (Impact to Public Heath) 37
3.1.4 การดำเนินการแก้ไขปัญหาเพื่อลดปัญหาคุณภาพน้ำในแต่ละวัน (Implementation on Water Quality Remediation) 39
3.1.4.1 มาตรการด้านการทะลุสระ (Construction Measures) 39
3.1.4.2 มาตรการที่ไม่ใช้ด้านการทะลุสระ (Non-Construction Measures) 42
3.2 การป้องกันและแก้ไขปัญหาการป้องกันน้ำท่วม (Prevention of Flooding and Water Logging in BMA) 43
3.2.1 มาตรการหลักในการป้องกันน้ำท่วม (Measures on Flood Prevention) 44

บทที่ 4 การจัดการขยะและของเสียอันตราย (Solid and Hazardous Waste Management)
4.1 ปัญหาขยะและของเสียอันตราย (Problems of Solid and Hazardous Waste) 49
4.2 สถานการณ์ปัจจุบัน (Present Situation) 49
4.2.1 ขยะทั่วไป (General Solid Waste) 49
4.2.2 ของเสียอันตราย (Hazardous Waste) 50
บทที่ 5 แผ่นดินทรุด (Land Subsidence) 60
5.1 ปัญหาแผ่นดินทรุดในกรุงเทพมหานคร (Problem) 60
5.2 สถานการณ์ปัจจุบัน (Present Situation) 61
5.2.1 ขนาดการทรุดตัวของพื้นดินทั้งหมดระหว่าง พ.ศ.2545 ถึง พ.ศ.2546 (Land subsidence in 2002-2003) 61
5.2.2 ขนาดการทรุดตัวของพื้นดินช่วง 5 ปี ระหว่าง พ.ศ.2542-2546 (The 5 - Year Subsidence During 1999-2003) 62
5.3 ผลกระทบของการทรุดตัว (Land Subsidence in Bangkok City and its Impact) 65
5.4 แนวทางการแก้ไขปัญหาแผ่นดินทรุด (Policy and Regulation) 65
5.4.1 ตั้งคณะกรรมการเร่งรัดแก้ปัญหาการทรุดตัว (The Cabinet Resolution on the Problem of Groundwater Use) 66
5.4.2 พระราชบัญญัติป่า_SURFACE (ฉบับที่ 3) พ.ศ.2546 (Groundwater Act [No. 3]. B.E. 2546 amends the Groundwater Act. B.E. 2520) 66

บทที่ 6 ผลกระทบทางเสียง (Noise Pollution) 67
6.1 ปัญหาผลกระทบทางเสียงในกรุงเทพมหานคร (Noise Pollution Problem in Bangkok Metropolis) 67
6.2 สถานการณ์ปัจจุบัน (Present Situation) 68
6.3 ผลกระทบของปัญหาผลกระทบทางเสียง (Impacts of Noise Pollution) 69
6.4 แนวทางการแก้ไขปัญหาผลกระทบทางเสียง (Measures on Noise Pollution Abatement) 69

บทที่ 7 พลังงาน (Energy) 71
7.1 ปัญหา (Problems) 71
7.2 สถานการณ์ปัจจุบัน (Present Situation) 71
7.3 ปริมาณการใช้พลังงาน (Energy Consumption) 72
7.3.1 ปริมาณการใช้พลังงานในส่วนการบริโภค (Fuel Consumption) 72
7.3.2 ปริมาณการใช้พลังงานไฟฟ้า (Electricity Consumption) 73
7.4 ยุทธศาสตร์พลังงานแห่งประเทศ (National Energy Strategies) 74
7.4.1 กำหนดเป้าหมายการใช้พลังงานแห่งประเทศ (Designate Energy Target for the Country) 74
7.4.2 ยุทธศาสตร์การใช้พลังงานอย่างมีประสิทธิภาพ (Strategy on Effective Energy Utilization) 74
7.5 ข้อสังเกตของคณะกรรมการพลังงาน (The Cabinet’s Observation) 76
7.6 นโยบายการอนุรักษ์พลังงานของกรุงเทพมหานคร (BMA’s Energy Conservation Policy) 77

บทที่ 8 โบราณสถานและสถาปัตยกรรม (Historical Places and Architectures) 78
8.1 สถานการณ์ปัจจุบัน (Present Situation) 78
8.2 แนวทางการดำเนินการของกรุงเทพมหานคร (Implementation Policy of BMA) 80

บทที่ 9 พื้นที่เขียว (Green Areas) 81
9.1 สถานการณ์ปัจจุบัน (Present Situation) 81
9.2 นโยบายและยุทธศาสตร์การพัฒนาพื้นที่เขียวของกรุงเทพมหานคร (Policy and Direction on Green Area Development of BMA) 82
9.3 ความคิดเห็นของประชาชนชาวกรุงเทพมหานครในการพัฒนาพื้นที่เขียว (Public Opinion of Bangkok People on Green Area Development) 83
9.4 Large Trees in Bangkok Metropolis
9.5 Development of Green Areas in Bangkok Metropolis
9.5.1 Necessity to Develop Green Areas
9.5.2 Strategy in Green Area Development
9.6 Objectives of Green Area Development

Chapter 10
Environmental Nuisance Control in Bangkok
10.1 Nuisance Problem in Bangkok Metropolis
10.2 Present Situation
10.3 Impacts of Nuisance Problems
10.4 Strategies to Solve Nuisance Problem
10.5 BMA's Strategies and Implementation
10.6 Recommendations

Chapter 11
Public Participation in Environmental Promotion and Conservation
11.1 Introduction
11.2 Solid Waste Management
11.3 Communities Love Canals
11.4 BMA Environmental Protection Volunteers
11.5 Rehabilitation and Conservation of Mangrove Forest of Bang Khunthien Seashore
11.6 Increasing Green Areas
11.7 Development and support of Good Environment in Entrepreneurial

Chapter 12
Agenda 21 - The Bangkok Agenda
12.1 The Bangkok Agenda
12.2 From Bangkok Agenda to Action
12.2.1 Preparation of the Sustainable Urban Management handbook
12.2.2 Preparation of District Catalogue
12.2.3 Preparation of the BMA Green Area Development Master Plan
12.2.4 Green Fleets
12.2.5 The Bangkok Comprehensive Plan
12.2.6 "Naa Ban Naa Mong" [Nice to Look House Project]
12.2.7 "Kon Rak Klong" [We Love Canals Project]
12.2.8 Mass Transit Project for Bangkok
12.2.9 Data System and Computer Network of SMA

Chapter 13
Important Events for the Environment
<table>
<thead>
<tr>
<th>No.</th>
<th>Table Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Meteorological Data of Bangkok Metropolis, monthly, averaged over 10 years</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>(1993 - 2002)</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Graphs showing the Bangkok Population Based on Sex and Age, 2002</td>
<td>13</td>
</tr>
<tr>
<td>1.3</td>
<td>Location of Industrial Factories in Bangkok Metropolis, 2002</td>
<td>16</td>
</tr>
<tr>
<td>1.4</td>
<td>Location of Goods Distribution Centers and Department Stores in Bangkok</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>2002</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>Land Communication in Bangkok Metropolis, 2002</td>
<td>18</td>
</tr>
<tr>
<td>1.6</td>
<td>Water Communication in Bangkok Metropolis, 2002</td>
<td>19</td>
</tr>
<tr>
<td>1.7</td>
<td>Number of Base and Mobile Telephones Bangkok Metropolis, fiscal year 2002</td>
<td>20</td>
</tr>
<tr>
<td>2.1</td>
<td>Particulate Matter of Small Sizes Less Than 10 Micron (PM10), on 24 Hour</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Average Measurements, in General Areas of Bangkok Metropolis During 1997 -</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2002</td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>Particulate Matter of Small Sizes Less Than 10 Micron (PM10), on 24 Hour</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Average Measurements, at Roadside of Bangkok Metropolis During 1992 - 2002</td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Biological Oxygen Demand (BOD) Loading for Bangkok Metropolis</td>
<td>32</td>
</tr>
<tr>
<td>3.2</td>
<td>Water Quality (BOD) in Bangkok Metropolis, 2002</td>
<td>33</td>
</tr>
<tr>
<td>3.3</td>
<td>Water Quality (DO) in Bangkok Metropolis, 2002</td>
<td>34</td>
</tr>
<tr>
<td>3.4</td>
<td>Water Quality (SS) in Bangkok Metropolis, 2002</td>
<td>34</td>
</tr>
<tr>
<td>3.5</td>
<td>Reported Cases of Acute Diarrhea Per 100,000 People in Bangkok Metropolis,</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>1993 - 2002</td>
<td></td>
</tr>
<tr>
<td>3.6</td>
<td>Reported Cases of Acute Diarrhea Per 100,000 People in Bangkok Metropolis</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>According to Age Groups, 2000 - 2002</td>
<td></td>
</tr>
<tr>
<td>3.7</td>
<td>Bangkok Metropolis Wastewater Treatment Project Sites</td>
<td>40</td>
</tr>
<tr>
<td>3.8</td>
<td>The Interceptor Sewer System</td>
<td>41</td>
</tr>
<tr>
<td>3.9</td>
<td>Polder System in Bangkok Metropolis</td>
<td>46</td>
</tr>
<tr>
<td>3.10</td>
<td>Monkey's Cheeks in Bangkok Metropolis</td>
<td>47</td>
</tr>
<tr>
<td>4.1</td>
<td>Amount of Solid Waste Collected within Bangkok Metropolis During 1987 - 2002</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>and Projection for 2003 - 2015</td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>Composition of Collected Solid Waste, 2002</td>
<td>50</td>
</tr>
<tr>
<td>4.3</td>
<td>Solid Waste Management of BMA</td>
<td>53</td>
</tr>
<tr>
<td>4.4</td>
<td>Sorting and Management Solid Waste in BMA</td>
<td>54</td>
</tr>
<tr>
<td>4.5</td>
<td>Hazardous Waste Management Scheme of BMA</td>
<td>56</td>
</tr>
<tr>
<td>4.6</td>
<td>Legislations on Solid Waste Management of BMA</td>
<td>58</td>
</tr>
</tbody>
</table>
งบที่ 5.1 แผนที่แสดงโครงการสำรวจระดับการทรุดตัวของพื้นดินในเขตกรุงเทพมหานคร และปริมณฑล ขนาดการทรุดตัว
ตั้งแต่ปี พ.ศ. 2545-2546 (The Map Showing Area of the Networks of Leveling Survey benchmark in
Bangkok Metropolitan Region in 2002 - 2003) 63
งบที่ 5.2 แผนที่แสดงโครงการสำรวจระดับการทรุดตัวของพื้นดินในเขตกรุงเทพมหานคร และปริมณฑล
ขนาดการทรุดตัว ตั้งแต่ปี พ.ศ. 2542-2546
(The Map Showing Area of the Networks of Levelling Survey benchmark
in Bangkok Metropolitan Region in 1999 - 2003) 63
งบที่ 5.3 บูพแสดงพื้นที่แนวเหินทรุดตัว พ.ศ.2540 (Map showing Land Subsidence in 1997) 64
งบที่ 5.4 บูพแสดงพื้นที่แนวเหินทรุดตัว พ.ศ.2544 (Map showing Land Subsidence in 2001) 64
งบที่ 5.5 บูพแสดงพื้นที่แนวเหินทรุดตัว พ.ศ.2545 (Map showing Land Subsidence in 2002) 65
งบที่ 6.1 ระดับเสียงเฉลี่ย 24 ชั่วโมงรู้สึก (L_{eq24hr}) ในกรุงเทพมหานคร พ.ศ. 2541-2545
(24-hour Average (equivalent) Sound Level (L_{eq24hr}) in Bangkok Metropolis during 1998 - 2002) 68
งบที่ 7.1 ปริมาณการใช้พลังงานไฟฟ้าในกรุงเทพมหานคร พ.ศ. 2543-2545
(Electricity Consumption in Bangkok 2000 - 2002) 74
งบที่ 10.1 สัดส่วนของเหตุผล derivar ว่าภาษาโดยแบ่งตามสาเหตุในปี พ.ศ. 2545
(Proportion of Nuisance Categorized by Causes in 2002) 91
List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Number of Water Customers, Productions, Distributions in Bangkok Metropolis, Fiscal year 1997 - 2002</td>
<td>20</td>
</tr>
<tr>
<td>1.2</td>
<td>Number of Electricity Customers, Amount of Sales According to User Types in Bangkok Metropolis, Fiscal year 2002</td>
<td>20</td>
</tr>
<tr>
<td>1.3</td>
<td>Number of Base and Mobile Telephones Bangkok Metropolis, Fiscal year 2002</td>
<td>20</td>
</tr>
<tr>
<td>2.1</td>
<td>Ambient Air Quality in Bangkok Metropolis</td>
<td>22</td>
</tr>
<tr>
<td>2.2</td>
<td>Air Quality At Roadside in Bangkok Metropolis, 2002</td>
<td>23</td>
</tr>
<tr>
<td>3.1</td>
<td>Quantity of Wastewater in Bangkok Metropolis</td>
<td>32</td>
</tr>
<tr>
<td>3.2</td>
<td>Average Water Quality of Chao Phaya River in Bangkok Metropolis and Surrounding Areas</td>
<td>35</td>
</tr>
<tr>
<td>3.3</td>
<td>Wastewater Treatment Project in Operation and Under Construction</td>
<td>39</td>
</tr>
<tr>
<td>3.4</td>
<td>Polder System (Polder System in 15 areas)</td>
<td>45</td>
</tr>
<tr>
<td>3.5</td>
<td>Results of Flood Prevention Project (Monkey's Cheek)</td>
<td>45</td>
</tr>
<tr>
<td>4.1</td>
<td>Physical Composition of Solid Waste in 1993 - 2002</td>
<td>51</td>
</tr>
<tr>
<td>4.2</td>
<td>Amount of Infectious Waste Generated and Collected from Sources</td>
<td>55</td>
</tr>
<tr>
<td>5.1</td>
<td>Groundwater Pumpage in Bangkok Metropolis, 1995 - 2001</td>
<td>61</td>
</tr>
<tr>
<td>7.1</td>
<td>Sales of Fuels in Bangkok Metropolis, 2002</td>
<td>73</td>
</tr>
<tr>
<td>9.1</td>
<td>Large Trees Statistics of BMA</td>
<td>86</td>
</tr>
<tr>
<td>10.1</td>
<td>Complaints Received on Nuisance Problems in Bangkok Metropolis, 2000 - 2002</td>
<td>90</td>
</tr>
<tr>
<td>10.2</td>
<td>Percentage of Environmental Health Complaints Regarded as Nuisance Problems</td>
<td>90</td>
</tr>
</tbody>
</table>
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 elevation is about 2.31 m. Mean Sea Level (MSL). The city is divided into 50 districts and 154 sub-districts. 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 29.2°C in 2002, with the maximum at 38°C and minimum at 19.2°C. The average, highest, and lowest averages during the period of 1993-2002 were 28.8°C, 38.8°C (in 1998) and 13.2°C (in 1999) respectively. The average wind velocity was 1.2 m/sec (4.3 km/hr). The average relative humidity is 73% and average precipitation is 1,652 mm.

With regards to the global greenhouse effect which increases the temperature worldwide, Department of Meteorology studied the temperature variation of maximum-minimum of BMA’s air temperature during the
past 10 years with long term averages. During the decade of 1991-2000, the maximum temperature average in summer is significantly higher than long term average, and the same is true for the winter. It can be concluded that during the past decade the temperature had been cooler in cool season and warmer in hot season.

Figure 1.1 Meteorological Data of Bangkok Metropolis, monthly averaged over 10 years (1993-2002)
Source: The Meteorological Department
### 1.2 Population

The total population of Bangkok according to household registration in 2002 was 5.78 million, which was 10% of the total population of Thailand. The population density is 3,686 per sq.km. with the increase of 0.98% per year. The average annual income was 78,594 baht (year 2000) and 0.6% of the population is classified as poor (Office of the National Economic and Social Development Board, 2002).

Population migration is on the declining trend. The actual population of city may not be known, as there are many people who commute to work in Bangkok or live in the city without registration. However, the study on the non-registered population in Bangkok indicated that the population may be 8.87 million. So the ratio of real population to the registered one is 1.57 (Department of City Planning, 1998).

#### Figure 1.2

Graphs showing the Bangkok Population Based on Sex and Age, 2002

Source: Department of Local Administration, Ministry of Interior, 2002

Note: The central household registration is for the people who can not be registered into household according to Section 4 of the Population Registration Act B.E. 1991.
1.3 Industrial Activities

During 1987-1997, there was rapid rise in number of factories, but after 1998, the number of factories decreased. In 2002, the total number of factories in Bangkok was 20,393, the workers were 578,882 and the capital investment was 276,312.61 million baht with total area of 48.25 sq.km. 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 now on the increase again.

The Bangkok Comprehensive Plan defines special zones for industrial estates at Lat Krabang and Bangchan. The total number of factories in two Industrial Estates was 307 in year 2002. The plan promotes development of nonpolluting 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.

1.4 Commercial and Service Sectors

BMA is highly developed economically and with large population, and this attracts entrepreneurs to develop goods distribution centers, especially consumer products at cheap prices. This has caused physical changes and land use changes in the city, and the activities attract more traffics into the areas and subsequently lead to increasing air pollution from motor vehicles.
1.5 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, 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 2002, there were a total number of 1,676 communities in Bangkok, population in communities were 1,402,545, and households were 365,298 with 291,954 houses (Department of Community Development, 2002). The increasing demand for infrastructure can be shown by the following: In 2002, tap water production was 1,505 million cubic meters, with 1,488,638 water users. Electricity demand was 24,400 GWH, mostly for residential users. Base telephones number 1,543,262 and mobile telephone 3,935,127. There are 675 roads, total area 58.08 sq.km. with road surface areas at 34.52 sq.km. (Department of Traffic and Transportation, 2002).

