BEIP-GIS

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)
BANGKOK METROPOLITAN ADMINISTRATION(BMA)
THE GOVERNMENT OF THE KINGDOM OF THAILAND

# ENVIRONMENTAL ATLAS

## BANGKOK METROPOLITAN AREA



PACIFIC CONSULTANTS INTERNATIONAL
SUURI-KEIKAKU CO.,LTD.

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# Preface

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct "The Study on Urban Environmental Improvement Program in Bangkok Metropolitan Area" and entrusted the Study to the Japan International Cooperation Agency (JICA).

JICA sent to the Kingdom of Thailand a study team headed by Dr. Katsuhide NAGAYAMA, Pacific Consultants International, and composed of members of Pacific Consultants International, and Suuri-Keikaku Co.,Ltd., four times between August 1995 and December 1996.

The team held discussions with the officials concerned of the Government of the Kingdom of Thailand and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Kingdom of Thailand for their close cooperation extended to the team.

February 1997

Kimio Fujita
President
Japan International Cooperation Agency

February 1997

Mr. Kimio FUJITA

President
Japan International Cooperation Agency
Tokyo, Japan

## Letter of Transmittal

Dear Sir,

We are pleased to formally submit herewith the special edition of "Environmental Atlas, Bangkok Metropolitan Area" as a supplement to the final report of "The Study on Urban Environmental Improvement Program in Bangkok Metropolitan Area" (referred to as "BEIP Study") which was undertaken in the Kingdom of Thailand from August 1995 through December 1996 by the Study Team, organized jointly by Pacific Consultants International and Suuri-Keikaku Co., Ltd.

The BEIP Study employed a computer-aid planning approach utilizing GIS (Geographic Information System) technique to identify the current environmental planning issues and simulate future changes in Bangkok urbanization in terms of land use, transportation, air quality and water-related environment. Through the planning work, the BEIP Study Team built up the "BEIP-GIS Data Base" in such a way that those who are interested in urban analyses, studies and planning for the Bangkok Metropolis may easily make use of the data base.

This "Environmental Atlas" compiles a number of selected outcomes of GIS derived from the process of the Study for those who want to know the Bangkok urban environment at a glance.

We owed a lot to many people for the accomplishment of the Study. We would like to express our sincere gratitude and appreciation to all those extended their kind assistance and cooperation to the Study Team, in particular, relevant officials of Bangkok Metropolitan Administration, the Thai counterpart agency.

Very truly yours,

Dr. Katsuhide NAGAYAMA

Team Leader,
The Study Team for the Study on Urban Environmental Improvement Program in Bangkok Metropolitan Area

# 1. An Outline of the Environmental Atlas

## 1.1 INTRODUCTION

*Based on a number of map data collected through the Study on Urban Environmental Improvement Program in Bangkok Metropolitan Area (BEIP), the JICA study Team built a Geographic Environmental Data Base, named "BEIP-GIS" to support the planning work.*

*Through the GIS-technique, the collected basic data were fully processed and analyzed to generate spatial information on natural attributes, environmental constraints, socio-economic conditions and existing problems of transportation in the study area. Results of those data manipulations were displayed in forms of maps and tables.*

*This Environmental Atlas compiles a number of selected outputs out of the results of the BEIP-GIS to visibly show the current urban environmental states, intermediate outcomes for planning process to identify planning issues, results of simulation analyses for future urbanization and land use, traffic conditions and air pollution distribution.*

*This Environmental Atlas has been prepared as an additional material to supplement the main report of the BEIP Study, and will make some contribution to those who are concerned with solution of urban environmental problems and urban planning of BMA.*

## 1.2 ON THE BEIP-GIS

### (1) Concept of Environmental Information System

*The GIS technique was applied for the planning process in the BEIP study. The system is called "Environmental Information System (EIS)" which was specially designed so as to support planning work for land use and environmental management, incorporating and integrating functional sub-systems of the transport sector, air pollution control measures, water-related environment with socioeconomic data/information for the Bangkok Metropolis. The concept of the architecture of EIS is represented as illustrated on Fig. 1.*

### (2) System Configuration

*For the operation of BEIP-GIS, the most updated hardware and the most standardized software systems were selected. These hard and software systems were installed in the study office, Department of Public Works, BMA, and available for data digitization, analysis and mapping. The system configuration for BEIP-GIS is shown in Fig. 2.*

### (3) Input Data Items

*In order to develop the BEIP-GIS, many kinds of both graphical and statistical data/information have been collected with cooperation of relevant agencies. All collected map data were digitized and input into the computer after necessary modification, adjustment and updating. A total of 22 sets of original map data were stored into the BEIP-GIS, which are demonstrated in this Environmental Atlas.*

## 1.3 DATA PROCESSING BY GIS

*Data processing by GIS consists of three hierarchical stages, namely, primary, secondary and tertiary process, according to the degree of the spatial data manipulation.*

*The primary data analyses: Simple overlay analyses of basic maps were conducted to identify spatial distribution patterns and characteristics in relation with regional factors. Cross tabulations in terms of area, length, density, average and/or frequency calculation were made to identify specific geographic features by district or sub-district unit in this stage. Statistical data such as population and housing were compiled into the corresponding statistical maps. Results of the primary data analysis may not only show existing urban conditions of*

*the BMA, but also bear informative indicators for urban planning considerations.*

*The secondary data analyses: Land suitability analyses were conducted to identify degree and characteristics of land suitability for urban development or conservation, based on a urban potential evaluation model. For the model building, a number of evaluation criteria affecting apparent urbanization pressures such as conditions of natural/environmental constraints, transport infrastructure availability/accessibility and public services locations, were selected from the urban planning point of view. To derive the overall evaluation of urbanization potentials, these criteria were weighted in consideration of the inherent meaning and effectiveness of each criterion. The provisional weighting system was calibrated by a multiple computing process up to significantly (more than 90 %) explain the actual present sate. The results of this data processing analyses are the basis for the following tertiary data analysis.*

*The tertiary data analyses: Simulation analyses for future urbanization in BMA were conducted as the tertiary data analysis. These are the most complex and sophisticated, combining with the results of the secondary data analyses. Future traffic conditions and air pollution distribution patterns were simulated to evaluate proposed policy options as well as get insight into the most-likely future state in the Bangkok urban environment*

## 2. Contents of the Environmental Atlas

*In the Environmental Atlas, a total of 57 map sheets are selected out of the BEIP-GIS. These maps are divided into six groups, based on the analytical categories as mentioned in the preceding section.*

***Data Items of BEIP-GIS***

***A: Existing Conditions (Basic Data)***

- *A-1 Bangkok Metropolitan Area Base Map*
- *A-2 Administrative Boundary*
- *A-3 Traffic Analysis Zones (Bangkok Metropolitan Region)*
- *A-4 Inundated Areas by 1983 Flood*
- *A-5 Simulated Land Subsidence Areas*
- *A-6 Existing Flood Protection Facilities*
- *A-7 Population Distribution (1995)*
- *A-8 Population Growth by Sub-district(1990-1995)*
- *A-9 Population Density by Sub-district*
- *A-10 Income Group Distribution by Traffic Analysis Zone*
- *A-11 Existing Land Use*
- *A-12 Distribution of Landmarks*
- *A-13 Characteristics of Recent Building Development (1992-1994)*
- *A-14 Land Sub-division Development(1988-1996)*
- *A-15 Recent Land Development in Suburban Areas (interpreted from Landsat TM Data)*
- *A-16 Green Coverage( except for cultivated land, interpreted from Landsat Data)*
- *A-17 Current Khlong Water Quality (BOD Concentration)*
- *A-18 Road and Railway Network*
- *A-19 Traffic Demands (Traffic Generation and Attraction)*
- *A-20 Noise Level of Bangkok Metropolis*

***B: Plans***

- *B-1 Land Use Zoning (designated by DTCP, 1992)*
- *B-2 Water Service Area Expansion Plan*
- *B-3 On-going and planned Road Projects by 2000*
- *B-4 Planned Bangkok Mass Transit Systems*
- *B-5 On-going Sewerage Projects and Planned Sewerage Zones)*

***C: Primary Data Analysis***

- *C-1 Built-up Area Ratio by Sub-district*
- *C-2 Green Coverage Ratio by Sub-district*
- *C-3 Greens in Built-up Area*
- *C-4 Accessibility to Large Parks*
- *C-5 Open Space Ratio by Sub-district*
- *C-6 Road Density by Sub-district*
- *C-7 Soi Density by Sub-district*
- *C-8 Accessibility to City Center( Unloaded)*
- *C-9 Accessibility to City Center(Loaded)*
- *C-10 Time Losses Distribution due to Traffic Congestion*
- *C-11 Disparities between Solid Waste Collection and Generation*

***D: Urban Environmental Problem Analysis***

- *D-1 Problem Areas on Natural Constraints*
- *D-2 Densely Inhabited Area*
- *D-3 Problem Areas on Living Environment*
- *D-4 Level of Road Traffic Congestion(1995)*
- *D-5 Problem Areas on Transport Environment*
- *D-6 A Simulation on Ambient Air Quality(1995)*