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 etc.
Figure 1.3: Location of Industrial Factories in Bangkok Metropolis, 2002
Figure 1.4 Location of Goods Distribution Centers and Department Stores in Bangkok Metropolis, 2002
Figure 1.5 Land Communication in Bangkok Metropolis, 2002
Figure 1.6 Water Communication in Bangkok Metropolis, 2002
### Table 1.1 Number of Water Consumers, Productions, Distributions in Bangkok Metropolis, Fiscal year 1997-2002

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Number of Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumers (persons)</td>
<td>1,024,863</td>
<td>1,046,165</td>
<td>1,057,802</td>
<td>1,077,001</td>
<td>1,103,208</td>
<td>1,136,985</td>
<td>1,176,370</td>
</tr>
<tr>
<td>Number of Productions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(million m³)</td>
<td>1,431,301</td>
<td>1,340,878</td>
<td>1,214,227</td>
<td>1,235,760</td>
<td>1,274,577</td>
<td>1,291,880</td>
<td>1,290,640</td>
</tr>
<tr>
<td>Number of Distributions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(million m³)</td>
<td>792,407</td>
<td>767,245</td>
<td>718,433</td>
<td>738,293</td>
<td>779,606</td>
<td>813,292</td>
<td>850,399</td>
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<tr>
<td>Average Distribution</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(m³ / month)</td>
<td>58,800</td>
<td>55,400</td>
<td>51,600</td>
<td>52,150</td>
<td>53,897</td>
<td>54,756</td>
<td>55,330</td>
</tr>
</tbody>
</table>

Source: Metropolitan Waterworks Authority, 2002

### Table 1.2 Number of Electricity Consumers, Amount of Sales According to User Types in Bangkok Metropolis, Fiscal year 2002

<table>
<thead>
<tr>
<th>User Types</th>
<th>Number of Electricity Customers</th>
<th>Amount of Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of Sales (Houses)</td>
<td>1,413,364</td>
<td>5,887.13</td>
</tr>
<tr>
<td>Small Business</td>
<td>354,238</td>
<td>4,114.30</td>
</tr>
<tr>
<td>Medium Business</td>
<td>14,402</td>
<td>5,308.48</td>
</tr>
<tr>
<td>Governments and NGOs</td>
<td>8,159</td>
<td>1,033.45</td>
</tr>
<tr>
<td>Public Electricity</td>
<td>3,188</td>
<td>143.06</td>
</tr>
<tr>
<td>Specific Business</td>
<td>1,677</td>
<td>1,495.82</td>
</tr>
<tr>
<td>Large Business</td>
<td>696</td>
<td>6,417.76</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,795,724</strong></td>
<td><strong>24,400.00</strong></td>
</tr>
</tbody>
</table>

Source: Metropolitan Electricity Authority, 2002

### Table 1.3 Number of Base and Mobile Telephones Bangkok Metropolis(1) Area, Fiscal Year 2002

<table>
<thead>
<tr>
<th>Type of Renter</th>
<th>Number of Telephone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Telephone(2)</td>
<td></td>
</tr>
<tr>
<td>House</td>
<td>1,543,262</td>
</tr>
<tr>
<td>Business</td>
<td>1,026,650</td>
</tr>
<tr>
<td>Government</td>
<td>361,269</td>
</tr>
<tr>
<td>Public Telephone</td>
<td>74,729</td>
</tr>
<tr>
<td>Telephone Organization of Thailand</td>
<td>56,082</td>
</tr>
<tr>
<td>Mobile Phone</td>
<td>24,532</td>
</tr>
<tr>
<td>Telephone Organization of Thailand(3)</td>
<td>3,935,127</td>
</tr>
<tr>
<td>- 470 NMT system</td>
<td>3,215(3)</td>
</tr>
<tr>
<td>- Concession</td>
<td>2,231</td>
</tr>
<tr>
<td>- 900 NMT system</td>
<td>3,932,896</td>
</tr>
<tr>
<td>- 900 GSM (including 1-2 call)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Telephone Organization of Thailand, 2002

Note: (1) Metropolitan consists of Bangkok, Nonthaburi, Prathumthani and Samutprakran
(2) Ordinary telephone number, branch boxes and public
(3) Including the public telephone using the mobile phone 470 system 26 numbers

**Figure 1.7** Number of Base and Mobile Telephones Bangkok Metropolis Area, fiscal year 2002
Source: Telephone Organization of Thailand, 2002
2.1 Air Quality Problem in Bangkok Metropolis

At the present, Bangkok is the center for economic, political and social activities with more than 10 million people residing and working. The total number of vehicles registered with Department of Land Transport in 2002 was 4.79 million while the road network has not been expanded adequately, causing traffic jams and vehicles to move at slow speed. This has led to air emissions of dust especially the small size particles (particulate matter with diameter less than 10 micron or PM10) from diesel engines of buses and trucks. Dust problem near the roads was identified as public health risk in Bangkok as the level was consistently higher than the acceptable standard, resulting from traffic and some industrial plants.

Another unique problem in Bangkok's air pollution is the odor and smoke from crematoriums due to incomplete combustion. In 2002 the Health Department and District Offices surveyed 309 crematoriums in Bangkok and found 112 which were sub-standard and could cause air pollution. They are located in inner city (40), junctures of city-suburbs (35) and suburbs (37).
2.2 Present Situation

Monitoring of air pollutants shows that air pollutants which are always over the acceptable ambient air quality standards of Thailand are particulate matter of small sizes (PM10), total suspended particulate (TSP), ozone (O3), sulfur dioxide (SO2) and carbon monoxide (CO). Sulfur dioxide (SO2) and nitrogen dioxide (NO2) are still within the standard applicable. The areas near the roads are mostly effected.

2.2.1 Ambient Air Quality

Ambient Air is defined as areas which are more than 50 meters from major roads. In these areas, Pollution Control Department of Ministry of Natural Resources and Environment have set up 10 monitoring stations. Only ozone exceeded the standard at most stations, but particulate matter with diameter less than 10 microns (PM10) exceeded the standard value some of the time. Other pollutants which include TSP, sulfur dioxide, nitrogen dioxide and carbon monoxide were found to be within the standard values (Table 2.1).

Table 2.1 Ambient Air Quality in Bangkok Metropolis

<table>
<thead>
<tr>
<th>Air Pollutants</th>
<th>Range (Min-Max)</th>
<th>Average</th>
<th>Standard Value</th>
<th>Number of data that exceeded standard/total data (% exceeding)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total suspended particulate (TSP), 24 hour average, in mg/m³</td>
<td>0.01-0.31</td>
<td>0.10</td>
<td>0.33</td>
<td>0/491 (0)</td>
</tr>
<tr>
<td>Small particulate matter (PM10), 24 hour average, μg/m³</td>
<td>16.7-141.7</td>
<td>49.4</td>
<td>120</td>
<td>7/1,775 (0.39)</td>
</tr>
<tr>
<td>Carbon monoxide, 1 hour average, in ppm</td>
<td>0-9.19</td>
<td>0.85</td>
<td>30</td>
<td>0/81,379 (0)</td>
</tr>
<tr>
<td>Carbon monoxide, 8 hour average, in ppm</td>
<td>0-5.2</td>
<td>0.90</td>
<td>9</td>
<td>0/83,928 (0)</td>
</tr>
<tr>
<td>Ozone, 1 hour average, in ppb</td>
<td>0-162.0</td>
<td>13.7</td>
<td>100</td>
<td>93/62,669 (0.15)</td>
</tr>
<tr>
<td>Sulfur dioxide, 1 hour average, in ppb</td>
<td>0-98.0</td>
<td>5.20</td>
<td>300</td>
<td>0/76,252 (0)</td>
</tr>
<tr>
<td>Sulfur dioxide, 24 hour average, in ppb</td>
<td>0-25.4</td>
<td>5.20</td>
<td>120</td>
<td>0/3,236 (0)</td>
</tr>
<tr>
<td>Nitrogen dioxide, 1 hour average, in ppb</td>
<td>0-157.0</td>
<td>23.9</td>
<td>170</td>
<td>0/79,930 (0)</td>
</tr>
</tbody>
</table>

Source: Pollution Control Department, Ministry of Natural Resources and Environment, 2002

Figure 2.1 Particulate Matter of Small Sizes Less Than 10 Micron (PM10), on 24 Hour Average Measurements, in General Areas of Bangkok During 1997-2002

Source: Pollution Control Department, Ministry of Natural Resources and Environment, 2002
2.2.2 Roadside Air Quality

There are 7 monitoring stations near the roadside in Bangkok and 21 temporary stations operated by Pollution Control Department of Ministry of Natural Resources and Environment. The monitoring results show higher concentrations of air pollutants than the ambient air as motor vehicles are large emitters. In the year 2002 particulate matter was still the most important problem and at some stations carbon monoxide, nitrogen dioxide and ozone occasionally exceeded the standards. For sulfur dioxide was still within the standard values. (Table 2.2).

Table 2.2 Air Quality At Roadside In Bangkok Metropolis, 2002

<table>
<thead>
<tr>
<th>Air Pollutants</th>
<th>Range (Min-Max)</th>
<th>Average</th>
<th>Standard Value</th>
<th>Number of data that exceeded standard/total data (%exceeding)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total suspended particulate(TSP) 24 hour average, in mg/m³</td>
<td>0.01-0.50</td>
<td>0.18</td>
<td>0.33</td>
<td>29/677 (4.3)</td>
</tr>
<tr>
<td>Small particulate matter (PM10), 24 hour average, in μg/m³</td>
<td>9.3-268.6</td>
<td>57.8</td>
<td>120</td>
<td>691,814 (3.8)</td>
</tr>
<tr>
<td>Carbon monoxide, 1 hour average, in ppm</td>
<td>0-16.6</td>
<td>1.90</td>
<td>30</td>
<td>0/56,815 (0)</td>
</tr>
<tr>
<td>Carbon monoxide, 8 hour average, in ppm</td>
<td>0-9.6</td>
<td>1.86</td>
<td>9</td>
<td>9/57,144 (0.015)</td>
</tr>
<tr>
<td>Ozone, 1 hour average, in ppb</td>
<td>0-113.6</td>
<td>8.78</td>
<td>100</td>
<td>1/12,790 (0.008)</td>
</tr>
<tr>
<td>Sulfur dioxide, 1 hour average, in ppb</td>
<td>0-76.0</td>
<td>7.71</td>
<td>300</td>
<td>0/21,595 (0)</td>
</tr>
<tr>
<td>Sulfur dioxide, 24 hour average, in ppb</td>
<td>0-52.9</td>
<td>7.71</td>
<td>120</td>
<td>0/1,069 (0)</td>
</tr>
<tr>
<td>Nitrogen dioxide, 1 hour average, in ppb</td>
<td>0-171.0</td>
<td>36.74</td>
<td>170</td>
<td>1/23,914 (0.004)</td>
</tr>
</tbody>
</table>

Source: Pollution Control Department, Ministry of Natural Resources and Environment, 2002

Figure 2.2 Particulate Matter of Small Sizes Less Than 10 Micron (PM10), on 24 Hour Average Measurements, at Roadside of Bangkok During 1992-2002

Source: Pollution Control Department, Ministry of Natural Resources and Environment, 2002
carbon monoxide were observed. The concentrations were at health threatening levels but other pollutants were within the standards. The mobile unit’s results showed that small sized particulate matter and carbon monoxide were at health threatening levels but other pollutants were within the standards but some showed signs of increase such as ozone, sulfur dioxide and nitrogen dioxide, especially on Ratchaprarob Road with high volume of traffic. The 24 hour average PM10 concentration on Ratchaprarob Road was 149.68-276.69 microgram/m3. For carbon monoxide (8 hour average) only Rachadapisek Road had it over the standard of 9 ppm (found at 0.44-21.99 ppm).

2.2.3 Air Quality Under BTS Elevated Commuter Train Platforms

BMA has monitored air quality under, outside and inside (ticketing office) BTS Elevated Commuter Train Platforms which were built over existing roads. The four stations are Sapan Kwai, Siam, Phrom Pong, and Saladaeng. The parameters were total suspended particulate(TSP) small sizes particulate(PM10), and carbon monoxide. The TSP was slightly over the standard at Sapan Kwai and Saladaeng stations, while the PM10 was over standard at all stations. Low concentrations of carbon monoxide were observed. The concentrations were higher under the stations than outside, and the ticketing office respectively. In October and November the concentrations were higher than other months. The results are similar to those of year 2001.
2.3 Health Impacts of Air Pollutants

Health impacts from different pollutants differ, but they all depend on the pollutant itself, time of exposure, and interactions among pollutants (such as synergistic effects which can cause more harm if there are more than one pollutant together). For Bangkok, the small particulate matter (PM10) can be considered harmful as the particles can go deep into the respiratory system and also carry other dangerous substances into the body.

It is evidenced that respiratory diseases are on the increase especially during dry season (November-February) so the control measures on dust must be intensive during the period.

2.4 Measures on Air Pollution Control

2.4.1 BMA and Other Agencies’ Measures

BMA together with other agencies has been working according to the policy in air pollution control as follow:

1. Setting up black smoke inspection points in 50 districts jointly with the traffic police and Land Transport Department.

2. Pollution Control Department together with Traffic Police Department and BMA has initiated pilot project on on-road inspection for black smokes and prohibit uses of vehicles which violate the black smoke standard, first be issuing temporary sticker which the owners must have their vehicles repaired within 30 days and report to the designated police station for recheck (Baromrachchonnee Station) or face permanent prohibition which can result in 5,000 baht fine if violated. Destroying the sticker is a crime which has jail sentence of up to 10 days or 500 baht fine, or both. During 18 August-17 September 2003, a campaign was made in Taksin Road to provide information to motorists and the inspection started during 18 September-17 December 2003, for a period of 3 months. After the assessment of results the campaign will be expanded to cover entire BMA area.

3. The meeting was held to discuss the problem of black smoke from private-operated busses, and the Bangkok Mass Transit Authority (BMTA) which operated bus system
17. A request was made to amend the concession contract with the private companies and not allowing sales of old BMTA buses to them. The Prime Minister already issued policy on prohibition of sale of old buses to be used as passenger buses by private companies on 3 February 2003.

4. Public information campaign was continuously made to avoid the highly polluted roads and BMTA was asked to use only clean buses in the inner city area which is polluted.

5. Monitor Bangkok air quality is continuous through the permanent monitoring station and another mobile unit, together with 17 stations operated by Pollution Control Department. The data were pooled and being used for air quality management planning and public information.

6. Provision of inspection and tuning service for air pollution completed with maintenance advice to reduce air pollution.

7. Public relation activities on air pollution and prevention, especially on vehicles, through pamphlets, websites, videotapes, and PR spots.

8. Maintenance of road shoulders to reduce dust.

9. Clamp down on the requirement of canvas to cover buildings under construction to prevent dust.

10. Focus on trucks which must have canvas covering the cargo and must also wash their wheels.

11. Increase of green area and sidewalk shrub planting to reduce exposed area which can cause dust. The pilot project was launched at the narrow shop-lined, busy Din Sor Road (from Democracy Monument to Wat Suthathewanaram) by planting shrubs along footpaths as walls to absorb pollutants and by washing the roads regularly to reduce dust.
12. Sweeping and cleaning roads at highly polluted areas especially at the intersections.

13. Public campaign on vehicle maintenance at the inspection and service centers provided, and on the use of 4-stroke motorcycles, in all 50 BMA districts.

14. Control emissions from government's vehicles with black smoke inspection twice a year and follow-up on maintenance of vehicles which do not comply with the standard.

15. Organization of green fleet project to reduce use of vehicles and promote environmentally friendly vehicles, promote use of public transport and provide information on clean vehicle technology and how to obtain them.

16. Coordination between BMA, Office of Traffic and Transport Policy and Planning, and the Police Department was made on traffic management which can reduce traffic congestion which are the main reason for air pollution. The completed projects undertaken under the government's policy were the elevated electricity commuter trains which has been in operation since December 1999 on two routes (Sukhumvit and Silom, for a total of 23.5 km) with daily passengers of 300,000, and the Metropolitan Rapid Transit's under ground commuter train is expected to be in service at the begin of 2004 (from Hua Lampong train station to Bang Sue, 20 km, and the "extension blue" route, 26 km to Chatuchak Park, and the Orange line, 35 km). All of these projects are expected to alleviate traffic problem and air pollution.

17. Abatement of air pollution from crematoriums by issuing a policy to all BMA districts to use the authority according to Chapter 16 of the Cemeteries and Crematoriums Act, B.E. 2528, to order temples which have crematoriums in the state that may cause danger or produce excessive pollutants to improve within specific time periods. The number of temples which did not comply to the standard was reduced from 112 in April 2002 to 53 in August 2003, and 11 temples were banned to cremate.

18. With regards to the air pollution under the BTS elevated train stations which are above the roads, the coordination was made to move bus stops to be outside the area under platforms and for the traffic police to help clear the traffic under the platforms during rush hours. These activities are expected to alleviate air pollution problem for the pedestrians and bus riders. BMTA was also asked to inspect and maintain their buses which pass under these platforms, and street wash and sweeping are performed on a regular basis. Street hawkers are not allowed under the platform area as to reduce number of people and the resulting congestion. Planting of trees and shrubs to reduce the air pollution impact and public campaign on vehicle use reduction and turn to mass transit system were also conducted.
With all the above measures taken the air quality has been on the improvement. Small dust particles are on the decline in both general and near road areas, but still near the ambient air quality standard level, as shown in Figure 2.1 and 2.2 for the 1992-2002 period. BMA will continue the measures to reduce the pm10 level to be under the standard. For other pollutants, carbon monoxide (8 hour average) and ozone (1 hour average) are still quite acceptable.

Pollution Control Department (in 2002) reported that the roads with highest levels of air pollutants were Sukhumvit Road (On Nuch Road intersection), Rama III Road (Tok Road intersection), Rama I Road (Ma Boon Krong or MBK intersection), Petchburi Road (Yommaraj intersection), Samsen Road (Sriyan intersection), Rachaprarop Road (Pratunam intersection), Bamroomuang Road (Man Sri intersection), Yaowaraj Road (Yaowaraj intersection), Sathupradit Road (Sathupradit post office intersection) and Larn Luang Road (Larn Luang intersection). They are primary target areas for BMA to reduce the air pollution problem.

### 2.4.2 Other Actions Supporting Air Quality Management

1. BMA started the BMA Environmental Protection Volunteers project with the objectives that the volunteers shall participate in the air quality management with BMA. The target groups are community leaders and teachers in BMA schools.

2. BMA has a website on air quality management and useful information, with regular updating. This includes the administration structure of Environmental Quality Management and Control Division, projects and activities undertaken, environmental laws and standards, links to other environmental websites, news, publications, Q&A by experts. The website is http://203.155.220.242/environment.

### 2.4.3 International Cooperation on Air Pollution Abatement

1. Improving Management and Supporting Guidelines in Air Quality in Metropolitan Cities (Athens, Bangkok and Bristol) under Asia Urbs support by European Commission.

It is a 24-month project (Sept 2002-Sept 2004) aimed at developing air quality management and related awareness within local authorities and stakeholders in Bangkok, Bristol and Athens. It is co-funded (65%) by the European Commission.
2.4.3 Gestion environnementale dans le cadre de l'initiative de lutte contre la pollution de l'air (Clean Air Initiative for Asia : CAI-Asia)

L'initiative de lutte contre la pollution de l'air CAI-Asia vise à définir et à promouvoir des stratégies intégrées pour la gestion de la pollution de l'air dans les villes d'Asie. L'objectif est de promouvoir et de démontrer les politiques et les réglementations relatives à la qualité de l'air à l'échelle régionale, en encourageant l'innovation et l'assistance aux autorités compétentes par le biais de formations et de séminaires. Les objectifs spécifiques de la CAI-Asia comprennent:

- Assurer une meilleure compréhension de la qualité de l'air dans les villes de l'Asie.
- Stimuler la mise en place de politiques et de réglementations visant à améliorer la qualité de l'air.
- Encourager l'innovation et l'assistance aux autorités compétentes.
- Promouvoir des initiatives pour améliorer la qualité de l'air.

Le projet est financé par la Commission européenne et co-financé par le gouvernement thaïlandais. Le projet s'achève en 2003 avec un budget total de EUR 769,600. Coordonnateur du projet est la Ville d'Athènes.

Le projet visera à évaluer et à améliorer la qualité de l'air dans les trois villes en identifiant les facteurs qui nuisent à la qualité de l'air et en proposant des solutions. En fin de compte, les partenaires produiront des guides pratiques et un plan d'action pour améliorer la qualité de l'air et la gestion de la pollution de l'air.

2.5 Air Pollution Abatement Planning

BMA plans for air quality management in the Sixth BMA Development Plan (2002-2006) by setting the targets in air pollution abatement through reduction of dust and other air pollutants (and also noise and vibration) from vehicles and industry, establishments, construction and crematoriums. The strategy is to maintain continuous efforts and the following directions are adopted:

1. Promote mass transit in place of private vehicles.
2. Cooperate with Land Transport Department on vehicle inspection and penalize the violators of emission standards.
3. Public information campaign to enhance understanding about the effect from air pollution.
4. Inspect and control dust emission from construction.
5. Organize training and seek cooperation of officials and operators relating to sand and earth movements and enforce regulations on violators.
6. Expand mass transit system such as water and commuter train transport.
7. Use clean technology in transport, especially the buses which can use Euro II or III, and BMA's vehicles to use cleaner fuel such as ethanol or natural gas.
8. Convert garbage into biogas which can then be used for the garbage trucks of BMA.
9. Designate high pollution areas in which tariffs will be collected for vehicles to enter.
10. Allow the public to participate in air, noise and vibration control by:
   10.1 Park the cars at home (car free day) on regular and continuous basis.
   11.2 Encourage car pool.
   11. Complete the network of air quality monitoring in entire BMA within 2004 by:
   11.1 Computerize air quality mentoring network
   11.2 Train officials in air quality monitoring to increase their potentials
   12. Campaign for public to increase use of bicycles.
3. Water Quality Management

3.1 Water Quality

3.1.1 Water Quality Problem in Bangkok Metropolis

Bangkok is the capital city which is the economic center of Thailand. Its activities include commercial, industrial and service have caused the expansion of the city and its population, resulting in accumulation of environmental pollution to the point that nature can not cope with the pollution loadings, especially for water pollution. This is evident in the rivers, canals and other water bodies which show signs of deterioration such as black color and offending odors due to lack of dissolved oxygen. At the present daily water effluent in Bangkok is around 2.5 million cubic meters per day, with 75% is from households and communities and 25% is from industries and commercials, as shown in Table 3.1 and Figure 3.1. On the average dissolved oxygen in Bangkok's canal water is only 0.1-1.5 mg/l which is considered unacceptable according to the surface water quality standard category 4 which is the class reserved for fairly clean fresh surface water resources which requires special treatment process if for consumption.
Table 3.1 Quantity of Wastewater in Bangkok Metropolis

<table>
<thead>
<tr>
<th>Year</th>
<th>From Households (cu.m/day)</th>
<th>Commercial (cu.m/day)</th>
<th>Industry (cu.m/day)</th>
<th>Total (cu.m/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>1,624,520</td>
<td>142,600</td>
<td>405,430</td>
<td>2,172,610</td>
</tr>
<tr>
<td>2007</td>
<td>1,877,450</td>
<td>159,240</td>
<td>477,575</td>
<td>2,514,265</td>
</tr>
<tr>
<td>2012</td>
<td>2,168,820</td>
<td>178,345</td>
<td>562,550</td>
<td>2,909,715</td>
</tr>
<tr>
<td>2017</td>
<td>2,493,230</td>
<td>200,660</td>
<td>662,650</td>
<td>3,356,540</td>
</tr>
</tbody>
</table>

Source: A Feasibility Study of BMA Wastewater User Charge, May 1998

Figure 3.1 Biological Oxygen Demand (BOD) Loading for Bangkok Metropolis
Source: A Feasibility Study of BMA Wastewater User Charge, May 1998

3.1.2 Present Situation

3.1.2.1 Surface Water Contamination

At present, the canal water pollution is very severe as the canals still act as sewers for direct discharge of wastewater in most of the Bangkok areas even though there is already a requirement for large buildings to treat wastewater and houses must have at least septic tanks. However, other wastewaters are discharged without treatment to the public sewers which drain into the canals. The result of the Feasibility Study on Treatment of Wastewater Sludge and Wastewater Reuse in BMA (1999) by Department of Drainage and Sewerage, BMA points out that wastewaters from industrial activities in Bangkok would likely to be less than previously estimated quantity (475,980 cu.m/day in year 2000 and 167,410 cu.m/day in year 2016) as the government has adopted the policy of pushing the factories out of the city through tax measures, so that the present and future wastewater problems are and will be from the households.
According to the responsibility of the Department of Drainage and Sewerage, BMA, it has continuously monitoring water quality in water bodies and canals. The monitoring results are shown in Figures 3.2-3.4 and in Table 3.2, which show that Bangkok’s water quality (see http://dds.bma.go.th/wqmd_surface1.htm for detail) has been at critical levels as compared with the surface water quality standards issued by the National Environmental Board. (See http://dds.bma.go.th/wqmd_canal.htm for detail)

Figure 3.2 Water Quality (BOD) in Bangkok Metropolis, 2002
Source: Department of Drainage and Sewerage, BMA, 2002
Figure 3.3 Water Quality (BOD) in Bangkok Metropolis, 2002
Source: Department of Drainage and Sewerage, BMA, 2002

Figure 3.4 Water Quality (BOD) in Bangkok Metropolis, 2002
Source: Department of Drainage and Sewerage, BMA, 2002
3.1.2.2 Groundwater Contamination

Houses in BMA rely on own septic tanks located underground. The water from the tanks seeps to the ground and the solids are collected and sent to the night soil treatment plant by trucks. Using septic tanks only yield an efficiency of 30-40% so that wastewater can still cause environmental problem. As soil in BMA is clayey with low permeability (1.0 X 10⁻⁷ cm/sec) and groundwater table is high, the septic tanks can not work well and this can lead to groundwater contamination and also results in higher septictank water level.

Table 3.2 Average Water Quality of Chao Phraya River in Bangkok Metropolis and Surrounding Areas

<table>
<thead>
<tr>
<th>Location</th>
<th>Temperature in Celsius</th>
<th>pH</th>
<th>DO (mg/l)</th>
<th>BOD (mg/l)</th>
<th>SS (mg/l)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Nonthaburi Pier</td>
<td>27.9</td>
<td>7.23</td>
<td>3.3</td>
<td>4.7</td>
<td>59</td>
<td>The surface water quality standard</td>
</tr>
<tr>
<td>2) Rama VI Bridge</td>
<td>27.8</td>
<td>7.23</td>
<td>3.1</td>
<td>4.1</td>
<td>55</td>
<td>category 4 is the class reserved for fairly clean fresh surface water resources used for: 1) consumption, but requires special treatment process before use; 2) industry, whereas BOD &lt;4.0 mg/l DO &gt; 2.0 mg/l</td>
</tr>
<tr>
<td>3) Tah Chang Pier</td>
<td>28.2</td>
<td>7.25</td>
<td>3.0</td>
<td>4.8</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>4) Phrabuddhayodfa Bridge</td>
<td>28.0</td>
<td>7.27</td>
<td>3.0</td>
<td>5.4</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>5) Sanpawoottahannrua Bridge</td>
<td>27.4</td>
<td>7.34</td>
<td>3.2</td>
<td>5.2</td>
<td>51</td>
<td></td>
</tr>
</tbody>
</table>

Source: Department of Drainage and Sewerage, BMA, 2002

3.1.2.3 Water Supply Management

At present, the Metropolitan Waterworks Authority (MWA) produces water supply based on the demand for the public in BMA, Nonthaburi and Samut Prakan Provinces, at the average of 4.15 million cubic meters per day in 1,486.5 sq.km area (47% of the responsible area of 3,192 sq.km) on survey dated 30 September 2003. There are 6.88 million people under service (89% of the total of 7.71 million).

In BMA, average water supplied by MWA is 3.5 million cu.m per day in 1,003.2 sq.km area (64% of the responsible area). There are 5.12 million people under service (94% of the total of 5.78 million people according to the household registry, MWA, 2002).

Water sources of MWA is the upstream of Chao Phraya River through Klong Prapa which started from Pathum Thani, 96 km. from the river mouth, to prevent pollution from Bangkok and salinity intrusion. The water is carried through the 31 km. canal which natural purification will be occur, and ends at the water treatment plants at Bang Khen, Sam Sen and Thonburi. Water quality
is within surface water quality standards Class 3 according to the Notification of the National Environmental Board, No. 8, B.E. 2537 (1994).

For the supply of some western parts of BMA which are rapidly growing and the Chao Phraya River may not adequate, the Royal Irrigation Department requested MWA to use the water from Mae Klong River which has some surplus. The water is conveyed through the 107 km. Klong Prapa to Mahasawadis Water Treatment Plant and the water quality is better than from Chao Phraya River, close to Class 2 of the surface water quality standards.

The water which is treated by water treatment plants of the Metropolitan Waterworks Authority complies to the recommended quality according to the World Health Organization (WHO) guidelines at all time. The monitoring and surveillance of incoming water from the upriver to the treatment plants and to the distribution network is under control of qualified scientists and modern technology, such as on-line water quality monitoring, which automatically and continuously monitor water quality and raise the alarm if the quality is not within the prescribed range. As Bangkok is low lying area and has problem of land subsidence, there is always a need to replace the older pipes in order to ensure water quality at the households equivalent to water quality at the treatment plant outlet. According to the research of Mahidol University the tap water in Bangkok is readily drinkable in every area.

However, freshwater is a limited resource while there are several types of users, such as agriculture, industry, navigation, so competition on water use is heating up. It is thus extremely necessary to treat wastewater before discharging to the natural water bodies and water usage by itself must be at high efficiency so that the water resources can be sustained. Treatment of low quality water can be much more expensive than treating cleaner water and it is found that water quality of the Chao Phraya River has become deteriorated in the past few years, which raises the prospect of tap water price increase if such trend continues.

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3.1.3 Impact of Water Pollution

Water quality problems in many areas of Bangkok produce the following impacts:

3.1.3.1 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.

3.1.3.2 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 individual 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 some species of fish and plant cannot survive, or the number of the survivors is reduced.

3.1.3.3 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
Figure 3.5 Reported Cases of Acute Diarrhea Per 100,000 People in Bangkok Metropolis, 1993-2002
Source: Epidemiological Subdivision, Disease Control Division, Department of Health, BMA

Figure 3.6 Reported Cases of Acute Diarrhea Per 100,000 People in Bangkok Metropolis According to Age Groups, 2000-2002.
Source: Epidemiological Subdivision, Disease Control Division, Department of Health, BMA

Epidemiological Subdivision, Disease Control Division, Department of Health, BMA for the year 2002 indicates that there were 39,144 cases of acute diarrhea, about 676.98 per 100,000 people. During the past 10 years the number of cases has been quite high, as shown in Figures 3.5 and 3.6, with the peak in 1998 (877.58 per 100,000 people) and followed by 1997 (826.8) and 1999 (747.3).
In 2002 the patients of the highest risk were in the age group of 0-4 years (4,381.46 per 100,000 people) and followed by 5-9 years old (850.11 per 100,000 people). These, however, might not represent the true extent of waterborne diseases, as most cases were not recorded.
3.1.4 Implementation on Water Quality Remediation

Remediation is divided into 2 categories as follow:

3.1.4.1 Construction Measures

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 sq.km. Every wastewater treatment plants combined have the designed capacity of 992,000 cu.m/day in the next 20 years. Table 3.3 provides the status and detail of each project and Figure 3.7 shows Bangkok Wastewater Treatment Project Sites.

Table 3.3 Wastewater Treatment Projects in Operation and Under Construction

<table>
<thead>
<tr>
<th>Project</th>
<th>Service Area (sq.km)</th>
<th>Treatment Capacity (cu.m/day)</th>
<th>Influent in 2002 (cu.m/day)</th>
<th>Effluent Quality</th>
<th>Project Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Si Phraya</td>
<td>2.7</td>
<td>30,000</td>
<td>20,000</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>2. Rattanakosin</td>
<td>4.1</td>
<td>40,000</td>
<td>33,000</td>
<td>12</td>
<td>0.8</td>
</tr>
<tr>
<td>3. BMA-1 (Dindaeng)</td>
<td>37.0</td>
<td>350,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4. Chongnonsi</td>
<td>28.5</td>
<td>200,000</td>
<td>107,000</td>
<td>4</td>
<td>4.1</td>
</tr>
<tr>
<td>5. BMA-3</td>
<td>44.0</td>
<td>157,000</td>
<td>100,000</td>
<td>4</td>
<td>10.7</td>
</tr>
<tr>
<td>5.1 Nongkhaem - Phasicharoen</td>
<td>42.0</td>
<td>65,000</td>
<td>47,000</td>
<td>4</td>
<td>2.4</td>
</tr>
<tr>
<td>5.2 Ratburana</td>
<td>33.4</td>
<td>150,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>191.7</td>
<td>992,000</td>
<td>307,000</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: Effluent standards of BMA are: BOD <20 mg/l, N <10 mg/l, P < 4 mg/l

Source: Department of Drainage and Sewerage, BMA, 2002
Figure 3.7 Bangkok Wastewater Treatment Project Sites
Source: Department of Drainage and Sewerage, BMA, 2002
For the permanent solution on wastewater BMA must not allow direct discharge of wastewater to the canals and construct central wastewater treatment plants which receive water from the interceptor sewers. In the wet season, rain water will also be collected and the overflow will be discharged to the drainage canals without causing water pollution, as shown in Figure 3.8.

![Figure 3.8 The Interceptor Sewer System](source)

Source: Department of Drainage and Sewerage, BMA, 2002

2) Improvement of the Community Wastewater Treatment Plants

In 1990-1997, 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 efficiency. This resulted in wastewater treatment met the building effluent standards.
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 canals. On the other hand, polluted canal water is pumped back to the river at an average of 2,083 m³/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 saline water entering into 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. Besides 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 Buddamanthon Sai 2 Pond is to improve Bang Jak canal.

3.1.4.2 Non-Construction Measures

1) Legislation Measures

There are many effluent standards applied in Bangkok by the BMA offices such as the Water Effluent Standards from Building formulated by the National Environmental 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 effluent standards from building set by BMA and NEB.

2) Public Relation Measures

In order to implement Central Wastewater Treatment Projects, public acceptance is necessary. Ama 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 staffs who monitor discharged water from building and for operators who are responsible for private wastewater treatment plants; (3) conduct public exhibitions and (4) provide more public 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
3.2 Prevention of Flooding and Water Logging in BMA

Thailand is within the monsoon region which has frequent and heavy rainfall. Chao Phraya River is the main river and the most important, with the watershed area of 160,000 sq.km or one third of the country, receiving water from the north of the country and draining through Bangkok to the sea at the Gulf of Thailand. Bangkok is thus subjected to the tidal movements.

In the past Bangkok had plenty of low lands, canals and marshes, and empty areas which enabled the people to use water as part of their lives and careers without worrying about flood problems, and the economic impacts from floods were not severe. When Bangkok has grown faster than the land use plan and infrastructures, together with land subsidence problem, then floods have become major problem and getting more severe.

As the causes of annual floods are from water flowing over rice fields around the city, water from the north, and tidal effects, the annual flood prevention action plan has to be divided into 2 categories:

1. Action program on prevention and remediation of flooding in BMA by draining storm water within and around the protected areas as fast as possible to minimize floods or shorten the time of flooding.
2. Action Program on prevention and remediation of flooding in BMA by draining water during high tides.