*D-7 Problem Areas on Sanitary Environment*

***E: Secondary Data Analysis (Land Suitability Analysis)***

*E-1 Assessment on Natural Conditions*

*E-2 Assessment on Urban Services*

*E-3 Assessment on Transport Services*

*E-4 Assessment on Urban Sanitary Services*

*E-5 An Overall Evaluation on Urbanization Suitability (1995)*

*E-6 Simulated Urbanized Area(1995)*

*E-7 Future Urbanization Potential(2011)*

*E-8 Future Land Use Simulation-Trend Based Policy Free Case-1*

***F: Simulation Analysis***

*F-1 Traffic Simulation-1: Level of Road Traffic Congestion (Present Demands and Future Supplies)*

*F-2 Traffic Simulation-2: Level of Road Traffic Congestion (Future Demands and Supplies)*

*F-3 Ambient Air Quality Simulation-1*

*F-4 Ambient Air Quality Simulation-2*

*F-5 Ambient Air Quality Simulation-3*

*F-6 Ambient Air Quality Simulation-4*

# 3. *Explanations of Maps*

*Brief explanations on the Maps complied hereafter in the Environmental Atlas are given as follows. The map code is identical to the one attached to corresponding map.*

## *3.1 BASIC MAP DATA/ INFORMATION*

### *A-1 Bangkok Metropolitan Area Base Map*

*Preparation of a base map is the first step of geographic data base development. The base map for the study area is compiled at a scale of 1:75,000 with combination of 20 sheets of 1:20,000 and additional 1:50,000 scale topographical maps. Main roads, Khlongs/water ways and railways are digitized and mapped on the 1:75,000 scale base map. Administrative boundaries of districts and sub-districts are also exactly input on this map.*

### *A-2 Administrative Boundary Map*

*Polygons enclosed with administrative boundaries are the basic units for socioeconomic statistical data analyses as well as the minimum spatial unit for the planning work. Totally 38 districts and 151 sub-districts boundaries are drawn in this map with a name list of these units.*

### *A-3 Traffic Analysis Zone (Bangkok Metropolitan Region )*

*Traffic Analysis Zone (TAZ) is the unit for traffic data collection and a series of transport analyses. In order to grasp traffic flows and transport characteristics in Bangkok, the surrounding provinces need to be included for the spatial framework. For this purpose, Bangkok Metropolitan Region (BMR) is divided into a total of 505 TAZs, out of which 332 TAZs are set in BMA. Each TAZ has socioeconomic statistical data and traffic attributes and characteristics derived from "Person Trip Home Interview Survey 1995", conducted jointly by the BEIP Study Team and the Urban Transport Data Management Project (UTDM) Team under OCMRT.*

## *3.2 Current Physical and Environment Conditions of BMA*

*In order to identify the current environmental conditions, the following map data/information are visible demonstrated:*

### *A-4 Inundated Areas by 1983 Flood*

*The distribution pattern of inundated areas by the 1983 flood in BMA is shown in this map. The original data was quoted from the Report of the Flood Mitigation Study for Bangkok conducted by JICA in 1985. As seen in this map, Blue shaded areas represent the inundated areas. The GIS calculates the total inundation area by this flood at 424 km$^2$ within the jurisdiction of BMA.*

### *A-5 Simulated Land Subsidence Areas*

*Land subsidence has been recognized as one of the most crucial problems which worsen urban development conditions and make flood mitigation more difficult in BMA since the 1980s. Extraction of ground water has been accelerated by the rapid economic growth in the 1990s, and land subsidence is still continuing in both BMA and BMR despite the control regulations to ground water use.*

*This map demonstrates iso-contour lines of anticipated possible height of land subsidence by the year 2017, based on the simulation analysis with the most severe scenario. The original data source is quoted from the JICA Study for Ground Water Management and Land Subsidence conducted in 1995. According to this map, Bangkok and its surrounding areas do/will suffer from continuous land subsidence unless proper counter measures are taken.*

### *A-6 Existing Flood Protection Facilities*

*After the large flood disaster in 1983, the flood protection project was implemented with construction of dikes, pumping stations and water gates, covering part of the jurisdiction of BMA. In this map, flood protection dikes, which is shown with red lines, were constructed along the fringe of the urbanized area of Bangkok. Inevitably, inland water drainage is recently getting an more important problem in the urban area.*

*A-7 Population Distribution (1995)*

*The most recent demographic population data were estimated and treated on a sub-district base. A-7 shows the population distribution 1995, representing its magnitude by sub-district. The original data comes from a series of projection analyses by the UTDM Team and the BEIP Study Team, based on "Population and Housing Census 1990" (National Statistical Office), Population Registration Data (BMA) and the other relevant demographic statistical data.*

*A-8 Population Growth by Sub-district (1990-1995)*

*Changes in population during the period between 1990 and 1995 are represented by a distribution pattern of population growth rates by sub-district. Areas with a higher growth rate are identified in outskirts rather than central areas. Obviously urban sprawl is taking place with spatial expansion of urbanization.*

*A-9 Population Density by Sub-district*

*As one of significant data to represent the nature of urbanization, A-9 shows a distribution pattern of Population Density*

*A-10 Income Group Distribution by Traffic Analysis Zone*

*This is very unique, showing a spatial characteristic of average income groups in BMR. The income groups are classified into seven categories in terms of monthly household income. The original data source comes from the results of "Person Trip Home Interview Survey 1995". It can be observed from this map that higher income groups tend to reside in the outskirts rather than the inner city.*

*A-11 Existing Land Use (1993)*

*Identification of the most current 1993 land use in BMA was worked out by Mapping Division, Department of City Planning, BMA, and the information was digitized into the BEIP-GIS by the BEIP study team for the planning purpose. This map, A-11, shows the urbanization pattern and distribution of open space. This is one on the most significant outcomes of the BEIP Study.*

*Treating the land use data in association with the district and sub-district boundary data through the overlaying data processing technique of GIS, each type of land use by administrative unit can be calculated and tabulated as shown in Table 1. These provide several implications for discussions on the urban growth management. For instance, the total built-up (urbanized) area was calculated at 541 km², or 34% of the entire BMA area, at present as of 1993.*

*A-12 Distribution of Landmark Facilities*

*Locational information of main buildings/landmarks and public service facilities were digitized and mapped out on the base map. Each is attached with its locational characteristics and attributes in the data base.*

*A-13 Characteristics of Recent Building Development (1992-1994)*

*Map A-13 represents a recent trend of urbanization in terms of the number of permissions of building construction during the period between 1992 and 1994 according to the BMA data. Building development concentrates in the central business district, and at the same time, an active momentum can be seen in some sub-urban areas.*

*A-14 Land Sub-division Development (1988-1996)*

*Map A-14 shows another current trend of urbanization observed from the number of permissions of sub-division (housing) projects during the period between 1988 and 1996. It can be apparently seen that sub-division development is very active in the fringe of the present built-up areas.*

*A-15 Recent Land Development in Suburban Area*

*In Map A-15, the yellow-shaded area indicates the non-vegetated land areas and/or urbanized areas which are interpreted from the "Landsat TM Data, May, 1995". And, the red-hatched areas indicate the urbanized areas extracted from the Existing Land Use 1993, Map A-11. Eventually, only the yellow-shaded areas with non-overlapped by the red-hatched areas may be regarded as the areas where were recently developed during the period between 1993 are 1995. For the generation of this map, the Landsat image data and the geographic data of BMA are simultaneously processed in the BEIP-GIS.*

*A-16 Green Coverage*

*Using the same satellite image of "Landsat TM Data, May, 1995", vegetated areas within the urbanized area are identified based on the same interpretation and over-laying process as above. This map shows a general trend of land use in BMA, i.e., less green space is accompanying in the urbanization process.*

*A-17 Current Khlong Water Quality (BOD Concentration)*

*Water quality at selected points in Khlongs were sampled and tested by MOSTE and the BEIP Study Team. Map A-17 collectively shows the most recent results of BOD concentration. The red-colored points stand for the most contaminated water. As seen in this map, the distribution of contaminated areas in Khlong water is almost equal to that of densely built-up area. In the suburbs of Bangkok, the BOD level is still at a relatively low level. And, it is a notable fact that the historical area, say, Rathnakosin and Phra Nakhon, the*

*water quality of Khlongs has been considerably improved due to the fresh water inflow from the Chao Phraya river.*

*A-18 Road and Railway Network*

*In the Bangkok Metropolis, there are a number of trunk/arterial road projects some of which are being implemented. Map A-18 indicates the exact locations and alignments of these on-going and/or planned road projects for the 8th National Plan by the responsible agencies, namely, 1) BMA; 2) PWD; 3) DOH and 4) ETA (Expressways) as of December 1996. This map implies a necessity of coordination among these agencies in terms of their alignment and construction schedule, because in some areas, for instance, in western part of the Middle Ring and at the Chao Phraya crossing in the southern part of the Outer Ring and the Middle Ring, different agencies have planned different alignment without any technical coordination among them.*

*A-19 Traffic Demands (Traffic Generation and Attraction)*

*Traffic generations and attractions were calculated by each TAZ based on traffic related surveys. Map A-19 shows comparative rations of traffic attraction to traffic generation in a raking system. Rank 1 is the highest zone which means that the volume of traffic attraction is much greater than that of traffic generation, while Rank 5 is the lower zone which means that there are little difference between traffic generation and attraction. Accordingly, it can be said that the zones categorized by Ranks 1 or 2 are thought to have some urban center functions.*