Flood Surveillance Locations in 2002

When the rainwater is over the capacity of drainage system the remaining water will cause flooding especially in low lying areas. The following locations are weak points in this respect in Bangkok:

1. Chaeng Wattana Road (Intersection of Soi 14)
2. Phaholyothin Road, Kasetsart Intersection
3. Thesabansongkro Road
4. Kampaengpet 3 Road

and should contribute toward the cost of wastewater treatment BMA, therefore, provides information with regards to the wastewater treatment system, the cost of wastewater treatment and the procedure in tariff collection to the public. It is also important that the public should be informed when the tariff collection 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.
3.2.1 ผังการหลักในการถ่วงกันกีฬา

3.2.1.1 ผังการสร้างกลุ่มเครื่อง (Structural System)

เนื่องจากการถ่วงกันกีฬาในระบบเป็นสิ่งสำคัญ ที่ทำให้ระบบมีความสามารถในการถ่วงกันกีฬา ทั้งในกรณีที่ไม่มีการถ่วงกันกีฬาในระบบ ระบบประกอบด้วยสิ่งที่มีผลของระบบ (Polder System) จำนวน 15 ตำแหน่ง รวมทั้งหมด 188.06 ตารางกิโลเมตร ซึ่งประกอบด้วย

1) การป้องกันน้ำจากภายนอกสิ่งที่มีผลของระบบ
   - ส่วนที่เป็นพื้นดินที่มีกิ่งก้านไม้ในรูปของถนน ทางรถไฟ ถนน และย่านรอบบ้าน
   - ส่วนที่เป็นทางสาธารณะ ใช้ประโยชน์ทางน้ำ ประตูที่ทำการบิน เป็นต้น

5. Ratchadapisek Road
6. Navamin Road (Indarrak Market)
7. Ramkamhaeng Road
8. Ladprao Road (in front of Makro)
9. Paholyothin Road, Sanam Pao area
10. Pracharat Road I, Tao Poon Intersection
11. Rama VI Road, expressway ramp exit
12. Pracha Songkroh Road
13. Petchburi Road, Bankadthong Intersection
14. Phramain Ground Roads
15. Chan Road, St. Louis Road, Sathupradit Road, Silom Road, Suanplu Road
16. Rama IV Road, Na Ranong and Mahanakorn Intersections
17. Sukhumvit Road, in front of Bang Chak Market and at Udomsuk Intersection, in front of the Meteorology Department
18. Srinakarin Road, in front of SEACON Square
19. Petchkasem Road, in front of the Mall Department Store at Bang Khae

Source: Division of Drainage System, Department of Drainage and Sewerage, BMA, 2000
### Table 3.4 Polder System in 15 areas

<table>
<thead>
<tr>
<th>No.</th>
<th>Area</th>
<th>Area Size (sq.km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Muang Thong Village Polder System</td>
<td>3.7</td>
</tr>
<tr>
<td>2.</td>
<td>Shinaket Village Polder System</td>
<td>4.96</td>
</tr>
<tr>
<td>3.</td>
<td>Ratchadapisek Rd (Klong Nam Kaew) Polder System</td>
<td>28.0</td>
</tr>
<tr>
<td>4.</td>
<td>Bangkok Polder System</td>
<td>8.3</td>
</tr>
<tr>
<td>5.</td>
<td>Ramkamhaeng Polder System</td>
<td>10.6</td>
</tr>
<tr>
<td>6.1</td>
<td>Ratchatavee (Indonesian Embassy) Polder System</td>
<td>1.9</td>
</tr>
<tr>
<td>6.2</td>
<td>Ratchatavee (Petchrama Cinema) Polder System</td>
<td>0.5</td>
</tr>
<tr>
<td>6.3</td>
<td>Ratchatavee (Mitsamphan) Polder System</td>
<td>0.6</td>
</tr>
<tr>
<td>6.4</td>
<td>Huay Kwang Polder System</td>
<td>0.8</td>
</tr>
<tr>
<td>7.</td>
<td>Patumwan Polder System</td>
<td>2.5</td>
</tr>
<tr>
<td>8.</td>
<td>Klong Toey and Watthana Polder System</td>
<td>23.0</td>
</tr>
<tr>
<td>10.</td>
<td>Ratchatavee (Rama VI Road) Polder System</td>
<td>2.2</td>
</tr>
<tr>
<td>11.</td>
<td>Phaya Thai Polder System</td>
<td>9.1</td>
</tr>
<tr>
<td>12.</td>
<td>Phra Nakorn Polder System</td>
<td>1.0</td>
</tr>
<tr>
<td>13.</td>
<td>Yan Nawa, Sathon and Bangkho Laem Polder System</td>
<td>16.3</td>
</tr>
<tr>
<td>14.</td>
<td>Taling Chan Polder System</td>
<td>5.6</td>
</tr>
<tr>
<td>15.</td>
<td>Thonburi and Klongsan Polder System</td>
<td>12.9</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>168.06</strong></td>
</tr>
</tbody>
</table>

Note: For other areas outside polders other measures will be used, such as removing the rubbish from the grill and by pumping the water out with portable pumps in appropriate areas.

Source: Department of Drainage and Sewerage, BMA, 2002

### Table 3.5 Results of Flood Prevention Projects (Monkey’s Cheek)

<table>
<thead>
<tr>
<th>No.</th>
<th>Flood Water Holders</th>
<th>Owner</th>
<th>Total Capacity (cu.m)</th>
<th>Holding Capacity (cu.m)</th>
<th>Benefits on Flood Prevention for The Following Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bung Nong Bon Swamp</td>
<td>BMA</td>
<td>8,000,000</td>
<td>5,000,000</td>
<td>Pro Vet and Phra Khanong Districts.</td>
</tr>
<tr>
<td>2</td>
<td>Bung Makkasan Swamp</td>
<td>BMA</td>
<td>650,000</td>
<td>261,600</td>
<td>Rajpararob, Sri Ayuthhaya, and Asoke Din Daeng Roads, Ratchatavee</td>
</tr>
<tr>
<td>3</td>
<td>Bung Rama IX Swamp</td>
<td>BMA</td>
<td>300,000</td>
<td>10,875</td>
<td>Rama IX Road, Huai Khwang District</td>
</tr>
<tr>
<td>4</td>
<td>Bung Phiboonwatana Swamp</td>
<td>BMA</td>
<td>64,000</td>
<td>48,000</td>
<td>Paholyothin Road, Pradipat Road, Praya Thai District</td>
</tr>
<tr>
<td>5</td>
<td>Bung Lampangquay Swamp</td>
<td>BMA</td>
<td>402,970</td>
<td>200,000</td>
<td>Klong Chan Area, Bung Kum District</td>
</tr>
<tr>
<td>6</td>
<td>Bung Kratram Swamp</td>
<td>BMA</td>
<td>233,400</td>
<td>81,000</td>
<td>Min Buri District</td>
</tr>
<tr>
<td>7</td>
<td>Bung Kum Swamp</td>
<td>BMA</td>
<td>581,530</td>
<td>148,000</td>
<td>Serinakornpattana Village and Thaveesuk Village Bung Kum District</td>
</tr>
<tr>
<td>8</td>
<td>Swamp in (previously) State Railway Authority’s Golf Course</td>
<td>BMA</td>
<td>160,000</td>
<td>107,000</td>
<td>Lad Phra Intersection, Kampongphet 3 Road, Chutuchak Park, Bang Sue District</td>
</tr>
<tr>
<td>9</td>
<td>Bung Taket</td>
<td>BMA</td>
<td>19,600</td>
<td>5,500</td>
<td>Bang Chan District</td>
</tr>
<tr>
<td>10</td>
<td>Swamp in the Army’s Cavalry Regiment 2 and Swamp in Army’s Ror 1 Ror Or Unit</td>
<td>Royal Thai Army</td>
<td>250,000</td>
<td>94,000</td>
<td>Paholyothin Road in front of Sanam Pao and Vibhavadi.rangsit Road, Phya Thai District</td>
</tr>
<tr>
<td>11</td>
<td>Klong Prem Prison Swamp</td>
<td>Department of Corrections</td>
<td>225,000</td>
<td>68,000</td>
<td>Nongmugging and Vibhavadi.rangsit Roads, Bang Sue District</td>
</tr>
<tr>
<td>12</td>
<td>Swamp near Burachatrathepkarn hospital</td>
<td>State Railway Authority of Thailand</td>
<td>64,000</td>
<td>12,800</td>
<td>Ratchatavee District</td>
</tr>
<tr>
<td>13</td>
<td>Bung Sua Dam Swamp</td>
<td>State Railway Authority of Thailand</td>
<td>65,000</td>
<td>22,750</td>
<td>Asok Road, Railway Road, Nakhon Makkasan Road, Ratchatavee District</td>
</tr>
<tr>
<td>14</td>
<td>Siam Cement Swamp (Bung Farang)</td>
<td>Siam Cement Co. Ltd (Public)</td>
<td>270,000</td>
<td>78,000</td>
<td>Vibhavadi.rangsit Road, Bang Sue District</td>
</tr>
<tr>
<td>15</td>
<td>Bung Ekamai Swamp</td>
<td>Expressway and Rapid Transit Authority of Thailand</td>
<td>3,500</td>
<td>3,500</td>
<td>New Petchburi Road, Huai Khwang District</td>
</tr>
<tr>
<td>16</td>
<td>Suan Siam Lake</td>
<td>Private</td>
<td>316,900</td>
<td>228,000</td>
<td>Ramindra Road, Minburi District</td>
</tr>
<tr>
<td>17</td>
<td>Swamp in the Army’s 11th Regiment</td>
<td>Royal Thai Army</td>
<td>430,000</td>
<td>288,000</td>
<td>Paholyothin and Ramindra Road</td>
</tr>
<tr>
<td></td>
<td><strong>Total flood water holding volume</strong></td>
<td></td>
<td><strong>12,036,900</strong></td>
<td><strong>6,657,025</strong></td>
<td></td>
</tr>
</tbody>
</table>

Note: The receiving ponds (monkey’s cheeks) which are in use at the present number 17, and can hold 6,657,025 cu.m of water.

Figure 3.9 Polder System in Bangkok Metropolis

Source: Department of Drainage and Sewerage, BMA, 2002
Figure 3.10: Monkey's Cheek in Bangkok Metropolis

Source: Department of Drainage and Sewerage, BMA, 2002
3.2.1 Measures on Flood Prevention

3.2.1.1 Structural System

As Bangkok is low lying and in some areas, the water levels can be higher than the others, so the polder system is being used in 15 areas, 168.06 km² in total, consisting of:

1) Prevention of water from outside into the protected area by dikes such as existing roads, railways, earth berms and buildings. At the waterways the gates are used.

2) Getting water out from the protected area is by draining through drainage system or by pumping.

3) Drainage within the protected area is through the storm water drains and sewer drains to the outside through the pipes or canals, and by holding the storm water for a while in local reservoirs or low lying areas (called monkey’s cheeks) before draining or pumping out.

3.2.1.2 Non Structural Measures

These measures are for general flood prevention especially in low density population areas. It is called Flood Plain Management which consists of:

1) Control of town planning and land use to keep some vacant areas for receiving storm water.

2) Control of buildings for the purpose of protection of them from floods.

3) Public relation on the possible floods and impacts so that the public can help themselves as necessary and cooperate with the responsible agencies.

4) Set up the Flood Forecasting and Warning System for the public.

5) Set up emergency task force units to prevent flooding and assist the effected people.

6) Set up the Supervision and Administration Unit so that the capability on planning and implementation can be enhanced and sufficient.
4.1 Problems of Solid and Hazardous Waste

Solid and hazardous waste increase every year in Bangkok due to the increase in population, consumerism, and changing lifestyles which occur as a result of rapid economic progress. Not only did the amount of waste produces change but also its composition. In a rapidly growing city like Bangkok this is a serious problem and waste must be collected completely, sorted properly, recycled wherever possible and the rest properly disposed of. The final disposal sites must have good management so as to not cause nuisance problems to the nearby communities.

4.2 Present Situation

4.2.1 General Solid Waste (Garbage)

In 1985 Bangkok only had 3,260 tons per day of solid waste. In 1995 it doubled to 6,633 tons per day and in 2002 to 9,472 tons per day (3.43 million tons per year). Figure 4.1 shows the increase and the projected amount in the future which estimates that by the year 2015 solid waste will be 18,750 tons per day. Figure 4.2 shows the composition of waste, which mainly consists of food scraps, plastics and foams, and papers. Table 4.1 shows its composition since 1992-2002 for Bangkok Metropolis.
Figure 4.1 Amount of Solid Waste Collected within Bangkok Metropolis during 1987-2002 and projection for 2003-2015
Source: Department of Public Cleansing, BMA

Figure 4.2 Composition of Collected Solid Waste, 2002
Source: Department of Public Cleansing, BMA, 2002
### Table 4.1 Physical Composition of Solid Waste (1993-2002)

<table>
<thead>
<tr>
<th>Type of Waste</th>
<th>Percentage of Total Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Combustibles</strong></td>
<td></td>
</tr>
<tr>
<td>Cloth</td>
<td>4.50</td>
</tr>
<tr>
<td>Plastic and foam</td>
<td>16.02</td>
</tr>
<tr>
<td>Wood and leaves</td>
<td>4.24</td>
</tr>
<tr>
<td>Food Scraps</td>
<td>15.76</td>
</tr>
<tr>
<td>Leather and Rubber</td>
<td>2.17</td>
</tr>
<tr>
<td>Unclassifiable</td>
<td>32.92</td>
</tr>
<tr>
<td>Metal</td>
<td>2.52</td>
</tr>
<tr>
<td>Glass</td>
<td>4.65</td>
</tr>
<tr>
<td>Stones and Ceramics</td>
<td>0.61</td>
</tr>
<tr>
<td>Bones and Shells</td>
<td>1.21</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Department of Public Cleansing, 2002

### 4.2.2 Hazardous Waste

**Infectious Waste:** The waste is from hospitals, both state and private, from treatment of patients and from laboratories. For example, the waste may contain parts of organs, needles, scalpels, syringes, blood-contaminated cloth, human and animal secretion which contaminate rubber tubes, gauzes, etc. The estimate for Bangkok's infectious waste in 2002 was 16.15 tons per day.

**Household Hazardous Waste:** This type of waste includes fluorescence tubes, insecticide cans, cleaning solution containers, batteries which contain heavy metals or hazardous substances.

**Electronic Waste:** such as computers and mobile phones are on the increase as they change the models often. Even though there are some efforts to recycle parts, the leftover parts become wastes and require appropriate treatment.

**Industrial Hazardous Waste:** This waste is from manufacturing processes of factories and are the responsibility of the factories to dispose under the regulations of Department of Industrial Works.
4.3 Impacts of Solid and Hazardous Waste

Uncollected Waste from households will cause offensive odors and are unsightly as well as breeding spots for flies and other vectors. The increasing amount every year poses a challenge for BMA in terms of collection and disposal efficiency. In addition, household wastes contain more hazardous components and dumping hazardous wastes with general solid wastes from agricultural and industrial activities without proper separation, can cause serious health damage to the general population.

4.4 Solid and Hazardous Waste Management

Collection and Separation of General Solid Waste: The Public Cleansing Department and 50 district offices are responsible for the collection of solid waste in Bangkok. BMA has applied direct and indirect methods for collecting solid waste. 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. 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 classified according to food waste, recyclable waste, and household hazardous waste. The collected waste is transported to 3 transfer stations at On-Nuch, Nong Khaem and Tha Raeng. The waste is transferred to sanitary landfills at Kumpaeng Saen district Nakhon Phathom province and Bang Plee district Samut Prakan province. Figure 4.3 shows the management scheme.
**Figure 4.3 Solid Waste Management of BMA**

Source: Department of Public Cleansing, BMA, 2002
The sorting of waste is done by the proper containers which are collected by BMA and disposed off according to the scheme in Figure 4.4. BMA controls the private contractors who landfill the General Solid Waste according to the standards and guidelines on community waste management by Pollution Control Department, Ministry of Natural Resources and Environment.
Hazardous Waste Management

BMA collects household hazardous waste such as batteries, fluorescent tubes, 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 Department and each district and stored at 3 transfer stations before transporting to the Authorized Treatment Centers that are authorized by Department of Industrial Works.

Infectious waste from state and private hospitals and clinics are collected by temperature-controlled vehicles and disposed by 2 incinerators at On-Nuch site. Each incinerator has the capacity of 10 tons per day. In 2002, BMA collected 13.82 tons/day of infectious waste from health facilities or 65.82 % of total infectious waste generated (16.15 tons/day). The rest was assumed to be illegally dumped with general waste. BMA hazardous waste management process is shown in Table 4.2.

Table 4.2 Amount of Infectious Waste Generated and Collected from Sources

<table>
<thead>
<tr>
<th>Source Type</th>
<th>Number</th>
<th>Number of Sources Which Can Collect</th>
<th>Infectious Waste Generation Coefficient</th>
<th>Number of Beds in Service</th>
<th>Infectious Waste Generation Rate (Kg/day)</th>
<th>Amount of Waste Collected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number</td>
<td>% of Total</td>
<td></td>
<td></td>
<td>Kg/day</td>
</tr>
<tr>
<td>State Hospitals</td>
<td>33</td>
<td>33</td>
<td>100</td>
<td>0.46</td>
<td>13,110</td>
<td>6,062</td>
</tr>
<tr>
<td>Private Hospitals</td>
<td>110</td>
<td>103</td>
<td>93.63</td>
<td>0.46</td>
<td>15,981</td>
<td>7,390</td>
</tr>
<tr>
<td>Public Health Centers</td>
<td>148</td>
<td>148</td>
<td>100</td>
<td>1.32</td>
<td>-</td>
<td>195</td>
</tr>
<tr>
<td>Private clinics and polyclinics</td>
<td>2,871</td>
<td>365</td>
<td>12.71</td>
<td>0.87</td>
<td>-</td>
<td>2,498</td>
</tr>
</tbody>
</table>

Source: Department of Public Cleansing, BMA, 2002
Figure 4.5 Hazardous Waste Management Scheme of BMA
Source: Department of Public Cleansing, BMA, 2002
4.5 Measures to Control Solid and Hazardous Waste from Households

**Public Participation**
1. Support the public in cleaning their own houses and communities. The shops, schools and establishments on main roads will be supported for being kept clean (including the pavements).
2. Designate time for general waste collecting between 6 PM - 3AM.
3. Encourage the public to sort the waste at source before disposal as a measure to minimize the waste, with the public participation to "Think and Save The Environment". Provide advice to the public on reduction of unnecessary use and focus on reuse, recycling and repair. The food scraps are recommended to be composted to reduce the amount of waste.

**Improvement of Collection Efficiency**
- Development of higher efficiency modes of collection
- Setting up database on garbage trucks of BMA
- Provision and maintenance of garbage trucks to maintain the efficiency
- Improvement of collection routes
- Collection by water routes

**Improvement on Disposal**
Authorizing the private contractors to transfer the solid waste from transfer stations at On-Nuch, Nong Khaem and Tha Raeng to sanitary landfills. Also privatize the collection and disposal of infectious waste.

**Laws and Regulations**
The governing law for solid waste and night soil management is the Public Health Act, B.E. 2535, BMA can operate through the options:
1. BMA operates the collection and disposal system.
2. BMA is entrusted to handle issues, such as privatization of Solid Waste disposal by sanitary landfills.
3. BMA may permit any person to operate the business of collecting transportation or disposing of solid waste as a business or for payment of service charges. BMA must operate according to the principles and conditions of this law, so BMA issues several local regulations as shown in Figure 4.6.
Public Health Act B.E. 2535 designates BMA as local agency who has the responsibility in solid waste management.

Ministerial Rule on Fees for solid waste collection and other fees. B.E.2545

BMA Regulation on Disposal of Solid Waste and Other Wastes B.E.2521 which allows BMA to charge the fee up to the ceiling prescribed in the Ministerial Rule, but BMA has not yet Collected the fee for disposal of infectious waste.

BMA Regulation on Disposal of Infectious Waste B.E. 2545

BMA Regulation on Disposal of Solid Waste and Other Waste B.E.2544 states about the principles of solid waste management.