*A-20 Noise Level*

*For the compilation of this Environmental Atlas, additional environmental survey data on Noise Level in Bangkok were provided by Department of Environmental Quality Promotion, Environmental Research and Training Center (ERTC). Noise level indicated in Map A-20 shows "10 minutes equivalent sound level". The data were taken from 7:00 to 22:00 hour in daytime and 22:00 to 0:00 hour in night time in 1966. The grid cell size of this map is 1 km by 1 km in the central areas and 2 km by 2 km for the other surrounding areas.*

### *3.3 Plans*

*B-1 Land Use Zoning (Designated by DTCP, 1992*

*The current Land Use Zoning System for Bangkok had established by DTCP in 1992. Map B-1 shows the future direction of land use in BMA based on the Urban Planning Act, however, many sub-division development has been taking place even in the designated "conservation area". These discrepancies between the institutional framework for land use zoning and the existing actual land use can be easily interpreted by a simple overlay analysis of those two maps.*

*B-2 Water Service Area Expansion Plan*

*The planned expansion areas for water service supply up to 2017 are indicated in Map B-2. The expansion of water service areas may indicate the spatial directions of future urbanization.*

*B-3 On-going and Planned Road Projects by 2000*

*The spatial structure of Bangkok Metropolis is about to be changed by several trunk arterial highways such as the Outer Ring Road and the Middle Ring Road. And, in order to mitigate heavy traffic congestion, a number of secondary roads are now being developed. Map B-3 shows those on-going and planned road projects targeting at the year 2000.*

*B-4 Planned Mass Transit Systems*

*Map B-4 shows the routes of the planned Mass Transit Systems in Bangkok in the long-term, depicted in the Master Plan by OCMRT. The entire mass transit system of Bangkok is structured with several lines to be operated by different bodies such as MRTA, BTSC and SRT/Hopewell. An integration scheme is needed to make the total system really functional.*

*B-5 On-going Sewerage Projects and Planned Sewage Zones*

*BMA is divided into 24 sewage zones, which are the planning service coverage unit of sewage treatment facilities. Map B-5 shows the current planning zones. Only "Zone 1" is under operation at present. For the yellow-colored zones such as Zones 2, 3, 4, 5.5 and 5.2, sewerage facilities are now being constructed. This current zone system, however, needs to be revised in accordance with a change in the urbanization pattern.*

### *3.4 Primary Data Analysis*

*C-1 Built-up Area Ratio by Sub-district*

*Area characteristics by sub-district unit were analyzed, based on the sub-district boundary data overlaying on several thematic maps with specific items. Some of the results of the analysis are listed in Table 2. These data are all the indicators to explain existing urban environment in BMA.*

*Map C-1 shows the built-up ratio for each sub-district defined as the percentage of built-up area to the corresponding sub-district area. This data is generated by an overlay process of the sub-district boundary map with the built-up area which is determined by the existing land use map. Each built-up area in terms of percentage was calculated in GIS and compiled into a table format.*

*C-2 Green Coverage Ratio by Sub-district*

*Map C-2 was compiled to identify the scarcity of green/vegetated area in BMA. This is treated with two kinds of information: the green coverage areas from the interpretation of "Landsat Satellite Image" and the sub-district boundary data map. Although the location of BMA is well suited for tropical vegetation growing, less green remains in the built-up area. Future urbanization should be well controlled to conserve green coverage and increase green in the built-up area.*

*C-3 Green in Built-up Area*

*Topographical allocations of green especially within the built-up area are identified in Map C-3.*

*C-4 Accessibility to Large Park*

*Map C-4 shows the equi-distance (3 km) or accessibility to large parks by the GIS technique of "Buffer Zone Generation". The 3 km service coverage area from/to any major large park covers only part of the urbanized area. Newly urbanized areas are generally poor in this public service.*

*C-5 Open Space Ratio by Sub-district*

*Map C-5 shows the distribution of percentages of open space (non built-up area ) by sub-district. This is an inverse result of Map C-1, Built-up Ratio.*

*C-6 Road Density by Sub-district*

*Map C-6 indicates a spatial condition of road service level by sub-district in terms of the road (except for "Soi") length per unit area (hectare). This map gives a significant implication for urban planning. Such a calculation is of powerful technique endowed with GIS.*

*C-7 Soi Density by Sub-district*

*Same as the above, Map C-7 shows another indicator of road service level particularly for "Soi". As seen in this map, the sub-districts with high Soi density are discreetly located, and have no clear-cut relation to the level of road density as shown in C-6.*

*C-8 Accessibility to City Center (Unloaded) and*

*C-9 Accessibility to City Center (Loaded)*

*Maps C-8 and C-9 show a zonal characteristic of accessibility to/from the city center by road transport, in terms of time-distance (minutes). The city center is represented by Hua Ranpong Station. These maps imply a general urban spatial economic sphere of Bangkok, and these unique outcomes demonstrate the powerful tool of GIS.*

*Map C-8 is the case that no traffic congestion takes place, or all road traffic can flow smoothly at the same speed as designed. Within 45 minutes (dark green), most of the built-up areas are covered. This is an ideal state where the urban economy may be performed very efficiently.*

*On the other hand, Map C-9 stands for the actual existing case as of 1995, based on the traffic analyses. Due to serious road congestion, vehicles run at slow speed. Eventually, the 45 minutes zone is limited only to the small areas in the central area. The urbanized area cannot be covered by "One-hour Economic Zone", and the eastern part of BMA is in almost three hours zone.*

*C-10 Time Losses Distribution due to Traffic Congestion*

*Difference in time at a grid cell between the cases of C-8 and C-9 may be defined as "time loss" caused by traffic congestion. Time loss is calculated by overlaying Map C-8 with C-9, and the volume of time loss at each grid cell is categorized into five ranks according to the relative level of traffic accessibility. Areas with a higher rank, represented by the red-colored grid cells, stand for the areas suffering from a higher economic and/or time loss due to the traffic congestion, thereby requiring the improvement in the traffic accessibility more seriously.*

*C-11 Disparities between Solid Waste Collection and Generation*

*Disparities between solid waste collection (supply capacity side) and generation (demand side) were computed based on the district data. The capability of solid waste collection is represented by the number of collection vehicles currently allocated to each district, while the volume of solid waste generation was estimated according to the projected population. The value of 1.0 means that the collection capability is balanced with the generation, and the value of more than 1.0, the generation of solid waste exceeds the collection capability. In Map C-11, red-colored areas shows the largest disparity area for solid waste collection and generation. The current allocation scheme of collection vehicles should be reviewed, based on this outcome.*

### *3.5 Urban Environmental Problem Analysis*

*Maps of the "D" category are some selected outcomes of the BEIP-GIS from the planning process to identify the current urban environmental problems and planning issues to be tackled.*

*D-1 Problem Areas on Natural Constraints*

*Flooded areas by the 1983 flood (Map A-4) and the simulated land subsidence map (Map A-5) were overlaid to identify the spatial distribution of physical and environmental constraints in BMA. Because of the natural background of BMA, flooding and land subsidence are the main physical constraints. Those areas where the potentiality of land subsidence is large and, at the same time, are subject to being inundated are thought to be relatively vulnerable and susceptible area against natural*

*disasters. In these areas, future urbanization should be careful with improvement of such existing conditions.*

*D-2 Densely Inhabited Area*

*The population density of the urbanized/built-up area in BMA was calculated at 150 persons per hectare on the average as of 1995, however, the old city is a high-densely inhabited area. The extremely high value of the population density accounted for 941 persons per hectare in Pom Prap Sattruphai Sub-district. In Talat Noi Sub-district, the population density was also 905 persons per hectare. The distribution pattern of densely inhabited areas are shown in this map.*

*D-3 Problem Areas on Living Environment*

*Four kinds of map data were integrated into Map D-3 to identify locations of problem areas in the living environment in BMA. Those are: 1) extremely high density areas; 2) slum problems; 3) urban sprawl areas without sufficient infrastructure; an 4) insufficient park accessibility.*

*D-4 Level of Road Traffic Congestion (1995)*

*The traffic volume data and the inventory data on the existing road network are surveyed and stored into the computer in the stream of the BEIP Study. The road network is divided into nodes and segments, and each segment is given to their own attributes such as number of traffics, traffic capacity, number of lanes and so on. These are the basic data base for nay transport analyses.*

*Based on those data, levels of road traffic congestion under the existing conditions were calibrated, and the results were mapped out on MAP D-4, covering the entire Bangkok Metropolitan Region (BMR) including the surrounding Changwats. The level of calculation is classified into five ranks: 1) Saturated; 2) Heavily Congested; 3) Congested; 4) Acceptable; and 5) Under Capacity.*

*D-5 Problem Areas on Transport Environment*

*The road density map (C-6) and the time loss evaluation map (C-10) are overlaid in association with the results of the traffic demand analyses to evaluate the current problem areas on the transport environment in BMA. Map D-5 shows the distribution of significantly serious areas by 1 km grid cell, from three standpoints which may provide with basic planning implications, namely, 1) Low road density, 2) Areas with a large traffic supply-demand gap (the computed traffic demands significantly exceed the capacity of the existing road supply), 3) Area suffering from traffic time loss due to congestion.*

*D-6 A Simulation on Ambient Air Quality (1995)*

*The BEIP-GIS is incorporated with the Air Pollutant Diffusion Simulation Model for BMA which holds the following attributes:*