BMA Regulation on Criteria on Solid and Other Waste Management of Building and Health Facilities B.E. 2545, specifying details in community solid waste management, infectious waste and night soil management

BMA Notification on Schedule and Location for Solid Waste Discharge

Figure 4.6 Legislations on Solid Waste Management of BMA
Source: Department of Public Cleansing, BMA, 2002.
4.6 Future Plans

The Sixth Bangkok Metropolitan Development Plan (2002-2006) aims to increase the efficiency of the system of disposal of solid waste, night soil and hazardous waste in order to protect the public health and environment from solid and hazardous waste. Many improvement activities have been specified such as:

- Aim that no uncollected garbage will be on public vacant lots, main roads and lanes, and in public water bodies.
- Lower the solid waste generation rate from 1 kg/person/day.
- Separation of at least 20% of hazardous waste generated from household.
- Increase the efficiency of fee collection for solid waste collection and transportation from 20% to 80% of the total households.
- Increase disposal technology for solid waste to at least 10% of the collected waste.
- Increase the efficiency of infectious waste collection to cover all health facilities.
- Increase efficiency in collection by issuing standard procedure on garbage collection service and increase the number of transfer stations, and support the use of NGV garbage trucks for the purpose of conservation of energy and environment.
- Develop the capability of solid waste management personnel at all levels.
- Install information system for public cleansing service to assist the administration of the system and improvement of service.
- Amend the regulations as to increase private sector's role in solid and hazardous waste management in place of BMA.

These animal figurines were made from waste materials and throw away retrieved from the recycle centre of Phra Sathapana, Bangkok.
5. แก่นันทหนวด
Land Subsidence

5.1 ปัญหานันทหนวดในกรุงเทพมหานคร

จากอธิบายที่ชี้แจงว่า ปัญหายี่เกี่ยวกับการแผ่นดินทรุดในเขต กรุงเทพมหานครและปริมณฑลอาจเกิดความเสี่ยงทางและฟื้นฟูให้เกิดความเสียหายกับประชาชนเป็นอย่างมาก เช่น ทำให้เกิดน้ำฟาร์มที่ทำให้
ที่ราบหล่น ท่อประปาเสียหาย อาคาร สิ่งก่อสร้างต่างๆ ทรุดตัว
ฟื้นฟูและทางเดินทำลายกราฟ เป็นต้น และจากข้อมูลการทรุดตัว
ของแผ่นดินในกรุงเทพฯ ปี พ.ศ. 2521 - 2546 พบว่ามีการทรุดตัว
ของแผ่นดินไม่เกินกว่า 1 เมตร เช่น หมุดตรวจวัดที่มหาวิทยาลัย
ราชดำเนิน วิทยาเขต เอกชีวะ และที่แยกริมหรือที่สุวรรณภูมิ ตลอดจน
(กองที่รักษาและยืดหยุ่นกรม กรมท่าอากาศยาน, 2546) ซึ่งสำนักงานที่
ที่ทำให้เกิดปัญหายี่เกี่ยวกับการแผ่นดินทรุดในเขตกรุงเทพมหานคร
และปริมณฑลเกิดจากการใช้น้ำจากถังในแต่ละวันอยู่ในอัตราที่
สูงมากและเตือนกันเป็นเวลานาน ตั้งแต่ทางที่ 5.1 ทำให้quatly
บริเวณมีการลดลงของระดับน้ำในช่วงอิทธิพลและ
ต่อเนื่องโดยไม่เกิดการคืนชีพๆ การแผ่นดิน และการมีการชุบหรือขยาย เป็นต้น
การทำให้สิ่งมีชีวิตได้รับผลกระทบต่อการอยู่อาศัยเป็นต้น

5.1 Problem

BMA and its surrounding regions are facing considerable land subsidence problems which result in waterlogging, damage to pipes, buildings, roads and pavements. From 1978-2003, the total land subsidence in Bangkok is about 1 meter at Ramkamhaeng University, Hua Mark and at the National Housing Complex at Klong Chan monitoring stations (Royal Thai Survey Department, 2003). Land subsidence is the result of over-extraction of groundwater for long time as shown in Table 5.1, causing the water level decline pumping. Other factors may include the shift of soil mass, the weight of buildings, and ruptures of underground pipes which cause water seepage into the ground.
Table 5.1 Groundwater Pumpage in Bangkok Metropolis, 1995-2001

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Number of Wells</th>
<th>Total Pumpage (m³/day)</th>
<th>Domestic Uses Number of Wells</th>
<th>Domestic Uses Pumpage (m³/day)</th>
<th>Commercial and Industrial Uses Number of Wells</th>
<th>Commercial and Industrial Uses Pumpage (m³/day)</th>
<th>Agricultural Uses Number of Wells</th>
<th>Agricultural Uses Pumpage (m³/day)</th>
<th>Government Agencies Number of Wells</th>
<th>Government Agencies Pumpage (m³/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>1,313</td>
<td>307,739</td>
<td>630</td>
<td>123,301</td>
<td>651</td>
<td>181,180</td>
<td>32</td>
<td>2,258</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1996</td>
<td>1,422</td>
<td>503,048</td>
<td>675</td>
<td>150,527</td>
<td>637</td>
<td>176,923</td>
<td>33</td>
<td>3,395</td>
<td>52</td>
<td>170,328</td>
</tr>
<tr>
<td>1997</td>
<td>1,375</td>
<td>402,940</td>
<td>696</td>
<td>155,336</td>
<td>618</td>
<td>176,461</td>
<td>32</td>
<td>3,260</td>
<td>4</td>
<td>65,805</td>
</tr>
<tr>
<td>1998</td>
<td>1,384</td>
<td>411,372</td>
<td>712</td>
<td>157,323</td>
<td>612</td>
<td>183,166</td>
<td>31</td>
<td>3,200</td>
<td>29</td>
<td>67,683</td>
</tr>
<tr>
<td>1999</td>
<td>1,440</td>
<td>491,317</td>
<td>742</td>
<td>159,445</td>
<td>638</td>
<td>189,014</td>
<td>31</td>
<td>3,175</td>
<td>29</td>
<td>67,683</td>
</tr>
<tr>
<td>2000</td>
<td>1,641</td>
<td>573,008</td>
<td>830</td>
<td>159,306</td>
<td>697</td>
<td>329,112</td>
<td>31</td>
<td>2,030</td>
<td>83</td>
<td>82,560</td>
</tr>
<tr>
<td>2001</td>
<td>1,879</td>
<td>567,935</td>
<td>902</td>
<td>193,333</td>
<td>857</td>
<td>290,625</td>
<td>37</td>
<td>1,417</td>
<td>83</td>
<td>82,560</td>
</tr>
</tbody>
</table>

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

5.2.1 Land subsidence in 2002-2003

5.2.1 Land subsidence in 2002-2003

5.2 Present Situation

From the monitoring results of the Royal Thai Survey Department, Ministry of Defence, between 1 December 2002 to 14 May 2003 for a total length of 973 km. with 714 reference points, the following can be described:

5.2.1 Land subsidence in 2002-2003

(1) Subsidence of 3-5 cm in 7 areas:
- King Mongkut’s University of Technology Thonburi, Tung Khru District, BMA
- Luang Por Pan Klong Dan Anusorn School, Bang Bo District, Samut Prakarn Province
- Dredging Operation Office III (Royal Irrigation Department), Samut Prakarn Province
- Supreme Military Commander; Chang Wattana Road, BMA
- Wat Klong Kru, Muang District, Samutsakorn Province
- Wat Klang Khru, Muang District, Samutsakorn Province
- Wat King Kaew, Bangplee District, Samut Prakarn Province
- Wat Bang Plee Yai, Bang Plee District, Samut Prakarn Province
- Samut Sakorn Provincial Administration Organization
- Bhuddamonthol, Nakorn Chaisri District, Nakorn Pathom Province
- Wat Sunthornsathit, Ban Paew District, Samut Sakorn Province
- Wat See Chomphoo, Nong Chok District, BMA
5.2.2 Study Area Subsidence Status: About 3 Years, 2003-2006

(1) Subsidence of 7-10 cm in 7 areas:
- Wastewater Treatment Plant, Don Muang District, BMA
- Wat Sunthornsathit, Ban Paew District, Samut Sakorn Province
- Wat Yai Ban Bor, Muang District, Samut Sakorn Province
- Samut Sakorn Provincial Administration
- Wat Lad Pladuk, Bangbuathong District, Nonthaburi Province
- Wat Ratbamroong, Suvinthavong Road, Nong Chok District, BMA
- Bangplee Ratbamroong School, Bangplee District, Samut Prakan Province

(2) Subsidence of 5-7 cm in 4 areas:
- Bhuddamonhol, Nakorn Chaisri District, Nakorn Pathom Province
- King Mongkut’s University of Technology Thonburi, Tung Krhu District, BMA
- Wat See Chompoo, Nong Chok District, BMA
- Wat King Kaew, Bangplee District, Samut Prakan Province

(3) Subsidence of 3-5 cm in 6 areas:
- Wat Mai Supadittharam, Nakorn Chaisri District, Nakorn Pathom Province
- Wat Ratsattrakrayaram, Banpaew District, Samut Sakorn Province
- Wat Sangsarn, Thayaburi District, Pathumthani Province
- Air Force Museum, Don Muang District, BMA
- Wat Prao Ngai, Sainoi District, Nonthaburi Province
- Pathumphani Technology School, Pathumthani Province

(4) The rest of the areas had subsidence of less than 3 cm.
Figure 5.1 The Map Showing Area of the Networks of Levelling Survey Benchmark in Bangkok Metropolitan Region in 2002-2003
Source: Division of Geodesy and Geophysics, Royal Thai Survey Department, 2003

Figure 5.2 The Map Showing Area of the Networks of Levelling Survey Benchmark in Bangkok Metropolitan Region in 1999-2003
Source: Division of Geodesy and Geophysics, Royal Thai Survey Department, 2003
Figure 5.3 Map showing Land Subsidence in 1997
Source: Department of Groundwater Resource, Ministry of Natural Resources and Environment, 2003

Figure 5.4 Map showing Land Subsidence in 2001
Source: Department of Groundwater Resource, Ministry of Natural Resources and Environment, 2003
5.3 Land Subsidence in Bangkok City and its Impact

In addition to the flood, Land subsidence also causes many problems including:

1. changes in the elevation and slope of streams, canals, and drains;
2. damage to bridges, roads, railroads, storm drains, sanitary sewers, canals, and levees;
3. damage to private and public buildings; and
4. failure of well casings due to pressure 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 stormwater and sewage out to Chao Phraya river and Gulf of Thailand.

5.4 Policy and Regulation

As the pumping of groundwater in BMA and its surroundings is at a rate higher than the natural recharge rate and is the main cause of land subsidence, the Cabinet issued a resolution on the problem of excessive groundwater pumping and there is now a new law, Groundwater Act, B.E. 2546, which amends the Groundwater Act No. 3, B.E. 2520.
5.4.1 The Cabinet Resolution on the Problem of Groundwater Use

The Cabinet Resolution was issued according to the letter of the Office of The Cabinet Secretariate Nor Ror 0504/Vor dated 30 April 2003 to the Ministry of Interior, Ministry of Industry, Ministry of Natural Resources and Environment, and other relevant agencies, providing principles of implementation on granting a permit for the use of groundwater in BMA and surroundings where the water supply by Metropolitan Water Works Authority or Provincial Water Works Authority are available, that such permit for groundwater use will only be extended to 31 December 2003. For other areas where the water service authorities still use groundwater, the use of groundwater by public and private sectors is still allowed until the water supply authorities discontinue the use of groundwater.

5.4.2 Groundwater Act (No. 3), B.E. 2546 amends the Groundwater Act, B.E. 2520 on the following:

1. that the state agencies or organizations which use groundwater in critical areas must obtain groundwater operating license (amendment of Chapter 4)
2. designate criteria, methods, and conditions on payment for groundwater fee and conservation, and the fee for private sector to collect such payments (amendment of Chapter 7)
3. Set up of Groundwater Development Fund to study and research on conservation of groundwater and the environment (amendment of Chapter 7.4-7.8)
4. designate the court case committee and criteria in court cases (amendment of Chapter 45 and add to Chapter 45/1).
Noise Pollution

6.1 Noise Pollution Problem in Bangkok Metropolis

Noise pollution in Bangkok Metropolis is due to economic activity that creates industrial, commercial, and service sectors in the city. The activities together with increasing traffic volume especially in the urban area, have created conflict of interest with regards to noise. As noise problem is subjective, even normal activity of one person can cause noise which offends others. A radio broadcast at night may disturb the sleeping neighbors.

However, everyone agrees that noise from traffic is certainly a pollution. Along the dense traffic streets of Bangkok Metropolis, the noise is from the number of the vehicles and the modification of certain vehicles (such as removing the muffler). So the problem must be approached on both the traffic side and the individual vehicle inspection.
6.2 Present Situation

Pollution Control Department monitors both ambient and roadside noise levels of Bangkok. During 2002, monitoring stations along the major roads recorded that for 96% of the time the 24-hr average noise level exceeded the ambient noise standard of 70 decibels A (dBA) in which noise levels ranged from 62-83 dBA. The highest level was observed at Mahai Sawan intersection on Taksin Road. For general areas, which are more than 50 meters away from the major roads the noise levels were lower than the roadside, ranging from 53-85 dBA but still exceed the standard 50% of the time. The highest level was observed at Singharajpitthaya School, Bang Khunthien District. It is concluded that the 24-hr average noise level mostly exceeds the standard and this has been the case during 1998-2002 (Figure 6.1).

The 24-hr average noise levels from boats, 56-58 dBA, along the canal sides did not exceed the standard level.

Figure 6.1 24-hour Average (equivalent) Sound Level (L_{eq 24 hr}) in Bangkok during 1998-2002
Source: Pollution Control Department, Ministry of Natural Resources and Environment, 2003

BMA also monitored and analyzed noise level along the Bangkok Transit System (BTS) Project during fiscal year 2002 at 4 stations (Sapan Kwai, Siam, Phrom Pong, and Sala Daeng) under the platform, outside the station, and ticket offices. It was found that the noise levels exceeded the 24 hour average, 70 dBA standard at every station. The highest level was under the station at Sala Daeng. At present BMA continues to regularly monitor the noise levels.
6.3 Impacts of Noise Pollution

Noise can create adverse impacts as follow:

6.3.1 Impede communication, warnings, and may lead to accidents.
6.3.2 May effect human perception and lead to slower decision making in high risk situations.
6.3.3 Loudness of noise can lead to hearing loss, which varies from individual to individual depending on the following factors:
   1) loudness
   2) characteristics of noise (such as consistent or intermittent)
   3) duration (in a day)
   4) noise frequency
   5) individual’s tolerance

6.4 Measures on Noise Pollution Abatement

Noise level standards and measurement methods have been in effect for both ambient and for point sources such as vehicles and boats under the Enhancement and Conservation of the National Environmental Quality Act, B.E.2535 (1992) and noise monitoring has been conducted on a regular basis.

BMA controls noise from motor vehicles with the cooperation of Traffic Police, Pollution Control Department, and Land Transport Department. On the expressways, noise barriers have been installed in areas where the noise levels are high. Regular monitoring provides measures to abate the problem. For example, noise from the BTS was lessened by installation of noise absorptive material under the station and on the ticketing floor. The future stations must consider design which reduce reflected noise.

Regarding noise pollution in communities along the canals, the Health Department of BMA requested the Marine Department, to monitor noise level from boats in service along the canals. In fiscal year 2003 this was implemented in Klong Saen Saeb, Klong Ladprao, and Klong Phrakanong. The 24-hour average noise level along Klong Saen Saeb was 59.5-68.0 dBA. Along Klong Phrakanong the level was 55.5-66.0 dBA. For Klong Ladprao (now without commuter boat service) the level was 52.5-55.5 dBA which is much lower than the 70 dBA standard.
The noise level of boats in Klong Saen Saeb was measured at four occasions in fiscal year 2003 during May to August. Three measurements were made at Wat Sri Boonruang Pier and one at Phan Fa Pier, with a total of 89 boats inspected. The noise level was between 82.4-98.6 dBA (the standard according to the Notification of The Revolutionary Council No. 16, B.E. 2514 is 100 dBA), so they comply to the standard. For boats in Klong Phrakanong all six boats in service were measured and the noise level was 99.8-106.8 dBA. The ones exceeding the standard were apprehended, fined and the owners had to fix the boat noise to be within the standard.

Noise problem resulting from the river boats which are under the control of the Marine Department (formerly Harbor Department) which has the authority to prohibit boats with excessive noise from operation is remedied by requiring these boats to undergo regular maintenance for noise control.
Energy

7.1 Problems

Energy is extremely useful and is used for consumption, providing convenience, production in industry and agriculture, and used mostly in transport. As Thailand is not self-sufficient in energy production, the energy has to be imported. This has resulted in several past and present crises such as expensive fuels, impacts on consumer prices, balance of payments as well as pollution from fuel uses.

7.2 Present 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 2002, the economic growth in Thailand was 5.2% from 2001 due to the increase in industrial production of 8.4% which benefited from expansion in domestic and import markets during the second half of the year.

The industrial expansion caused commercial energy demand of Thailand to increase 6.6% from 2001 and the increase is evident for every fuels, particularly natural gas.

Commercial energy production increased 6.2% in 2002. Domestic oil production increased 22.1% as there were 3 new areas in operation which are: Maliwan (Chevron), Sangkrajai (PTTEP) and Yala (Big Oil Project of Unocal consisting of Pa Muk, Kapong, Surat and Yala areas) and natural gas production also increased.

The import of fuel (net) increased 5.5% mainly due to import of natural gas from Burma (24.3% increase), imported coal (13.2% increase), while imports of condensate, fuels, and electricity decreased. The overall dependence on commercial energy from foreign sources thus declined from 63% in 2001 to 62% in 2002.

### 7.3 Energy Consumption

Bangkok uses all types of fuels such as gasoline, diesel, fuel oil, LPG and others along with electricity.

#### 7.3.1 Fuel Consumption

Fuel consumption of Thailand in 2002 was 36,600.165 million liters, and Bangkok used 14,598.768 million liters, which was 39.9% of total consumption of Thailand. It comprised of diesel (34.3%), aviation fuel JP (25.36%), unleaded gasoline (18.71%), fuel oil (11.97%), LPG (5.92) as shown in Table 7.1.
Table 7.1 Sales of Fuels in Bangkok Metropolis, 2002

<table>
<thead>
<tr>
<th>Fuel Types</th>
<th>Quantity (million liters)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasohol</td>
<td>0.493</td>
<td>0.003</td>
</tr>
<tr>
<td>Gasoline Octane 91</td>
<td>1,479.210</td>
<td>10.132</td>
</tr>
<tr>
<td>Gasoline Octane 95</td>
<td>1,253.301</td>
<td>8.580</td>
</tr>
<tr>
<td>Kerosine</td>
<td>43.499</td>
<td>0.300</td>
</tr>
<tr>
<td>JP Octane 100/130</td>
<td>3.113</td>
<td>0.021</td>
</tr>
<tr>
<td>JP 1</td>
<td>3,604.146</td>
<td>24.690</td>
</tr>
<tr>
<td>JP 8</td>
<td>98.095</td>
<td>0.670</td>
</tr>
<tr>
<td>High Speed Diesel</td>
<td>4,912.599</td>
<td>33.650</td>
</tr>
<tr>
<td>Low Speed Diesel</td>
<td>95.620</td>
<td>0.655</td>
</tr>
<tr>
<td>Biodiesel (from palm tree)</td>
<td>1.059</td>
<td>0.007</td>
</tr>
<tr>
<td>Fuel Oil</td>
<td>1,746.937</td>
<td>11.970</td>
</tr>
<tr>
<td>LPG (in million kg)</td>
<td>864.495</td>
<td>5.920</td>
</tr>
<tr>
<td>Asphalt (in million kg)</td>
<td>430.623</td>
<td>2.950</td>
</tr>
<tr>
<td>Lubricating oil for gasoline engines</td>
<td>8.609</td>
<td>0.056</td>
</tr>
<tr>
<td>Lubricating oil for diesel engines</td>
<td>26.801</td>
<td>0.180</td>
</tr>
<tr>
<td>Lubricating oil for plane engines</td>
<td>0.110</td>
<td>0.0007</td>
</tr>
<tr>
<td>Lubricating oil for other engines</td>
<td>28.202</td>
<td>0.193</td>
</tr>
<tr>
<td>Grease (in million kg)</td>
<td>1.854</td>
<td>0.013</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>14,598.768</strong></td>
<td><strong>100.000</strong></td>
</tr>
</tbody>
</table>

Source: Information Service of Bureau of Fuel Trade and Stockpile

7.3.2 Electricity Consumption

In 2002 Thailand used electricity at 99,123 Giga Watt Hour (GWH) and Bangkok used 35,476 GWH or 35.8% of the country. The highest figure of electricity consumption is from industrial sector, which was 38.91% of the total electricity consumption of Bangkok. The others were 34.35% from business, 21.22% from residential and 5.52% from other sectors. The electricity consumption in Bangkok increased 5.3% compared to 2001 and the increase is in every sectors. Business and industry sectors used 12,186 and 13,804 GWH respectively, increasing 6.0% while the residential users used 7,526 GWH, an increase of 3.3%.
7.4 National Energy Strategies

The Ministry of Energy organized the Workshop on Energy Strategy 1: Energy for Competitiveness of Thailand, on August 28, 2003, and came up with the following:

7.4.1 Designate Energy Target for The Country
At the present the ratio of energy growth to economic growth of Thailand is 1.4:1 and on the increase, so it aims for the ratio of 1:1 in 25 years within 2007.

7.4.2 Strategies on Effective Energy Utilization
(1) Transport Sector
- Transform public and goods transport from small vehicles to rail, together with multimodal transport which is efficient, such as investment in electric train system and mass transit system in Bangkok, and the depot system. The comprehensive plan is being drafted by the relevant agencies to be completed within 5 years.

(2) Industrial Sector
- Transform structure and strategy on industrial development, considering the factors that some of the industry uses high energy but with low economic return, and switch to the opposite and also improve manufacturing processes by using efficient machines with good management.

- Support competitive potential of the effective energy industry and energy conservation.

- Development of renewable energy accounts for only 0.5% of total commercial energy of the country even though it has the potential in Thailand. The goal is to increase renewable energy to 8% within the next 10 years,
(3) Strategies on Economic Procurement Security

(4) Strategies on Energy Security

(4.1) Electricity

(4.2) Energy Procurement Security

(5) Strategies to Make Thailand Regional Energy Center

and the new power plants must use renewable energy 3-5 % of the capacity. In addition, special fund and tax privilege, as well as support on research and development on the substantial and continuous basis will be carried on by the relevant agencies.
The Thai Cabinet, at the meeting on 2 September 2003, acknowledged the result of the Workshop on Energy Strategy 1: Energy for Competitiveness of Thailand, on August 28, 2003 and agreed in principles of the strategy with the following observation for improvements:

(1) The bottom line of country's energy use is on clever and maximum effective use, so it will depend on availability and appropriateness of each source, cost, technology and related factors on the case by case basis.

(2) In addition to oil which is the main energy source, the use of other types of energy should consider the importance of renewable energy such as natural energy: solar, wind and water, and bio-energy such as using agricultural products (sugar cane, tapioca, palm) to produce fuels at the highest possible ways in order to decrease oil use. However consideration must be paid to the environment especially in using particular plant to make fuels.

(3) In addition to the promotion of rail system in mass transit which will reduce gasoline consumption, the remaining vehicles should be supported to switch to cleaner fuels such as NGV. Marine and water transports are also fuel economical.

7.5 The Cabinet's Observation

The Thai Cabinet, at the meeting on 2 September 2003, acknowledged the result of the Workshop on Energy Strategy 1: Energy for Competitiveness of Thailand, on August 28, 2003 and agreed in principles of the strategy with the following observation for improvements:

(1) The bottom line of country's energy use is on clever and maximum effective use, so it will depend on availability and appropriateness of each source, cost, technology and related factors on the case by case basis.

(2) In addition to oil which is the main energy source, the use of other types of energy should consider the importance of renewable energy such as natural energy: solar, wind and water, and bio-energy such as using agricultural products (sugar cane, tapioca, palm) to produce fuels at the highest possible ways in order to decrease oil use. However consideration must be paid to the environment especially in using particular plant to make fuels.

(3) In addition to the promotion of rail system in mass transit which will reduce gasoline consumption, the remaining vehicles should be supported to switch to cleaner fuels such as NGV. Marine and water transports are also fuel economical.
7.6 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, 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
   - 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
   - Office paper
     - back to back photocopy (both sides of paper)

BMA started the Project on Environmental Conservation. The volunteers are also trained and visited exhibits in energy conservation. They will be working on energy conservation campaign in their communities.
8. Present Situation

Bangkok has been the capital city of Thailand for more than two hundred years. The city has served as the center for public administration, education, economy, social, culture. The area of Rattanakosin is the invaluable national cultural heritage of Thailand and has many government offices, academic institutes and other important historical sites, receiving considerable tourist attention. The problem with high density of buildings and traffic together with encroachment and unsuitable land use and subsequent deterioration of the historical monuments led to the Cabinet’s appointment of the Rattanakosin Island Project Committee on July 4, 1978 (now named Rattanakosin Island and Old City Conservation and Development Committee) as the conservation area has extended from the original area to the canals which ring the city. The Committee is responsible for policy and planning development of the master plans and action plans level for the implementation agencies. The present
Rattanakosin State is divided into 3 areas which are the inner and outer Rattanakosin areas and the Thon Buri area across the Chao Phraya River as follow:

1. The Inner Rattanakosin area is from the Chao Phraya River from the Royal Palace to the original City Canal (Kiong Lord) with the total area of 1.8 square kilometer or 1,125 rai by Thai measurement. It is located within the Royal Palace Sub district, Phra Nakhon District.

2. The Outer Rattanakosin area is from the Chao Phraya River in the north and from the south of the original City Canal to the canals which ring the city (Klong Bang Lampoo, Klong Ong Ang) with the total area of 2.3 square kilometer or 1,413 rai. It is located within Chanasongkram, Talad Yod, Bavorinives, San Chaophosua, and Burapapirom Sub districts, Phra Nakhon District.

3. The Thon Buri area opposite Rattanakosin area is appointed according to the Notification of Ministry of Interior which designates the area to limit some types of building from construction, alteration, or use. The area designated in 1991 is 1.74 square kilometer or 1,088.8 rai, in the Bangyikhan Sub district in Bang Phlat District, Sirirach Sub district in Bangkok Noi District, Wat Arun Sub district in Bangkok Yai District, Wat Kalaya Sub district in Thon Buri District and Somdet Chaophraya Sub district in Klong San District.
8.2 Implementation Policy of Bangkok Metropolitan Administration

BMA as the local environmental arts conservation agency does not have the direct responsibility of historical monuments, but BMA regards the beautiful and historically important national heritages to be tourist attractions which if well managed, will benefit the local community. In 2003 Thailand hosted the Asian Pacific Economic Forum (APEC) during 20-21 October, 2003, and BMA together with other agencies prepared the implementation plans to improve the City of Bangkok in a sustainable manner, and this plan is in accordance of the Bangkok Agenda 21 (2002-2021). The plan involves the continuous environmental development of buildings in the Rattanakosin area and surroundings, and BMA seeks cooperation from the users of the buildings such as academic institutions and offices to improve or renovate the historical buildings and their surroundings, and also the ancient monuments, city walls, temples and bridges in the Rattanakosin area.

The policies and measures on Rattanakosin Conservation are as follow:

1. BMA’s Regulation in 1995 which designates the area to limit some types of building from construction, alteration, or use, in the Inner Rattanakosin area, Royal Palace Sub district, Phra Nakhon District.

2. BMA’s Regulation in 1987 which designates the area to limit some types of building from construction, alteration, or use, in Outer Rattanakosin area, in the Chanasongkram, Talad Yod, Bavornivives, San Chaophosua, and Burapaipoom Sub districts in Phra Nakhon District.

3. BMA’s Notification on Designation of Plan and Architecture Styles in the Shophouses in the Outer Ratankosin Area.

4. BMA’s Regulation in 1992 which designates the area to limit some types of building from construction, alteration, or use, in the Thon Buri area opposite Rattanakosin area in the Bang Yikhan Sub district in Bang Phlat District, Sirirach Sub district in Bangkok Noi District, Wat Arun Sub district in Bangkok Yai District, Wat Kalaya Sub district in Thon Buri District., Somdet Chaophraya Sub district in Klong San District.
9. Present Situation

Bangkok has the area of 1,568.737 sq.km (980,461 Rais) and has total green area for recreation and environment (as lung of the city) only 8,097.0481 rais or 0.83% of the total area, or 2.24 sq.m per capita (which according to the population registration at 31 December 2002 is 5,782,159). The green area per capita according to the standard set by the City Planning Department of BMA, is 4 sq.m per capita, the international standard (10 sq.m per capita) and much lower when compared to large cities in other countries.
9.2 Policy and Direction on Green Area Development of BMA

BMA has always tried to develop green areas and the policy is reflected in its national and local development plans. In the Ninth National Economic and Social Development Plan (2002-2006) the emphasis is made on livable cities and communities, with the strategy on sustainable development structure for countryside and town as "...develop livable cities and communities according to their potential and conform with culture, values, and need of the people in the society, by creating good environment which develops quality of life of the people to be peaceful, convenient, clean, safe, and orderly. This is performed by remediation and prevention of environmental degradation in cities and communities together with raising public awareness on the environment such as wastewater and garbage management, preservation of rivers and canals, reduction of air pollution, and increase in recreation areas and public parks to suit the density of the population. The city and community landscapes should be neat and nice...". For the part of BMA, there are development plans in environment, city planning and land uses under the policy of city development by directly increasing green areas and change of unused areas to public parks or green areas. In the sixth Bangkok Metropolitan Development Plan (2002-2006) the master plan on green areas is planned and this was again mentioned in the Bangkok Agenda 21 (2002-2021).
9.3 Public Opinion of Bangkok People on Green Area Development

In the public survey on development and use of green areas of Bangkok by the citizens, by Faculty of Forestry, Kasetsart University, for City Planning Department of BMA in 2003, the questionnaires were administered to two groups of people: the current users of public parks (593 samples or 61.9 %) and general public (365 samples or 38.1 %). It was found that the majority (91.9 %) had used the green areas as follow: for public parks (94.0 %), sport areas (18.3 %), community parks (13.6 %), small parks (7.1 %) and other green areas (6.6 %). Most people (83.9 %) who use the public parks are satisfied with the use of the parks and 89.3 % intend to use the parks again. Most uses of green areas are similar: resting, exercising, reading and enjoying scenery.

When asked about future use of green areas 90.9 % wanted to use green areas in the future and 95.9 % wanted BMA to arrange for more areas especially in high density populated areas and the inner city, by developing small gardens and sport areas. Majority (84.6%) thought that the local people should participate in development and maintenance of their communities' green areas. The recommendations were also made with regards to the vacant areas under the elevated expressways, government and educational institutes' lands might have potential to be converted to public areas. The public opinion is going along with the BMA's direction on such development.
9.4 Large Trees in Bangkok Metropolis

Even though Bangkok is more than 220 years old but there are hardly any trees which are that old, as most of them were cut down when the city expanded. At the present these large trees are highly valued by the public for conservation and there is a need for tree registration in Bangkok. BMA has taken care of large trees by trimming and curing diseases to prolong their lives. In 1999 BMA organized a “Large Tree Contest” to campaign for public’s interest in tree conservation and registration. There were 26 types and 53 trees which received the awards.

9.5 การดูแลบันทึกจดหมายของกรุงเทพมหานคร

9.5.1 ความจำเป็นในการดูแลบันทึกจดหมาย

9.5.2 ยุทธศาสตร์การดูแลบันทึกจดหมาย

From the final report on BMA Master Plan on Green Area by Faculty of Forestry, Kasetsart University, for City Planning Department of BMA in 2003, there were 298 large trees in 65 varities, 51 genus and 25 family. These do not include the trees within the Royal Palace and military areas. The most common large trees are Bhodi trees (43), rain trees (40), bullet wood (25), banyan trees (20). In addition there are Pterocarpus indicus Willd., Diospyros decandra Lour., Hopea odorata Roxb., tamarind, rosewood, and Alstonia scholaris R.Br., etc. The district with most large trees is Dusit as many old palaces and temples are within this district.
9.5 Development of Green Areas in Bangkok Metropolis

9.5.1 Necessity to Develop Green Areas

Green areas are like lungs of Bangkok city, consisting of public parks of all types with total area of 8,097.0481 rai or about 2.24 sq.m. per capita. This is considered to be too small according to the livable city concept of World Health Organization (WHO).

9.5.2 Strategy in Green Area Development

BMA has the following strategies to develop green areas for recreation and environment:

9.5.2.1 Increase of actual green area by

1) Build public parks of several types according to the set targets:

(1.1) Main public parks which:
- Can be used by the public without any restrictions
- Is more than 10 rais (1.6 ha) in area
- Has various vegetation species which requires technical knowledge to take care of them and rotate all year round, and has a nursery.
- Has amenities for recreation and sport activities such as playgrounds, swimming pool, and educational facilities such as public library, botanical garden.
- Has continuous activities to service the public.

(1.2) Road Parks along the pavements which are wider than 3 meters

(1.3) Small Parks within communities or housing complexes, using the available areas of government and private lands. This is mainly for each community’s recreation and environmental purposes.

(1.4) Parks in government offices, villages, religious places, educational institutions, sport areas, and other private parks which BMA support the plant seedlings.

(1.5) Rooftop gardens are alternatives to ground-based green areas and are supported by campaigns directed at government and private buildings to have rooftop gardens wherever possible.

2) Planting of trees and shrubs in areas which are existing parks and new ones, including communities, vacant lots in government and private lands, along the roads, villages, religious lands, academic institutions, sport arenas, youth centers, BMA flats, along the canals, etc.
9.5.2.2 Increase of The Service Potential

1) In public parks the public can have activities in addition to recreation and exercises, such as picnic, swim, ride bicycle, camping and play sports. In December the winter flower show is organized (in honor of H.M. The King’s Birthday) and in August the royal flower show (in honor of H.M. The Queen’s Birthday). A lot of colourful plants are grown to beautify the parks during the important periods. The parks serve as knowledge parks and many other activities.

2) Develop Bangkok’s scenery to be greener, clean and bright for the APEC meeting by:
• ปรับปรุงภูมิทัศน์พื้นที่รองรับอุตสาหกรรม ด้วยการ ปลูกต้นไม้พืชตลอดแนวแนวริมคลองทั้ง 2 ฝั่ง ปลูกไม้ระดับทดแทน ชั้นต่างๆ และปลูกต้นไม้ที่มีคุณค่าทางศิลปะและศิลปินภูมิ
• ปรับปรุงภูมิทัศน์พื้นที่บริเวณด้านใน ด้วยการ ปรับปรุงทางพื้นและจานหลัก ด้วยการ ตัดต้นไม้ที่ลดความสูงของต้นไม้ และปลูกไม้ระดับทดแทน
• ตลาดเมืองต้นไม้ป่าไม้ ได้แก่ บริเวณคูคลอง เมืองเดิม บริเวณตลาดประชาราษฎร์ ท่าเมืองริม 20 จุด
• ตลาดเมืองต้นไม้ condol ไม่ตอบสนองความ ส่วนรวม
• ตลาดเมืองต้นไม้ ทางริมคลอง ต้องได้รับการ ปรับปรุงภูมิทัศน์ทางชั้นต่าง ทางด่วน ทางบก ทางบก
• ปรับปรุงภูมิทัศน์พื้นที่ตลาดหลักช้านิคม ได้แก่ ถนนวิถีกรุงเทพ ตัวการปลูกไม้แทน ขนาดรอบและริมรื่อง ปรับปรุงบนตลาดหลักช้านิคม โดยการปลูกไม้ ขนาดรอบคลอง และไม้ระดับทดแทนตลาด ถ้วยกีฬามะรุมชัย
• ปรับปรุงภูมิทัศน์พื้นที่ตลาดหลักช้านิคม ด้วยการปลูก ชัย และปลูกต้นไม้ที่มีคุณค่าทางศิลปะและชั้นต่าง ชัยแห่งริมตลาดนิคม และติดต้นไม้ ต่างๆ
• ปรับปรุงภูมิทัศน์พื้นที่ระยะมุมริมรื่องที่ 6 ชัยการปลูกต้นไม้ต่างๆ ในริมคลอง ในนิคม และตลาดนิคม
• ตกแต่งเมืองต้นไม้ประการธรรม บริเวณถนน ราชวิชรนราธิวาส ข้าวสารนิคม ถนนนิคม ข้าวสาร
• ปรับปรุงภูมิทัศน์พื้นที่แยกทางฝั่งกระโดง พระรามที่ 9 ตั้งกับถนนระดับเหนือ ด้วยการปรับปรุงพื้นที่ปลูกต้นไม้ ก่อสร้างทางเดินและสันหลังกลับ ก่อสร้างลานกีฬา และติดต้นไม้ระดับทดแทน ต่อส่วน
• ปรับปรุงภูมิทัศน์ที่วิ่งระหว่าง ถนน ถนน และ บริเวณทางแยกต่างระดับ ด้วยการปรับปรุงพื้นที่ปลูกต้นไม้ ก่อสร้างทางเดิน ลานกีฬา ลานกีฬา และติดต้นไม้ระดับทดแทน ต่อส่วน

• Improving the Phra Mane Field (Sanam Luang) by re-turfing, planting of Hokkien tea around the existing tamarind trees, and repairing automatic sprinkler system.