*1) Simulated air pollutants:*

*PM-10, CO, $SO_2$, NOx and $NO_2$*

*2) Computerized value:*

*Annual arithmetical mean concentration by 500m x 500m grid cell in the urbanized area (within the Outer Ring Road), and 1 km x 1 km grid cell in the outskirts;*

*3) Pollutants sources:*

*Motor vehicles, thermal power plants and households; and*

*4) Model:*

*Gaussian Puff Equation (following the JEA, 1993).*

*The detailed methodology is described in the BEIP final report.*

*The results of the simulation analyses of the present state are shown in Map D-6. The red and orange-colored cell stands for the area with a significantly higher concentration than that stipulated in the current Thai Environmental Standards. As seen in this map, grid cells with the higher concentrations of PM-10 and $NO_2$ than the standards are distributed almost over the whole built-up area in BMA. On the other hand, the concentration of $SO_2$ would be more than its standard in some limited areas and that of CO is mostly less than its standard in all areas in MBA.*

*The main source of air pollutants must be major trunk roads with heavy traffic, since the areas along major roads are with a higher concentration of PM-10 and $NO_2$ than the surroundings. The most concentrated areas are found along the First and Second Stage Expressways.*

*D-7 Problem Areas on Sanitary Environment*

*The air pollution simulation map (D-7), the contamination map of Khlong water (A-17) and the problem map of solid waste collection and generation (C-11) are totally integrated in this Map D-7 to identify the distribution of problem areas on the sanitary environment in BMA. Air pollution and water-contaminated areas are overlapped within the built-up area and the solid waste collection problem areas are distributed in the suburbs of BMA where urban sprawl has been taking place.*

### *3.6 Secondary Data Analysis (Land Suitability Analysis)*

*Given an arithmetical model, the geographic analysis allows users to study land suitability in the real-world process. The GIS technique enhances this process by providing tools which can be combined with meaningful sequences to develop new models. In the secondary data analyses of the BEIP-GIS, a "Polygon-Overlay Analysis" for evaluation of the urban development potentiality are conducted. The process of the modeling analysis consists of the following steps;*

*1) Selection of Evaluation Criteria;*

2) *Application of a "Scoring System" given to the selected criteria;*

3) *Consideration of a "Weighting System" among the criteria in consideration of the significance of each criterion;*

4) *Combining and overlaying these different maps.*

*From Maps E-1 to E-5 are generated based on the above data processing. The basic criteria and each weighted score are as shown in Table 3. The characteristics of each output is described below.*

*E-1 Assessment on Natural Conditions*

*Map E-1 shows an overall assessment of the existing natural and physical conditions in BMA, overlaying the flood area map (A-4), the simulated land subsidence map (A-5) and the flood protection facilities map (A-6). Prior to the overlay analysis, each classified elements is weighted according to the importance of urban land use development. The total score was computed by each geographic units and finally classified into five categories.*

*The greater the score is given, the higher vulnerable to the natural disaster. Potentiality of the land subsidence is an significant element for the environmental management in the deltaic lowland area like Bangkok. Enlargement of inland water inundation due to the progress of land subsidence needs to be stopped with additional enforcement of drainage capability in the urbanized and/or would-be-urbanized areas.*

*E-2 Assessment on Urban Services*

*Map E-2 shows the assessment of accessibility (equi-distance) to major urban service facilities such as regional hospitals and main commercial centers/zones in BMA. These were calculated by the "buffer zone creation module" of GIS. For indication of the legend, the greater the score of an area is given, the better urban services the area may enjoy in Bangkok.*

*E-3 Assessment on Transport Services*

*Accessibility to trunk roads, railways and bus services are collectively computed to evaluate the level of transport services, by using the "buffer zone creation module" of GIS. The larger the score, the better accessibility area to the transportation services in Map E-3.*

*E-4 Assessment on Urban Sanitary Services*

*The geographic information of the water supply services (Map B-2) and the sewage services (Map B-5) are integrated and compiled for evaluation of the level of urban sanitary services. At present, the sewage service area is limited to the old central area, so the result of the overlay analysis is similar to the water service area map.*

*E-5 An overall Evaluation on Urbanization Suitability*

*An overall evaluation on "Urbanization Suitability" is made by overlaying with the above four (4) categories of the assessment, namely, Map E-1, E-2, E-3 and E-4. Totally thirteen (13) kinds of map data are integrated into this map. The yellow-shaded areas having a score more than 21 points are evaluated to be the most suitable areas for urban development, while the red-colored areas stand for being less suitable for urbanization under the present conditions. The intermediate areas are classified into three (3) zones according to levels of suitability for urbanization. It can be seen from the distribution pattern of the areas with higher suitability areas that the transportation networks are likely to be a key factor for future urbanization.*

*E-6 Simulated Urbanized Area (1995)*

*Based on the urbanization suitability analysis as shown in Map E-5, an "Urbanization Potential Model" was developed to simulate the urbanization process. The model is a Weighted Scoring Model with thirteen (13) factors same as the above, and calibrated so that the model can explain the existing state at more than 90% accuracy.*

*Map E-6 shows the result of the simulation analysis under the present conditions. For the simulation analysis, all the data are divided into 1 km x 1 km grid cells. Urbanization is taking place in the higher scored grid cells.*

*E-7 Future Urbanization Potential*

*The future urbanization potential, aiming at the year 2011, was simulated with the same model developed as above. is analysis. For this simulation model, the existing future plans of infrastructures such as water supply, sewage, road network and mass rapid transit systems are taken into consideration as new factors, besides the basic urban data. Thus, should the planned infrastructures be provided without any change in the institutional framework for urban growth management, the land potentials of urbanization will be distributed as shown in Map E-7. Higher urbanization potential areas are distributed around the marginal zones of the existing built-up area. Higher potential areas can be observed as a ribbon type of corridor which is extending to the outskirts of Bangkok.*

*E-8 Future Land Use Simulation (Trend Based Policy Free Case-1)*

*Map E-8 shows the most-likely urbanization pattern in the future. Based on the future urbanization potential model, a future urbanized land use pattern is simulated with the population of approximately 10.4 million in the year 2011. To this end, the future population density at newly built-up areas is assumed to be 110 person/ha, which is the same level as the present population density at the built-up areas in suburban*

*districts. Consequently, urbanization is expected to occur in the same direction as present, if no policies for urban growth control was undertaken on the urban spatial structure but the existing planned infrastructures be all provided.*

### *3.5 Simulation Analysis (Tertiary Data Analysis)*

*F-1 Traffic Simulation (Level of Road Traffic Congestion under Present Demands with Future Supplies)*

*This traffic simulation model tested the impact on the transport environment, if all the road projects and the mass transit proposed for the 8th national development plan had been completed at present in 1995. In this case, the level of congestion in terms of the length of congested roads decreases significantly in comparison to the presented situation. About 90% of all the road segments fall down into the level of "acceptable" or "under capacity". This analysis implies that the supply schedule of transport infrastructures was behind more than ten years.*

*F-2 Traffic Simulation (Level of Road Traffic Congestion under Future Demands with Supplies)*

*This traffic simulation analysis presents the most-likely case in the year 2011. The future trend-based demand was assigned onto the future transport network including all the 8th plan road projects and the mass transit systems. Unfortunately, the level of congestion in this case is not improved in comparison to the present level. Thus, this simulation suggests that additional transport facilities are inevitably required and that other effective transport measures such as the transport demand management and changes of urban structural systems should be introduced in the future to release such a anticipated pressure of traffic congestion.*

*F-3 Ambient Air Quality Simulation-1, and*

*F-4 Ambient Air Quality Simulation-2*

*The BEIP Air Pollutant Diffusion Model simulates annual arithmetic averages of major four (4) kinds of pollutants, namely, PM-10, CO, $SO_2$, NOx and $NO_2$, because the air pollution simulation under a short-time span, such as 1-hour-average, is likely to cause a great error. Grid cells (500m by 500m inside the Outer Ring Road and 1 km by 1 km outside it) are categorized into six groups by their simulated concentration, using the results of statistical analysis of existing monitoring data and ambient air standards of various time span.*

*Maps F-3 and F-4 present the simulation results of the future ambient air quality based on the present vehicle traffic volume as of 1995, given different conditions. In Map F-4, the following conditions differ from Map-3:*

- *Future Vehicle Emission Factors, reflecting the planned regulations both for New and In-use vehicles and the planned desulfurization of HSD;*
- *Future road network under the 8th National Plan; and*
- *Future mass transit system network under the Mass Transit Master Plan.*

*Most of the grid cells would not be rated as "Higher than the Standard" nor "Extremely Higher than the Standard". Vehicle regulations are considered to be the main factor to improve in this simulation.*

*F-5 Ambient Air Quality Simulation-3*

*The simulation analysis represented by Map F-5 was conducted under the condition of "Future Transport Demand under free urbanization of Bangkok". The increase of transport demand will offset the air pollution improvement by the planned policies shown in Map F-4. Moreover, new expressway (Ram Inthra-At Narong Expressway) will cause a new high concentration area.*

*F-6 Ambient Air Quality Simulation-4*

*The simulation analysis represented by Map F-5 was based on "Future Transport Demand given the development of "Sub-centers" recommended by the BEIP Study. This analysis is to be conducted to identify the impacts of the sub-center development on improvement of air quality. As the result, it can be said that the level of ambient air quality under the transport demand control by the sub-center development would be better than that under the case of "Free Urbanization of Map F-5". However, there would still exist grid cells over than the ambient air standard.*

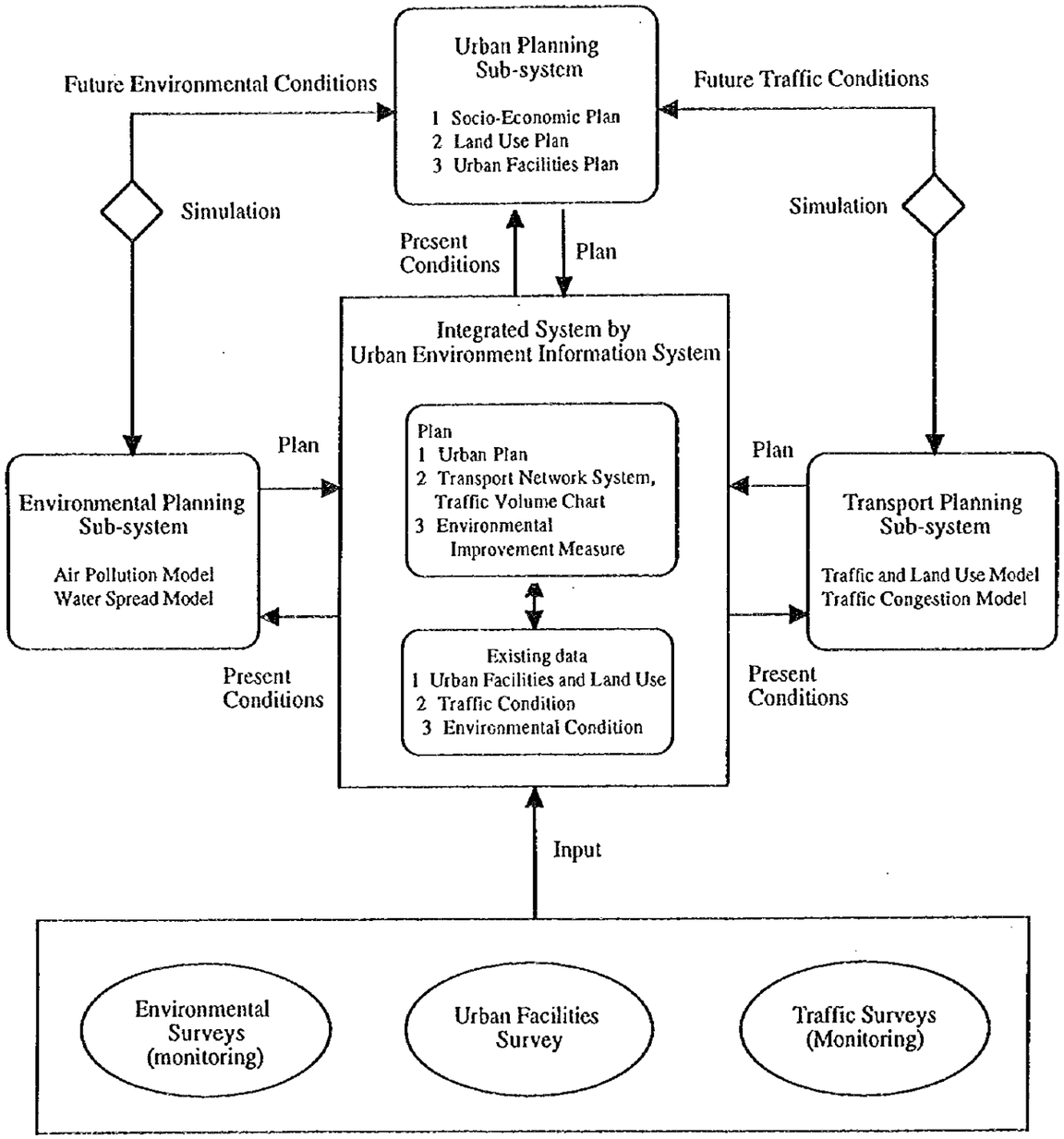



**Figure 1** Concept of Urban Environmental Information System

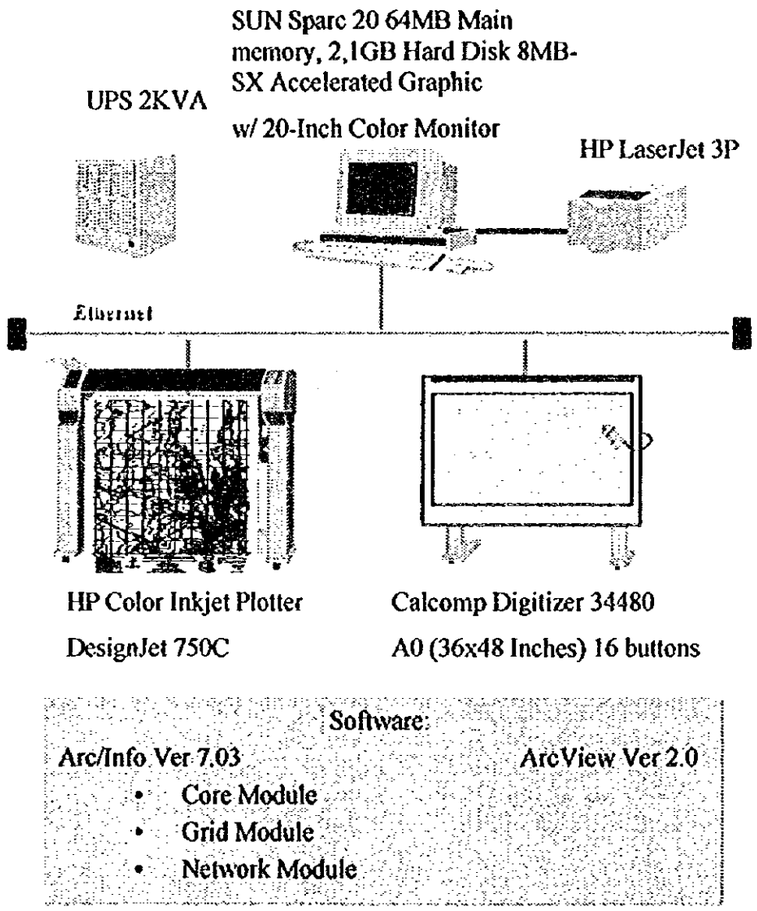



**Figure 2** System Configuration

## Table 1 Landuse Statistics per District

| DISTRICT NAME | HIGH DENSITY | MID DENSITY | LOW DENSITY | COMM-ERCIAL | INDUS-TRIAL | WARE-HOUSE | GOVERN MENTAL | AGRI-CULTUR | CONSER-VATION | PARK | SCHOOL | RE-LIGION | WATER BODY | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bang Kapi | 1.354 | 14.175 | 10.415 | 2.905 | 0.358 | 0 | 0.610 | 13.434 | 0 | 1.584 | 0.199 | 0 | 0 | 45.074 |
| Bang Khen | 0 | 7.300 | 8.077 | 0.836 | 0 | 0 | 8.399 | 53.256 | 0 | 0 | 0.037 | 0.438 | 0 | 78.343 |
| Bang Kho Laem | 0 | 5.434 | 0.151 | 0.552 | 0.090 | 0.388 | 0.115 | 0.312 | 0 | 0.130 | 0.033 | 0.100 | 1.153 | 8.458 |
| Bang Khun Thian | 0 | 9.663 | 10.963 | 0.187 | 0.910 | 0.040 | 0.018 | 134.339 | 0 | 0.011 | 0.116 | 0.103 | 0.203 | 156.553 |
| Bang Phlat | 0 | 4.089 | 4.222 | 0.959 | 0.038 | 0 | 0.016 | 1.454 | 0 | 0 | 0.085 | 0.048 | 0.947 | 11.858 |
| Bang Rak | 0 | 0.036 | 0 | 3.372 | 0 | 0 | 0.274 | 0 | 0 | 0.014 | 0.205 | 0.017 | 0.126 | 4.044 |
| Bang Sue | 7.435 | 1.289 | 0.851 | 0.746 | 0.693 | 0 | 0.161 | 1.211 | 0 | 0 | 0.091 | 0.012 | 0.596 | 13.085 |
| Bangkok Noi | 0.615 | 3.315 | 3.379 | 1.179 | 0 | 0 | 0.882 | 1.983 | 0 | 0 | 0.168 | 0.210 | 0.566 | 12.297 |
| Bangkok Yai | 0.085 | 3.680 | 0.157 | 0.864 | 0.128 | 0 | 0.137 | 0.653 | 0 | 0 | 0.173 | 0.175 | 0.189 | 6.241 |
| Bung Kum | 0.985 | 18.177 | 7.535 | 0.389 | 0.849 | 0 | 0.051 | 33.332 | 0 | 1.736 | 0.065 | 0 | 0 | 63.119 |
| Chatu Chak | 3.519 | 16.606 | 2.219 | 1.368 | 0.212 | 0 | 4.720 | 0.732 | 0 | 2.678 | 0.419 | 0 | 0.005 | 32.478 |
| Din Daeng | 0 | 6.493 | 0 | 1.025 | 0 | 0 | 0.483 | 0 | 0 | 0.128 | 0.349 | 0 | 0 | 8.478 |
| Don Muang | 0.035 | 15.245 | 6.451 | 0.525 | 0 | 0 | 15.586 | 20.284 | 0 | 0 | 0.447 | 0 | 0 | 58.573 |
| Dusit | 0.138 | 2.674 | 0.018 | 0.272 | 0.144 | 0 | 5.185 | 0 | 0.897 | 0.824 | 0.280 | 0.119 | 0.749 | 11.300 |
| Huai Khwang | 0 | 5.693 | 3.397 | 1.227 | 0 | 0 | 0.060 | 5.925 | 0 | 0 | 0.048 | 0 | 0 | 16.350 |
| Jomtong | 0.011 | 7.869 | 3.347 | 0.906 | 0.393 | 0 | 0.050 | 10.359 | 0 | 0 | 0.097 | 0.283 | 0.439 | 23.754 |
| Khlong San | 0 | 3.900 | 0 | 0.984 | 0.171 | 0.047 | 0.138 | 0.016 | 0 | 0 | 0.124 | 0.056 | 0.579 | 6.015 |
| Khlong Toei | 2.309 | 16.533 | 0.285 | 3.147 | 0.058 | 0.872 | 2.590 | 0.544 | 0 | 0.319 | 0.348 | 0 | 0.949 | 27.954 |
| Lat Phrao | 0.521 | 10.175 | 5.936 | 0.620 | 0.066 | 0 | 0.050 | 11.114 | 0 | 0 | 0.062 | 0 | 0 | 28.544 |
| Latkrabang | 0.153 | 2.314 | 7.012 | 0 | 2.088 | 0 | 0 | 116.979 | 0 | 0 | 0.027 | 0.020 | 0 | 128.593 |
| Minburi | 0.052 | 3.323 | 7.202 | 0.529 | 1.907 | 0 | 0.107 | 163.895 | 0 | 0 | 0.254 | 0 | 0 | 177.269 |
| Nong Chok | 0 | 0.452 | 5.656 | 0 | 0 | 0 | 0 | 234.948 | 0 | 0 | 0.000 | 0 | 0 | 241.056 |
| Nong Khaem | 0 | 5.071 | 9.530 | 0.143 | 0.746 | 0.012 | 0.490 | 30.622 | 0 | 0 | 0.138 | 0.203 | 0 | 46.955 |
| Pathumwan | 0.120 | 0.375 | 0.024 | 3.093 | 0 | 0 | 1.709 | 0.073 | 0 | 1.265 | 1.355 | 0 | 0.066 | 8.080 |
| Phasi Charoen | 0.006 | 16.748 | 3.523 | 1.467 | 0.436 | 0.196 | 0.101 | 33.286 | 0 | 0 | 0.430 | 0.254 | 0.175 | 56.622 |
| Phaya Thai | 0 | 7.989 | 0 | 0.289 | 0 | 0 | 0.529 | 0 | 0 | 0.112 | 0.061 | 0 | 0.093 | 9.073 |
| Phra Khanong | 1.424 | 23.853 | 0.767 | 0.789 | 0.239 | 1.356 | 0.332 | 3.738 | 0 | 0 | 0.520 | 0 | 0.924 | 33.942 |
| Phra Nakhon | 0.196 | 0.244 | 0.066 | 2.065 | 0.017 | 0 | 0.778 | 0 | 0.294 | 0.360 | 0.333 | 0.442 | 0.601 | 5.396 |
| Pom Prap Sattrupha | 0.181 | 0.054 | 0 | 1.569 | 0 | 0 | 0.240 | 0.017 | 0 | 0 | 0.154 | 0.171 | 0.058 | 2.444 |
| Prawet | 0 | 13.125 | 11.399 | 0.921 | 0.814 | 0 | 0 | 38.497 | 0 | 0.579 | 0.024 | 0 | 0.117 | 65.476 |
| Ratburana | 0.387 | 10.048 | 2.129 | 0.993 | 0.546 | 0.464 | 0.279 | 30.235 | 0 | 0.083 | 0.248 | 0.187 | 1.426 | 46.725 |
| Ratchathewi | 0.495 | 1.375 | 0.466 | 1.467 | 0 | 0 | 2.605 | 0.167 | 0 | 0.140 | 0.453 | 0 | 0.052 | 7.225 |
| Samphanthawong | 0 | 0 | 0 | 1.033 | 0 | 0 | 0.055 | 0 | 0 | 0 | 0.026 | 0.123 | 0.172 | 1.409 |
| Sathon | 0.003 | 5.020 | 0 | 0.814 | 0.140 | 0.098 | 0.594 | 0.096 | 0 | 0.018 | 0.298 | 0.039 | 0.131 | 7.251 |
| Suan Luang | 0 | 9.272 | 4.201 | 0.492 | 0.025 | 0 | 0.017 | 6.090 | 0 | 0.121 | 0.247 | 0 | 0.276 | 20.741 |
| Taling Chan | 0 | 5.435 | 15.712 | 0 | 0 | 0 | 0.026 | 65.153 | 0 | 0 | 0.221 | 0.300 | 0.755 | 87.602 |
| Thonburi | 0.143 | 5.202 | 0.107 | 1.348 | 0.072 | 0.114 | 0.140 | 0.200 | 0 | 0 | 0.136 | 0.198 | 0.477 | 8.133 |
| Yan Nawa | 1.166 | 6.957 | 0.229 | 0.595 | 0.087 | 0.879 | 0.214 | 0.526 | 0 | 0.025 | 0.099 | 0.054 | 1.574 | 12.405 |
| Total | 21.333 | 269.203 | 135.426 | 39.670 | 11.267 | 4.466 | 47.741 | 1013.470 | 1.191 | 10.127 | 8.370 | 3.548 | 13.103 | 1578.915 |

Unit : $km^2$

## Table 3 Criteria and Weighted Score for Urban Development Potential Evaluation

| Evaluation Condition | | Score | -3 | -2 | -1 | 0 |
|---|---|---|---|---|---|---|
| Physical Constraint | N1 | Ground Subsidence | >1.5m | 1.0 - 1.5m | 0 - 1.0m | 0m |
| | N2 | Inundation by 1983 Flood | Yes | | | No |
| | N3 | Inundation by 1995 Flood | Yes | | | No |
| | N4 | Flood Protection Zone *1) | A zone | B zone | C zone | Others |

| Evaluation Condition | | Score | 1 | 0 |
|---|---|---|---|---|
| Urban Environment | U1 | Water Services | Yes | No |
| Services | U2 | Sewerage Services | Yes | No |

| Evaluation Condition | | Score | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| Transportation | T1 | Accessibility to Trunk Roads | 0.5km of R1/R2 | 1km of R1/R2 | 0.5km of R3 | 1km of R3 | None |
| Services | T2 | Accessibility to Railways | 0.5km from STN | 1km from STN | 1.5km from STN | 2km from STN | None |
| | T3 | Accessibility to Bus Services | 500m zone | | 1000m zone | | None |

| Evaluation Condition | | Score | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| Living Facilities | F1 | Accessibility to Hospitals | <1km | 1 - 2km zone | 2 - 3km zone | 3 - 5km zone | >5km |
| Services | F2 | Accessibility to Commercial | <2km | 2 - 5km zone | 5-10km zone | 10-15km zone | >15km |