• Improving scenery along Central Ratchadamoen Avenue by planting plants in the removable containers which can be replaced and arranged to create flowering plants with grassy areas and fountains.

• Improving the scenery along the old town canals by planting Bougainvillea sp. along the canal sides and also with ornamental plants, and replanting the dead or stunt ones.

• Improving scenery at Sanam Chai by repairing pavements and recreation area, moving and trimming of trees, increasing lighting and adding ornamental plants.

• Decorating the city with fountains at the old city canal, Prem Prachakorn canal, in front of the government house, and 20 other important intersections.

• Decorating the city with flowering plants.

• Decorating the expressways with flowering shrubs at the ramps.

• Improving the scenery along the main and secondary roads in 50 districts of the city by planting ornamental plants, trees (replacement), small parks and decorate under the overpass bridge with ornamental plants.

• Improving the scenery along the main roads into the city mainly Vibhavadirangsit Road by planting medium sized trees and ornamental plants in the islands under the elevated Donmuang Tollway. Trees and shrubs are also planted on the curbs and in central islands under the elevated Baromratchonnee Road.

• Improving scenery of Sararom Park by adding trees and ornamental plants, repairing structures and adding benches, trash cans.

• Improving scenery around Rama VI Monument (near Lumpini Park) by reclaiming the construction area used during electric rail construction and plant trees with a fountain installed.

• Decorating the city with sculptures along Narathiwatthchanchanakarin and Sathorn Roads.

• Improving scenery at the interchange of Rama VI and Sri Nakarin Road by planting trees, build running tracks, recreation area, sport area and lightings.

• Improving government and private vacant lots along the elevated roads by planting trees, build running tracks, recreation area, sport area and lightings.
9.6 Objectives of Green Area Development

BMA developed the Master Plan for BMA’s Green Areas by setting the objective of increasing green areas as public parks or open green areas to 2.5 sq.m. per capita by 2007 (short term goal) and 3.5 sq.m. by 2017 (medium term goal) and 4.0 sq.m. by 2027 (long term goal). The main target is on public parks which are large, as the public opinion favored the larger parks. For other type of green areas such as golf courses, open air arenas and wooded areas they must be maintained at the present level even though they may not be openly accessible to the public but they can still act as the lung of the city.

(Note: Additional information of Public Park Office can be viewed at www.bma.go.th in the page of Department of Social Welfare)
10.1 Nuisance Problem in Bangkok Metropolis

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 it grew by 27 percent. In 1999, there were 126,677 factories throughout Thailand with 16 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 2002 as defined in the Public Health Act, B.E.2535 (1992) stood at 40,846. This rapid growth has caused environmental degradation, resulting in impacts on livelihood of communities surrounding those factories and businesses.

During the period of 1999-2002, the complaints from nuisance received by BMA were mostly on noises and followed by odor problems. They were mostly caused by facilities which were classified as detrimental to health (currently classed as 13 categories, and 129 types.) BMA is responsible for nuisance problems as follow:

1. ปัญหาเสียงรบกวนที่ประชาชนเรียนร้องเรียนได้รับความต้องการจากกฎหมายควบคุมที่อยู่อาศัย (ปัญหาเสียงรบกวน) ได้แก่ ปัญหาเสียงรบกวน และปัญหาเสียงรบกวน ตามกฎหมายควบคุมที่อยู่อาศัย ซึ่งมีจุดประสงค์เป็น 13 กลุ่ม 129 ประเภท

89
2. ตามพระราชบัญญัติการสาธารณสุข พ.ศ. 2535 ผู้รักษาการกรุงเทพมหานครได้รับการแต่งตั้งจากรัฐมนตรีว่าการกระทรวงสาธารณสุขให้ด้วยตำแหน่งเจ้าหน้าที่มีอำนาจ ได้มีอำนาจที่ตรวจสอบและระงับพฤติการณ์ในเขตพื้นที่กรุงเทพมหานคร นอกจากนี้ยังมีหน้าที่พิจารณาคดี ความผิดฐานของการเกี่ยวกับปัญหาคลองวิทยาลัย ขึ้นอยู่กับแผนพัฒนากรุงเทพมหานคร ฉบับที่ 6 (พ.ศ. 2545 - 2549) ยุทธศาสตร์การพัฒนาด้านสิ่งแวดล้อมมีส่วนที่เกี่ยวข้องในการปัญหาคลองวิทยาลัย ซึ่งระบุในวัตถุประสงค์ของการพัฒนาในข้อ 5 “เพื่อคุ้มครอง รักษาสภาพอากาศ คุณ และความสงบสุข”

1. As a public agency which must take care of livelihood and well being of the public according to BMA Act, B.E. 2535,
2. According to the Public Health Act, B.E. 2535, the Bangkok Governor is appointed by Minister of Public Health to be the local officer to investigate and remedy the nuisance problems in Bangkok Metropolitan.

Nuisance abatement issue is included within the Sixth BMA Development Plan (2002-2006) in Development Strategy No. 5 “To reduce air, dust, noise pollution and vibration”.

10.2 Present Situation

The records of nuisance complaints during 2000-2002 in Bangkok Metropolis are shown in table 10.1, 10.2 and Figure 10.1. Most of the complaints are on noise, odor, dust, and nuisances from animal raising, for example.

Table 10.1 Complaints Received on Nuisance Problems in Bangkok Metropolis 2000-2002

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Complaints</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>5,201</td>
</tr>
<tr>
<td>2001</td>
<td>6,050</td>
</tr>
<tr>
<td>2002</td>
<td>5,840</td>
</tr>
</tbody>
</table>

Source: Division of Environmental Health, 2002

Table 10.2 Percentage of Environmental Health Complaints Regarded as Nuisance Problems

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage of Total Number of Complaints</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Noise</td>
</tr>
<tr>
<td>------</td>
<td>--------</td>
</tr>
<tr>
<td>2000</td>
<td>39.74%</td>
</tr>
<tr>
<td>2001</td>
<td>37.65%</td>
</tr>
<tr>
<td>2002</td>
<td>34.94%</td>
</tr>
</tbody>
</table>

Source: Environmental Health Division, Health Department, BMA , 2002
It is generally found that the following types of activities or establishments (which are classified as detrimental to public health according to the Public Health Act, B.E. 2535) are causes of nuisance problems to the nearby residents. These activities are:

- Pubs and Karaoke places
- Metal parts or utensil manufacturers
- Automobile Garages (with painting)
- Animal raising including domestic animals
- Printing presses
- Plastic manufacturers including celluloid, bakelite, or similar products
- Metal smelters

10.3 Impacts of Nuisance Problems

Nuisance problem, by definition, is any activity which causes odor, light, radiation, noise, heat, toxic substances, vibration, dust, soot, ash, or any other things which deteriorate or may cause harm to health (normally not life-threatening but can cause impacts on physical and mental health especially on sleep, conversation and communication) including adverse effect on the working efficiency especially in work with high concentration, bothering the mind and feel annoyed causing the tension or disease.
10.4 Strategies to Solve Nuisance Problem

BMA, Environment and Sanitation Section of District Offices and Environmental Health Division, Health Department, has carried out various measures aimed at reducing and mitigating environmental nuisances by means of prevention of the problems and also through continuous surveillance. These measures are as follows:

- Giving suggestion and recommendation both before and during operation
- Ordering entrepreneur to make improvement or correction
- Penalty or fine
- Temporary shutdown of operating units/premises, for example.

10.5 BMA’s Strategies and Implementation

In the Sixth BMA Development Plan (2002-2006) the objectives of strategies on environmental development were made clearly with the following directions in nuisance prevention and abatements:

- Increase promotion and conservation of good environmental condition of Bangkok Metropolis
  - Prevent and remedy flood problems
  - Reduce and control releases of water pollutants
  - Increase efficiency in solid and hazardous waste management.
- Reduce and control air pollutants, noise and vibration.
- Control sanitation of buildings, establishments, places, so that they do not cause pollutants which can be detrimental to health.
- Encourage public participation in environmental management.

10.6 Recommendations

The increase in nuisance problems in Bangkok Metropolitan is becoming complicated which requires cooperation of other agencies, both central and local. The key steps are to establish the standards for nuisances, and implementation directives for the establishments which are known to cause them. It is believed that there are measures to reduce and mitigate environmental nuisances effectively.
11.1 Introduction

Environmental promotion and conservation will be successful only with cooperation from all parts of the society. Public participation can be used to obtain public opinion, decision sharing, and generation of ideas. BMA has used the principle of public participation in the environmental tasks for a long time, and in 2002 there are activities for public participation in the areas of conservation, surveillance, prevention, and mitigation. The emphasis is on the development of knowledge and understanding of the environment. The series of training, seminars, and field trips include:

11.2 Solid Waste Management

The campaign for public involvement in solid waste management has been continuous with new disposal methods, with hazardous wastes separation, reuse and recycle to reduce the amount of household wastes. BMA also constructs local communities’ waste stations and campaigns for volunteers to help collecting the garbage. Some of the biodegradable wastes are being recycled locally with the methods demonstrated by BMA.
11.3 Communities Love Canals

It is normal that the communities along the canals have to face water pollution and cannot use the water, in addition to the negative aesthetics. The Community Development Department has organized the Communities Love Canals Project in order to recruit cooperation of the people to help protect the canals in their communities. The representatives of people from all communities were invited to brainstorm for the measures to prevent dumping of garbage, to treat wastewater before discharge to the canals, and to increase green area along the canals. The pilot communities which were selected with the tasks of cleaning, tree planting, and dredging in their areas are such as those in Inthamara 1 Community, Phaya Thai District, Rod Anant Community, Bung Kun District, Sook Charoen Pattana Community, Bang Kapi District, Surao Bandon Community, Wattana District, Rim Klong Pattana Community, Kanna Yao District, Poonbampen Community, Phasi Charoen District, Lang Suan Bureerom Community, Thung Khru District. The pilot project is expected to expand to other communities.

11.4 BMA Environmental Protection Volunteers

The Division of Environmental Quality Management and Control of BMA started the Environmental Protection Volunteer Project since 1999 with public participation strategy towards environmental problem abatement. The project started at tertiary level students and then to secondary schools (under BMA) and communities, in order to have key members of the volunteers to work with BMA. Currently BMA is organizing a training for community leaders who will be the trainers for this project (4 classes, total 132 persons) and teachers in BMA school (3 classes, 248 teachers). The previous trainings produced not only the members but also the directions for environmental works in communities and schools as well as chances for exchange of opinions on making the environmental works sustainable. The group of future trainers and BMA also produce a tri-monthly journal as a medium to connect information.
11.5 Rehabilitation and Conservation of Mangrove Forest at Bang Khunthien Seashore

BMA highly regards the importance of rehabilitation and conservation of its only seashore at Bang Khunthien, by letting the local public provide opinions on the strategy to bring back the lost land and mangrove forest to the natural condition during the technical meeting on 5 August 2002. In addition, Bang Khunthien District organized Youth Camps on Mangrove Forest Development Volunteers twice a year. In 2002 there were 250 participants and they planted 100,000 trees a year.

11.6 Increasing Green Areas

The increase of green area by the public and private sectors is being supported by organizing contests with royal prizes (Prueksanakara Prize from Her Majesty The Queen Sirikit) in 3 categories: Front of the house (920 houses), Planting of large trees for H.M. The King (34 places) and Community-level Park Roads (11 areas). The increase of green areas in BMA leads to development of community meeting and recreational places.
11.7 Development and Support of Good Environment in Entrepreneurial

Division of Environmental Health, Department of Health, BMA, has organized campaigns to increase environmental awareness of the entrepreneurial and factories by setting up the project on clean technology consciousness. The project aims for creating the establishment's involvement in environmental impacts resulting from production processes through alternatives which result in minimum or no wastes. This includes modifications in raw materials, reuse and recycle, and energy conservation of all types. In 2001 and 2002 the Division of Environmental Health implemented the project on development and to support livable, workable establishments within Bangkok Metropolitan and there were 189 establishments which joined the project. When the project was completed, 40 establishments achieved the gold certificates, while 65 achieved silver certificates and 37 with bronze certificates. The project improves environmental working condition and encourage development of occupation health, safety and environment.

It is evident that public participation in promotion and conservation of the environment has been continuously undertaken by all levels of BMA organization in order to gain public cooperation to work closely with BMA, and many achievements were made towards making Bangkok an environmental friendly and attractive city to live in.
Thailand participated in the United Nations Conference on Environment and Development:UNCED or the Earth Summit in Rio de Janeiro, Brazil, in 1992, and ratified Agenda 21, which is the global master plan towards sustainable development of social, economic and environment aspects. The Bangkok Metropolitan Administration has prepared and started implementing Bangkok Agenda 21 since 1998 by identifying the 20 year program for improvement of the City, its environment and quality of life.

Bangkok Agenda 21 is the result of participation of Bangkok Metropolitan Administration, the public representatives, and relevant agencies in the Bangkok Strategic Forum. It contains 10 chapters and covers all the responsibilities of the Bangkok Metropolitan Administration as follows:

1. The strategy for a sustainable Bangkok: a safe city with high quality of living
2. Lead urban economy toward sustainability
3. Use urban planning to improve quality of life
4. Reorganize traffic and transport to raise quality of air and neighborhoods
5. Invest in green urban areas
6. Make Bangkok a clean city
7. Focus on good governance in BMA to meet the challenges of the future

12. The Bangkok Agenda

12.1 Agenda 21-The Bangkok Agenda

Bangkok Agenda 21 was prepared and started implementing since 1998 by identifying the 20 year program for improvement of the City, its environment and quality of life.

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6. Make Bangkok a clean city
7. Focus on good governance in BMA to meet the challenges of the future
12.2 From Bangkok Agenda to Action

Bangkok Agenda requires actions to make the City a good place to live in, and the actions gear towards improvement of environment and quality of life in the City.

Bangkok Metropolitan Administration has already started the actions according to the Bangkok Agenda under the sustainable framework as follow:

12.2.1 Preparation of the Sustainable Urban Management Handbook in hard copies and CD-ROMs and distributed to every units in Bangkok Metropolitan Administration.

12.2.2 Preparation of District Catalogue as a tool for budgeting of city development and public participation:

- Every district has prepared its data bank with BMA-VIS software with the data updated every 6 months.
- Department of Policy and Planning of BMA has improved the BMA-VIS software further to "BMA-Plan software" which is used for planning and analysis of district development.
- Preparation of an easy Manual to Make District Catalogue which consists of district office plan, public orders, and the district office data bank.
- Training for the trainers on district catalogue in order to disseminate knowledge and understanding on preparation of the district office plan to the 50 districts of Bangkok Metropolitan Administration.

12.2.3 Preparation of the BMA Green Area Development Master Plan

The Master Plan targets green area development by increasing green areas for public parks or general public areas for recreation.

12.2.4 Green Fleets

This project aims for reduction of air pollution from motor vehicles, by encouraging and establishing environmental consciousness, as well as...
12.2.4 Green Fleets

This project standardizes operating systems of BMA, which consists of 9 systems as follow: resource accounting, personnel, accounting, budgeting, finance, income, purchasing, contracting, and complaint service. This also creates good cooperation among units and reduces repetitiveness, while the administrators acknowledge the data and information rapidly.

12.2.5 The Bangkok Comprehensive Plan

The Bangkok Comprehensive Plan is used for development planning and maintenance of the city and surrounding areas, and enables resource utilizations, communication and transport, public services, and the environment in accordance of city development in other regions and surroundings.

12.2.6 “Naa Baan Naa Mong” (Nice to Look House Project)

This project encourages the public to understand the value of contributing to the development by taking care of individual’s properties as well as streets, waterways and public properties.

12.2.7 “Kon Rak Klong” We Love Canals Project

The project aims to establish public environmental consciousness, especially in people who live along waterways, who will help with the improvement of rivers, canals and reservoirs and set the example.

12.2.8 Mass Transit Project for Bangkok

The aim of this project is to alleviate traffic problem in Bangkok by providing alternatives to private cars within the central business district areas. The Bangkok Metropolitan Administration shall provide mass transit service of high efficiency covering high demand areas and support the networks of the Expresway and Rapid Transit Authority of Thailand and State Railway of Thailand.

12.2.9 Data System and Computer Network of BMA

Bangkok Agenda is the master plan for the next 20 years of implementation and is used as a guideline of each of the successive Bangkok Metropolitan Development 5-year Plan.
Bangkok Metropolitan Administration has completed construction and started to operate five central wastewater treatment plants at Si Phraya, Rattanakosin, Chong Nonsri, Tunk Kru and Nong Kham. Two more are undergoing construction at Din Daeng and Chatuchak. In the Sixth BMA Development Plan (2002-2006) there will be two more at Klong Toey and Thonburi. Annual operation cost for the five treatment plants is currently 220 million baht. According to the Polluter Pays Principle (PPP), since 75% of the wastewater was produced by 1.9 million households in Bangkok Metropolis, and the rest from other entrepreneurs, and in order to enable sustainability of the completed and future treatment plants, BMA needs to propose regulation on wastewater treatment fee for the BMA Council to consider, which is now in the stage of setting up the extraordinary committee to consider and then to seek approval of the Council. Mr. Samak Sundaravej, the Bangkok Governor, said that according to the study on operating cost the private citizen will pay 2 baht/cubic meter of tap water used, and the first 10 cubic meters of each month will be exempted (for example, if water use is 40 cubic meters, the water bill will be 40 x 2 = 80 baht). In the first year BMA will shoulder half of the burden.
BMA also banned from undertaking cremations. Mr. Samak Sundaravej, the Bangkok Governor, commented about the Ruling Court's verdict (16 March 2003) to terminate the garbage landfill site at Raja Theeva, Bang Phi District, Samut Prakarn Province, that BMA was seeking an area to cope with 3,500 tons/day garbage, and was waiting for the possible appeal by the present contractor (Pairote Somphongphanich Partnership).

There is an old permitted landfill site which has been closed since 1997 near Chalong Krung Road, Lad Krabang District, which has garbage illegally dumped there and caused wastewater to drain to the pond behind the police station. The Lad Krabang District sprayed insecticide and dredged the pond, getting 4,000 kg of garbage, and coordinated with the owner of the landfill site which expressed determination to remediate the site and convert it to a recreational area for the public.

Crematoriums received orders from BMA through Chapter 16 of the Graveyards and Crematoriums Act, B.E. 2528, that the district offices ordered the temples to improve or change the operation until such actions were taken. This reduced the number of temples which did not conform with the standards from 112 in April 2002 to 53 in August 2003, and 11 temples were banned from undertaking cremations.