*1) A : Eastern King's Dike
B : Inner Dike - King's Dike
C : Tonburi Lowlands

*2) R1 : Primary Road
R2 : Secondary Road
R3 : Trough Road

## Table 2 : Sub-district Statistics Produced by GIS Data Manipulation

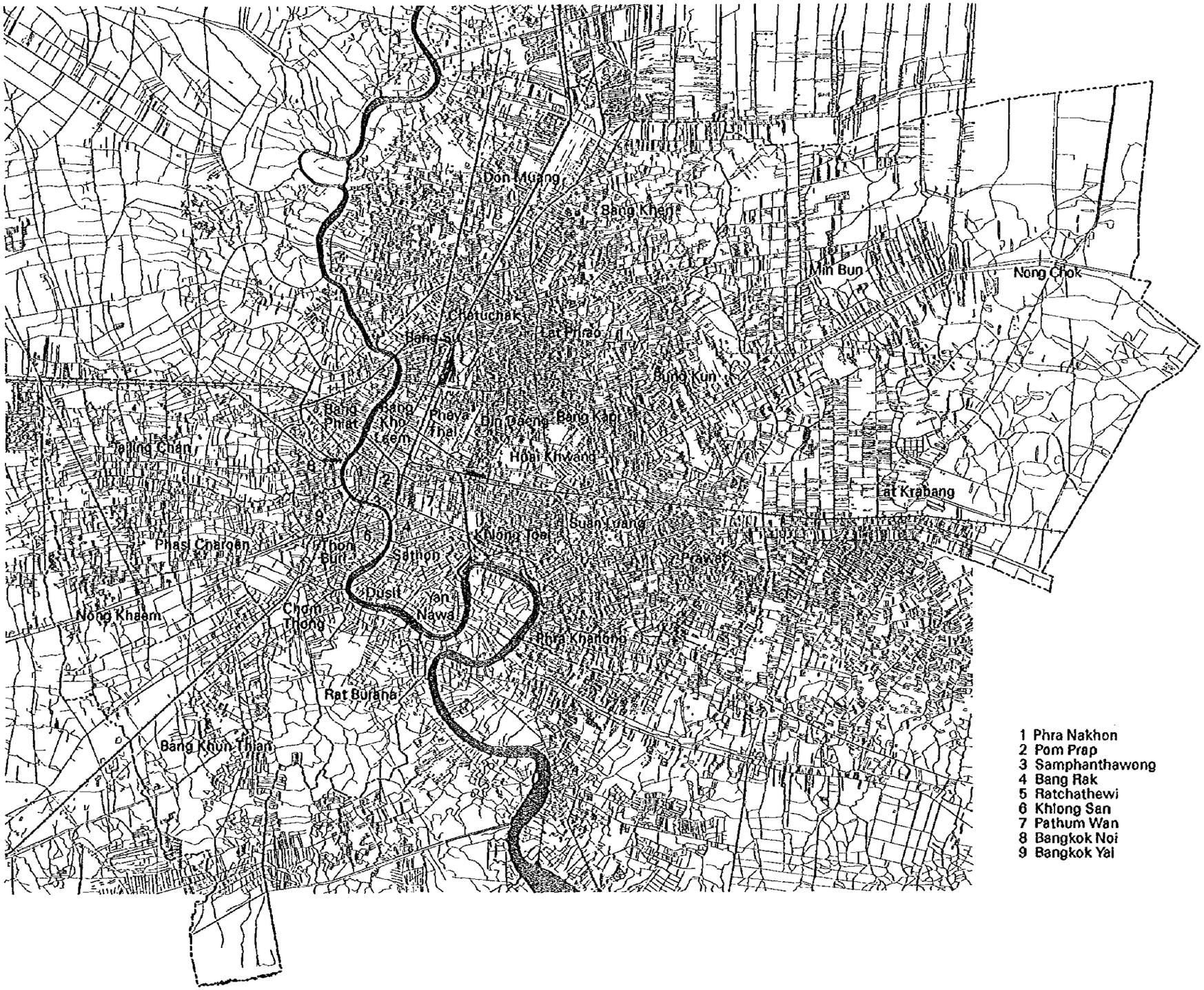
| District | Sub-District | Code | Area (km2) | Build Area (km2) | P_Density Gross (per Km2) | P_Density Net (per Km2) | Increase Rate (%) | Open Space (%) | Build-up Rate(%) | R_Density Gross (rai/Ha) | R_Density Net (rai/Ha) | Soi Density (no/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bang Kapi | Hua Mak | 103203 | 15 70 | 8 27 | 7,575 | 14,376 | 5 92 | 37 22 | 52 70 | 95 | 181 | 88 87 |
| | Khlong Chan | 103201 | 12 43 | 8 52 | 10,061 | 14,645 | 4 94 | 31 30 | 68 70 | 116 | 168 | 93 23 |
| | Wang Thong Lang | 103202 | 16 97 | 13 26 | 8,523 | 10,905 | 6 00 | 21 85 | 78 15 | 118 | 153 | 89 23 |
| Bang Khen | Anusawari | 101401 | 15 68 | 13 99 | 6,300 | 7,065 | 9 55 | 10 83 | 89 17 | 101 | 113 | 87 25 |
| | Khlong Thanon | 101402 | 16 90 | 3 32 | 10,541 | 53,698 | 15 84 | 80 37 | 19 63 | 72 | 367 | 84 30 |
| | O-ngoen | 101405 | 13 62 | 0 82 | 480 | 7,953 | 9 97 | 93 97 | 6 03 | 24 | 401 | 68 59 |
| | Sai Mai | 101404 | 14 00 | 1 84 | 3,218 | 28,233 | 12 90 | 86 83 | 13 17 | 55 | 422 | 83 86 |
| | Tha Raeng | 101403 | 18 14 | 5 12 | 2,259 | 8,150 | 13 82 | 71 79 | 28 21 | 41 | 145 | 87 79 |
| Bang Kho Laem | Bang Khlo | 101503 | 4 71 | 4 02 | 14,941 | 17,506 | 2 15 | 2 89 | 85 35 | 66 | 77 | 68 67 |
| | Bang Kho laem | 101502 | 2 14 | 1 48 | 13,776 | 19,882 | 2 26 | 6 99 | 69 29 | 59 | 86 | 71 64 |
| | Wat Paya Kri | 101501 | 1 61 | 1 36 | 27,590 | 32,589 | 1 75 | 1 60 | 84 66 | 66 | 79 | 73 53 |
| Bang Khun Thian | Bang Bon | 101303 | 35 36 | 8 25 | 2,687 | 11,511 | 10 21 | 76 62 | 23 35 | 25 | 108 | 79 98 |
| | Samae Dam | 101305 | 45 93 | 11 39 | 2,357 | 9,502 | 10 56 | 74 99 | 24 81 | 35 | 141 | 80 93 |
| | Tha Kham | 101302 | 35 27 | 2 35 | 384 | 12,283 | 6 32 | 96 73 | 3 13 | 19 | 617 | 88 41 |
| Bang Phlat | Bang O | 101704 | 3 08 | 1 92 | 25,310 | 40,591 | 17 65 | 25 16 | 62 35 | 58 | 93 | 87 30 |
| | Bang Phanru | 101702 | 2 40 | 2 27 | 10,149 | 10,748 | -1 45 | 5 57 | 94 43 | 91 | 96 | 86 51 |
| | Bang Phlat | 101701 | 3 33 | 2 59 | 13,175 | 16,902 | -6 39 | 16 39 | 77 95 | 99 | 127 | 80 95 |
| | Bang Yikhan | 101703 | 3 04 | 2 67 | 33,111 | 37,736 | 19 22 | 0 00 | 87 74 | 73 | 84 | 76 65 |
| Bang Rak | Bang Rak | 101802 | 0 48 | 0 35 | 27,838 | 37,758 | 15 83 | 0 00 | 73 73 | 56 | 75 | 55 11 |
| | Maha Phruttharam | 101803 | 0 65 | 0 64 | 78,122 | 78,981 | 15 16 | 0 00 | 98 91 | 120 | 121 | 58 65 |
| | Si Lom | 101804 | 1 56 | 1 55 | 17,345 | 17,411 | 9 69 | 0 00 | 99 62 | 88 | 89 | 19 72 |
| | Si Phraya | 101801 | 0 76 | 0 76 | 80,568 | 80,568 | 21 45 | 0 00 | 100 00 | 96 | 96 | 53 21 |
| | Suriwong | 101805 | 0 60 | 0 60 | 20,293 | 20,293 | 8 76 | 0 00 | 100 00 | 133 | 133 | 59 46 |
| Bang Sue | Bang Sue | 101601 | 13 09 | 11 28 | 25,883 | 30,030 | 2 35 | 9 26 | 86 19 | 100 | 117 | 81 87 |
| Bangkok Noi | Arun Amarin | 101005 | 2 94 | 2 73 | 24,073 | 25,926 | 0 00 | 1 43 | 92 85 | 63 | 68 | 83 36 |
| | Ban chang Lo | 101004 | 2 32 | 2 22 | 25,933 | 27,095 | -2 21 | 2 89 | 95 86 | 84 | 87 | 60 58 |
| | Bang Khun Non | 101002 | 1 65 | 1 33 | 6,138 | 7,630 | -12 62 | 14 11 | 80 45 | 53 | 66 | 77 88 |
| | Bang Khun Si | 101003 | 4 00 | 2 31 | 15,369 | 27,390 | 5 31 | 40 91 | 57 57 | 57 | 100 | 92 00 |
| | Sirirat | 101001 | 1 38 | 1 16 | 34,131 | 40,567 | 10 77 | 0 00 | 84 14 | 63 | 75 | 57 75 |
| Bangkok Yai | Wat Arun | 101102 | 0 86 | 0 76 | 31,834 | 35,869 | 4 86 | 0 00 | 88 75 | 79 | 89 | 68 98 |
| | Wat Tha Phra | 101101 | 5 39 | 4 64 | 14 248 | 16,539 | 0 52 | 0 00 | 86 15 | 75 | 87 | 81 03 |
| Bang Kum | Khanna Yao | 103902 | 21 31 | 6 93 | 2,266 | 6,971 | 5 53 | 59 35 | 32 51 | 53 | 163 | 88 66 |
| | Khlong Kum | 101901 | 24 85 | 14 00 | 6,089 | 10,810 | 6 91 | 43 67 | 56 33 | 95 | 169 | 93 94 |
| | Saphan Sung | 101903 | 16 96 | 7 13 | 3,046 | 7,249 | 7 37 | 57 98 | 42 02 | 65 | 154 | 87 79 |