BMA welcomed the experts on environmentally acceptable cremation construction group, to survey and report for crematoriums in the area at no cost. BMA also planned for two environmentally friendly crematoriums. Mr. Samak Sundaravej, the Bangkok Governor welcomed this decision.
Governor, welcomed a party of Mr. Apichai Chvajarernpun, Director General of Pollution Control Department, Ministry of Natural Resources and Environment, Dr. Jarupong Boon-Long, adviser to the German Technical Cooperation (GTZ) and the experts, who paid a visit to exchange opinions and reported on the progress of the survey of crematoriums in the temples in Bangkok Metropolis.

BMA received a support of 160 million baht from the Energy Conservation Promotion Fund, in order to purchase 69 garbage trucks using natural gas as fuel, NGV, which saves the operating cost and reduces air pollution. This project is a cooperation between BMA and the Petroleum Authority of Thailand. BMA contributed 80 million baht out of the total 240 million baht.

There was a fire at the illegal storage of pesticides at communities along the railroad at Cheu Ploeng Road, Klong Toey District, which caused widespread odour problem from the chemicals to the public and the students from Phraharuthai Convent which is in that area.

The new law on anti-smoking is now effective in Thailand, which bans smoking in public places including air-conditioned restaurants and shopping centers. Establishments which do not control smoking will be fined more than 20,000 baht and the smokers will also be fined 2,000 baht. This is to prevent adverse health effects of indoor smoke.

BMA issued a regulation controlling all types of restaurants (more than 12,000 restaurants) before APEC Summit Meeting in October 2003. The operators must have training certificates or face operating license problem. BMA has two restaurant development courses: (1) for the operators, and (2) for the waiters and dishwashers. Initially the training is for all 12,000 restaurants with 6 hours lecture and 3 hour practice sessions. The certificates were given to the successful trainees. By 1 October 2003, all 12,000 restaurants had been trained.

There were 12,000 restaurants in Bangkok Metropolitan area. The operators and waiters and dishwashers have to be trained before they can open restaurants. A total of 80,000 operators and 240,000 waiters and dishwashers have been trained. The personnel of the restaurants are given training certificates by the Public Health Act, B.E. 2535.

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The Health Department organized the project "Borax-free Pork, The New Option for Bangkok People" to provide training to the pork producers and give certificates to the sellers who sell borax-free pork. The certificate can be seen by the public and provide confidence for the consumers.

The draft BMA regulation on animal raising or abandon (added version) passes through the BMA Council readily after there were cases of illegal animal breeding such as the Madagascar cockroaches which may cause health impacts to the public. BMA is now controlled area for 6 types of animal, which are dogs, cats, elephants, cows, water buffaloes and animals according to the laws on wild animals conservation, B.E.2535, which requires permit from Royal Forest Department. Now the Ministry of Public Health announces that the giant cockroaches can communicate diseases. The cockroaches breed fast and killing them requires large amount of pesticides.

The current Bangkok City Plan will expire on 4 July 2004 so BMA is preparing a new one which will be adjusted to the present situation. This city plan revision may cause hardships to some, so Town and Country Planning Department had organized a public hearing, which resulted in majority expression of desire for more conservation and public park areas to increase green area proportion of the city.

In order to have the open and beautiful scenery around Rama VIII Bridge preserved as the surrounding area is culturally unique, and connected to Ratanakosin Island, BMA has requested the Ministry of Interior, to issue a notification according to Section 13 of Building Control Act B.E.2522 and designate area which prohibits adaptation or construction of certain types of buildings. This notification has been effective since 4 April 2003 but will be enforced for only 1 year, so the BMA must issue its own BMA regulation for this purpose on a permanent basis.
BMA was assigned by the Royal Thai Government to create Benjakitti Public Park within the present tobacco plant. The area of the park is 434 Rais plus the pond area of 82 Rais (69.4 and 13.1 hectares respectively). The surrounding area needs to have environmental protective measures. BMA has requested the Ministry of Interior, to issue a notification according to Section 13 of Building Control Act B.E.2522 and designate area which prohibits adaptation or construction of certain types of buildings. This notification has been effective since 24 May 2003.

The vacant lot between Sri Nakarin Road-Rama IX Interchange, Suan Luang District, with the area around 130 Rais (20.8 hectares) is under care of the Expressway and Rapid Transit Authority of Thailand, and the Department of Highways. This area is among six areas which have allowed Public Park Office of BMA to improve the scenery and develop it into public parks and green areas. The tree planting, gardening, and sport area for recreation and exercise for the public are undergoing improvement and should finish by December 2003.

Natural Resources and Environment Minister Prapat Panyachatraksa met with Mr. Samak Sundaravej at the BMA to plan for the environmental improvement for the APEC Summit meeting in October 2003. The Royal Thai Government supported one billion baht for large tree planting, garbage management, wastewater, canal improvement and wandering elephant in BMA.
The Bang Khun Thien seaside is the only Bangkok area under management systems of BMA on water, air and garbage problems. In addition, on this day BMA planted 900 mahogany trees along Phutthamonthon sai 1, between Borommaratchachonnani to Chimplee Road, Bangrak District, and also organized training on home gardening in urban areas.

Asia Urbs Programme was originated by EU funding to assist in decentralization and support mutual understanding and environmental awareness between Asia and Europe by supporting projects on urban development. The project is jointly supported by the local governments of Asia and Europe.
What is "Improvement and Support for Urban Air Quality Management"?

For 24 months (September 2002-September 2004), the project will aim for development of management and awareness of the local and related agencies in Bangkok, Athens, and Bristol, by 21 million baht support from EU fund under Asia Urbs Programme, which is 65% of the project budget. The remaining 12 million baht will be shared by the three cities, in which Bangkok's share is 3.8 million baht. Athens City is the coordinator of this project. The air quality in 3 cities will be assessed for "hot spots" or high air pollutant concentration areas identified, with the measures to follow.

BMA joined Environmental Experience Exchange Project with other 10 countries in Asia and Africa (Indonesia, Malaysia, Philippines, Kampuchea, Japan, Ghana, Ethiopia, Tanzania, Nigeria, Kenya, and Thailand). The project is divided into 2 phases, the first phase is on garbage management (2002-2003) and the second phase will be on air and water quality management (start in 2004). The project is supported by United Nations Development Programme (UNDP) for the first phase. Mr. Samak Sundaravej, the Bangkok Governor, signed the MOU for the cooperation for two environmental projects. One is on garbage management project (BMA got UNDP support of 1.7 million baht and the training was on 21 July-2 August 2003).

The Kitakyushu Project for clean environment is the project created during the Ministerial Conference on Environment and Development in Asia and the Pacific 2000 Kitakyushu, Japan in September 2000. The project is from 2001 to 2005 and aims for environmental quality and public health for the urban population in the Asia-Pacific region. BMA joined this project.

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3. Department of City Planning, BMA, 2000. Designates the area to limit some type of building from construction, alternation, or use in Bangkok.
5. Department of Community Development. 2002. Number of Communities in Bangkok.
# List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>BMA</td>
<td>Bangkok Metropolitan Administration</td>
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<tr>
<td>BMTA</td>
<td>Bangkok Mass Transit Authority</td>
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<tr>
<td>BOD</td>
<td>Biochemical Oxygen Demand</td>
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<tr>
<td>BOD/N Ratio</td>
<td>Biochemical Oxygen Demand / Nitrogen Ration</td>
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<tr>
<td>BTS</td>
<td>Bangkok Mass Transit System</td>
</tr>
<tr>
<td>°C</td>
<td>Celsius Degree</td>
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<tr>
<td>cm</td>
<td>Centimeter</td>
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<tr>
<td>CO</td>
<td>Carbon Monoxide</td>
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<tr>
<td>dBA</td>
<td>Decibel A</td>
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<tr>
<td>DDS</td>
<td>Department of Drainage and Sewerage</td>
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<tr>
<td>DO</td>
<td>Dissolved Oxygen</td>
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<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
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<tr>
<td>GENCO</td>
<td>General Environment Conservation Public Company Limited</td>
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<tr>
<td>GIS</td>
<td>Geographic Information System</td>
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<tr>
<td>GWH</td>
<td>Giga Watt Hour</td>
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<tr>
<td>HC</td>
<td>Hydro Carbon</td>
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<td>hr</td>
<td>Hour</td>
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<td>H₂S</td>
<td>Hydrogen Sulfide</td>
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<tr>
<td>JICA</td>
<td>Japan International Cooperation Agency</td>
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<tr>
<td>km</td>
<td>Kilometer</td>
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<tr>
<td>Ldn</td>
<td>Noise Levels Average over day and night</td>
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<tr>
<td>LNG</td>
<td>Liquefied Natural Gas</td>
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<tr>
<td>LPG</td>
<td>Liquefied Petroleum Gas</td>
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<tr>
<td>m</td>
<td>Meter</td>
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<tr>
<td>m³</td>
<td>Cubic Meter</td>
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<tr>
<td>mg/l</td>
<td>Milligram per liter</td>
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<td>mg/m³</td>
<td>Milligram per Cubic Meter</td>
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<td>m/sec</td>
<td>Milligram per second</td>
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<tr>
<td>min</td>
<td>Minimum</td>
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<td>max</td>
<td>Maximum</td>
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<tr>
<td>MRTA</td>
<td>Metropolitan Rapid Transit Authority</td>
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<td>MWA</td>
<td>Metropolitan Waterworks Authority</td>
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<td>NEB</td>
<td>National Environment Board</td>
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<td>NEPO</td>
<td>National Energy Policy Office</td>
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<td>NEQA</td>
<td>National Environmental Quality Act</td>
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<tr>
<td>NGOs</td>
<td>Non-Governmental Organizations</td>
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<tr>
<td>NH₃</td>
<td>Ammonia</td>
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<td>NHA</td>
<td>National Housing Authority</td>
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<td>NOₓ</td>
<td>Nitrogen Oxides</td>
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<td>PCD</td>
<td>Pollution Control Department</td>
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<tr>
<td>PM10</td>
<td>Particulate Matter with the Diameter Equal or less than 10 micron</td>
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<tr>
<td>ppm</td>
<td>Parts per Million</td>
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<tr>
<td>ppb</td>
<td>Parts per Billion</td>
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<tr>
<td>Sec.</td>
<td>Second</td>
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<td>SS</td>
<td>Suspended Solids</td>
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<td>TDRI</td>
<td>Thailand Development Research Institute</td>
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<td>Temp.</td>
<td>Temperature</td>
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<tr>
<td>TKN</td>
<td>Total Kjeldahl Nitrogen</td>
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<td>TSP</td>
<td>Total Suspended Particulate</td>
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<tr>
<td>mg</td>
<td>Microgram</td>
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<td>WHO</td>
<td>World Health Organization</td>
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<td>WQMD</td>
<td>Water Quality Management Division</td>
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<tr>
<td>WWTP</td>
<td>Wastewater Treatment Plants</td>
</tr>
</tbody>
</table>
### List of Committees on Bangkok State of the Environment Report

<table>
<thead>
<tr>
<th>Number</th>
<th>Committee Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bangkok State of the Environment Report Steering Committee</td>
</tr>
<tr>
<td>1.1</td>
<td>Khunying Nathanon Thavisin</td>
</tr>
<tr>
<td></td>
<td>Permanent Secretary for the BMA</td>
</tr>
<tr>
<td>1.2</td>
<td>Mr. Ksemsan Suwamarat</td>
</tr>
<tr>
<td></td>
<td>Chairman of the Board of Director Wastewater Management Authority</td>
</tr>
<tr>
<td>2</td>
<td>Department of Environmental Quality</td>
</tr>
<tr>
<td></td>
<td>Promoting, Ministry of Natural Resources and Environment</td>
</tr>
<tr>
<td>3</td>
<td>Department of Pollution Control</td>
</tr>
<tr>
<td></td>
<td>Ministry of Natural Resources and Environment</td>
</tr>
<tr>
<td>4</td>
<td>Department of Groundwater Resources,</td>
</tr>
<tr>
<td></td>
<td>Ministry of Natural Resources and Environment</td>
</tr>
<tr>
<td>5</td>
<td>Department of the Royal Irrigation,</td>
</tr>
<tr>
<td></td>
<td>Ministry of Agriculture and Cooperatives</td>
</tr>
<tr>
<td>6</td>
<td>Department of Public Works and Town</td>
</tr>
<tr>
<td></td>
<td>Country Planning, Ministry of Interior</td>
</tr>
<tr>
<td>7</td>
<td>Department of the Meteorological,</td>
</tr>
<tr>
<td></td>
<td>Ministry of Information and Communication Technology</td>
</tr>
<tr>
<td>8</td>
<td>Department of Land Transport,</td>
</tr>
<tr>
<td></td>
<td>Ministry of Transport and Communication</td>
</tr>
<tr>
<td>9</td>
<td>Urban Environmental and Area Planning Division,</td>
</tr>
<tr>
<td></td>
<td>Ministry of Natural Resources and Environment</td>
</tr>
<tr>
<td>10</td>
<td>Bureau of Environmental Management and Rehabilitation,</td>
</tr>
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<td></td>
<td>Department of Primary industries and mines,</td>
</tr>
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<td>Ministry of Industrial</td>
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<td>11</td>
<td>Factory Control and Inspection Bureau,</td>
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<td>12</td>
<td>Bureau of Environmental Health,</td>
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<td>Department of Health,</td>
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<td>Ministry of Public Health</td>
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<td>13</td>
<td>Petroleum Division, Energy Policy and Planning Office,</td>
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<td></td>
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<td>14</td>
<td>United Nations Environment Programme</td>
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<td>15</td>
<td>The Metropolitan Waterworks Authority</td>
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<td>16</td>
<td>Traffic Police Division, Royal Thai Police</td>
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<td>17</td>
<td>Environmental Research Institute, Chulalongkorn University</td>
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<td>18</td>
<td>The College of Public Health,</td>
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<td>Chulalongkorn University</td>
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<td>19</td>
<td>Faculty of Public Health, Mahidol University</td>
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<tr>
<td>20</td>
<td>Faculty of Environment and Resources Studies, Mahidol University</td>
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</table>
กรุงเทพฯ ประจำปี 2003

22. สมาคมส่งเสริมสวัสดิการ

23. บริษัท บริการและพัฒนาเพื่อการอนุรักษ์สิ่งแวดล้อม จำกัด (มหาชน) (เอ็นจี)

24. สำนักงานสิ่งแวดล้อม สำนักงานสิ่งแวดล้อม

25. กลุ่มงานสิ่งแวดล้อมและสิ่งแวดล้อม

26. กลุ่มงานและประสานงานทรัพยากรฯ สำนักการโยธา

27. กลุ่มงานและประสานงาน สำนักการโยธา

28. ตลาดการตลาดและแผนภูมิ

29. ตลาดการศึกษา สำนักการโยธา

30. ตลาดการตลาดและแผนภูมิ

31. ตลาดการตลาดและแผนภูมิ

32. ตลาดการตลาดและแผนภูมิ

33. ตลาดการตลาดและแผนภูมิ

34. ตลาดการตลาดและแผนภูมิ

35. ตลาดการตลาดและแผนภูมิ

36. Mr. Jan Ipland

37. Mr. Jan Ipland

38. ผู้ช่วยราชการประจำกรุงเทพมหานครตามโครงการ

39. ผู้ช่วย.longitudeต่างๆและช่างที่ได้รับการทุ่มเทพลังงาน

40. ผู้ช่วย.longitudeต่างๆและช่างที่ได้รับการทุ่มเทพลังงาน

41. ผู้ช่วย.longitudeต่างๆและช่างที่ได้รับการทุ่มเทพลังงาน

42. ผู้ช่วย.longitudeต่างๆและช่างที่ได้รับการทุ่มเทพลังงาน

43. ผู้ช่วย.longitudeต่างๆและช่างที่ได้รับการทุ่มเทพลังงาน

44. ผู้ช่วย.longitudeต่างๆและช่างที่ได้รับการทุ่มเทพลังงาน

45. ผู้ช่วยlongitudeต่างๆและช่างที่ได้รับการทุ่มเทพลังงาน

46. ผู้ช่วยlongitudeต่างๆและช่างที่ได้รับการทุ่มเทพลังงาน

47. ผู้ช่วยlongitudeต่างๆและช่างที่ได้รับการทุ่มเทพลังงาน

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60. ผู้ช่วยlongitudeต่างๆและช่างที่ได้รับการทุ่มเทพลังงาน

22. The Environmental and Community Development Association

23. General Environment Conservation Public Company Limited (GENCO)

24. Public Park Office, Department of Social Welfare, BMA

25. Infrastructure and Environment Planning Division, Department of Policy and Planning, BMA

26. Planning and Public Utility Co-ordination Division, Department of Public Works, BMA

27. Traffic Information System Division, Department of Traffic and Transportation

28. Technical and Planning Division, Department of City Planning

29. Water Quality Management Division, Department of Drainage and Sewerage, BMA

30. Technical and Planning Division, Department of Community Development, BMA

31. Technical and Planning Division, Department of Community Development, BMA

32. Environmental Health Division, Department of Health, BMA

33. Mechanical and Maintenance Division, Department of Finance, BMA

34. Technical Division, Department of Education, BMA

35. Technical Division, Department of Medical Service, BMA

36. Mr. Jan Ipland

37. Director of Environmental Quality Management and Control Division, Department of the Permanent Secretary for the Bangkok Metropolitan Administration, BMA

38. Head of Pollution Control Sub-Division, Environmental Quality Management and Control Division, Department of the Permanent Secretary for the Bangkok Metropolitan Administration, BMA

39. Ms. Termai Chongpoonphol

40. Ms. Kasinee Kaewkong

1. Director of the environment Quality Management and Control Division
2. Ms. Tippawan Kettain
   Head of Pollution Control Sub-division
3. Ms. Siriporn Tantivanich
   Head of Environment Promotion and Dissemination Sub-division
4. Ms. Phussadee Supradish
   Head of Environment Impact Study and Analytical Sub-division
5. Mr. Bunlaeng Narapinit
   Environmentalist 5
6. Ms. Suchada Kietkaran
   Environmentalist 5
7. Ms. Kasinee Kaewkong
   Environmentalist 5
8. Mr. Jarupong Pengglieng
   Environmentalist 5
9. Ms. Termsiri Chongpoonphol
   Environmentalist 5
10. Ms. Ornouma Saksess
    Environmentalist 4
11. Ms. Thipyanee Suwanwijit
    Environmentalist 4
12. Ms. Suttasinee Arkhompat
    Environmentalist 4
13. Ms. Nattasorn Thawonrat
    Environmentalist 4
14. Mr. Prompon Sutthinunchai
    Environmentalist 3
15. Mr. Sukhirat Pakdeewan
    Environmentalist 3