| Chatu Chak | Lat Yao | 100401 | 32 48 | 29 06 | 7,011 | 7,835 | 2 04 | 2 25 | 89 49 | 113 | 126 | 86 07 |
| Din Daeng | Din Daeng | 103701 | 8 48 | 8 35 | 32,538 | 33,036 | 22 79 | 0 00 | 98 49 | 158 | 161 | 87 22 |
| Don Muang | Si Kan | 100603 | 29 69 | 11 20 | 4,757 | 8,791 | 8 22 | 45 83 | 54 12 | 79 | 145 | 89 01 |
| | Talat Bang Khen | 100602 | 21 24 | 16 18 | 4,133 | 5,426 | 7 30 | 23 82 | 76 18 | 60 | 79 | 74 54 |
| | Thong Song Hong | 100601 | 16 64 | 10 91 | 6,757 | 10,305 | 9 36 | 34 44 | 65 56 | 97 | 148 | 95 14 |
| Dusit | Dusit | 100701 | 2 36 | 1 96 | 20,156 | 24,196 | 3 59 | 0 00 | 83 30 | 74 | 89 | 40 71 |
| | Si Yak Maharak | 100705 | 0 37 | 0 36 | 49,354 | 50,912 | 1 70 | 0 00 | 96 94 | 84 | 87 | 37 50 |
| | Suan Chitlada | 100704 | 1 88 | 0 55 | 14,530 | 49,553 | -0 97 | 0 02 | 29 32 | 60 | 206 | 17 41 |
| | Thanon Nakhon Chaisi | 100702 | 5 57 | 5 12 | 32,298 | 35,162 | 2 43 | 0 00 | 91 85 | 86 | 93 | 60 54 |
| | Wachira Phayabarn | 100703 | 1 13 | 0 84 | 26,608 | 35,697 | 1 98 | 0 00 | 74 54 | 64 | 86 | 54 68 |
| Huai Khwang | Bang Kapi | 103603 | 6 13 | 3 15 | 1,101 | 2,139 | -22 34 | 48 55 | 51 45 | 56 | 108 | 73 91 |
| | Huai Khwang | 103601 | 4 88 | 2 73 | 9,611 | 16,431 | -13 75 | 44 14 | 55 86 | 82 | 140 | 83 49 |
| | Samsen Nok | 103604 | 5 34 | 4 55 | 5,281 | 6,207 | -6 93 | 14 92 | 85 08 | 129 | 152 | 86 35 |
| Jomtong | Bang Kho | 100501 | 3 41 | 1 57 | 15,126 | 32,823 | 1 83 | 26 80 | 46 08 | 55 | 119 | 88 28 |
| | Bang Khun Thian | 100503 | 6 09 | 3 94 | 7,539 | 11,653 | 2 84 | 34 61 | 64 69 | 39 | 60 | 81 16 |
| | Bang Mot | 100504 | 8 85 | 4 69 | 5,074 | 9,579 | 6 66 | 44 93 | 52 97 | 28 | 53 | 60 15 |
| | Chom Thong | 100502 | 5 40 | 2 75 | 10,903 | 21,378 | 4 58 | 45 66 | 51 03 | 35 | 70 | 67 40 |
| Khlong San | Bang Lam Phu Lang | 100303 | 2 25 | 2 01 | 22,876 | 25,648 | 4 55 | 0 00 | 89 19 | 78 | 88 | 81 07 |
| | Klong San | 100301 | 1 08 | 0 94 | 29,996 | 34,236 | 4 80 | 0 00 | 87 62 | 63 | 72 | 52 40 |
| | Klong Ton Sai | 100302 | 1 74 | 1 61 | 19,992 | 21,705 | 0 90 | 0 00 | 92 11 | 84 | 91 | 51 19 |
| | Somdet Chaophraya | 100304 | 0 94 | 0 86 | 27,275 | 29,833 | 1 08 | 1 64 | 91 43 | 112 | 123 | 57 64 |
| Khlong Toei | Klong Tan | 100202 | 11 34 | 10 86 | 7,616 | 7,959 | -2 55 | 4 03 | 95 69 | 129 | 135 | 83 93 |
| | Klong Toei | 100201 | 9 02 | 8 13 | 14,692 | 16,309 | 6 10 | 0 01 | 90 08 | 98 | 109 | 64 68 |
| | Phra Khanong | 100203 | 7 59 | 7 16 | 11,547 | 12,238 | 1 68 | 1 14 | 93 35 | 117 | 124 | 81 04 |
| Lat Phrao | Chorakhe Bua | 103102 | 14 47 | 7 14 | 4,629 | 9,332 | 5 72 | 50 61 | 49 39 | 106 | 215 | 87 65 |
| | Lat Phrao | 103101 | 14 08 | 10 28 | 6,899 | 9,443 | 6 24 | 26 94 | 73 06 | 118 | 162 | 90 45 |
| Latkrabang | Khlong Sam Prawet | 103004 | 17 44 | 0 84 | 457 | 9,474 | 12 03 | 95 18 | 4 82 | 36 | 741 | 82 04 |
| | Khlong Song Tonnun | 103003 | 16 17 | 1 63 | 2,210 | 21,977 | 16 91 | 89 55 | 10 05 | 42 | 417 | 92 09 |
| | Khum Thong | 103002 | 26 62 | 1 38 | 284 | 5,466 | 7 38 | 94 81 | 5 19 | 4 | 69 | 0 00 |
| | Lam Prathiu | 103006 | 33 28 | 2 69 | 558 | 6,901 | 9 71 | 91 91 | 8 09 | 31 | 383 | 72 09 |
| | Lat Krabang | 103001 | 10 73 | 3 74 | 3,593 | 10,292 | 5 68 | 65 09 | 34 91 | 70 | 200 | 84 30 |
| | Thap Yao | 103005 | 24 36 | 1 33 | 630 | 11,543 | 8 32 | 94 54 | 5 46 | 18 | 324 | 76 42 |
| Minburi | Bang Chan | 102604 | 22 60 | 3 53 | 1,637 | 10,735 | 14 76 | 84 38 | 15 62 | 47 | 302 | 74 37 |
| | Minburi | 102601 | 20 26 | 5 99 | 4,364 | 14,732 | 13 48 | 70 46 | 29 54 | 58 | 189 | 82 57 |
| | Sai Kongdin | 102602 | 13 19 | 0 35 | 453 | 17,122 | 11 48 | 97 35 | 2 65 | 25 | 929 | 75 83 |
| | Sai Kongdin Tai | 102603 | 16 17 | 0 87 | 610 | 11,324 | 8 67 | 94 61 | 5 39 | 42 | 777 | 82 56 |
| | Saniwa Tawanok | 102606 | 40 08 | 0 57 | 274 | 19,240 | 8 31 | 98 57 | 1 43 | 21 | 1,474 | 85 15 |
| | Saniwa Tawantok | 102605 | 28 72 | 0 77 | 233 | 8,631 | 8 14 | 97 30 | 2 70 | 20 | 758 | 80 79 |
| | Sansaep | 102607 | 36 24 | 1 29 | 717 | 20,130 | 10 87 | 96 44 | 3 56 | 31 | 864 | 77 10 |

| District | Sub-District | Code | Area (km2) | Build Area (km2) | P_Density Gross (per Km2) | P_Density Net (per Km2) | Increase Rate (%) | Open Space (%) | Build-up Rate(%) | R_Density Gross (rai/Ha) | R_Density Net (rai/Ha) | Soi Rate (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nong Chok | Khlong Sip | 103502 | 30.70 | 0 29 | 274 | 29,322 | 9 13 | 99.06 | 0 94 | 10 | 1,069 | 51.56 |
| | Khlong Sip Song | 103503 | 41 31 | 1 08 | 193 | 7,379 | 9 39 | 97.39 | 2 61 | 7 | 279 | 0 00 |
| | Khok Faet | 103505 | 21 54 | 0 93 | 760 | 17,585 | 13.29 | 95.68 | 4 32 | 10 | 224 | 38 36 |
| | Khu Fang Nua | 103504 | 18 00 | 0 14 | 443 | 55,455 | 10 08 | 99 20 | 0 80 | 22 | 2,802 | 72 57 |
| | Krathum Rai | 103501 | 40 39 | 0.77 | 557 | 29,245 | 11.01 | 98 09 | 1 91 | 7 | 368 | 0 00 |
| | Lam Plak Chi | 103507 | 33 30 | 1 02 | 286 | 9,345 | 10 33 | 96 93 | 3 07 | 8 | 245 | 24 02 |
| | Lam Toi Ting | 103506 | 24.99 | 0 52 | 299 | 14,458 | 8 40 | 97.93 | 2 07 | 5 | 243 | 0 00 |
| | Nong Chok | 103508 | 30 82 | 1 36 | 422 | 9,572 | 9 58 | 95.59 | 4.41 | 9 | 158 | 0 00 |
| Nong Khaem | Lak Song | 103403 | 17.83 | 5 84 | 3,109 | 9,497 | 8.43 | 67 27 | 32 73 | 33 | 112 | 93 99 |
| | Nong Khaem | 103402 | 14 68 | 5 21 | 2,293 | 6,467 | 11 27 | 64.54 | 35.46 | 39 | 110 | 100 00 |
| | Nong Khang Phlu | 103401 | 14.44 | 5 29 | 3,809 | 10,396 | 14 74 | 63.36 | 36 64 | 37 | 155 | 89 59 |
| Pathumwan | Pathumwan | 102002 | 2 11 | 1 59 | 32,184 | 42,700 | 13 88 | 3.47 | 75.37 | 39 | 51 | 39 45 |
| | Rong Muang | 102003 | 1 25 | 1 21 | 68,873 | 71,022 | 12 23 | 0 00 | 96.91 | 104 | 108 | 37 22 |
| | Suan Lumphini | 102004 | 3 40 | 2 27 | 25,175 | 30,878 | 17 59 | 0 00 | 81 53 | 77 | 94 | 51 67 |
| | Wang Mai | 102001 | 1 33 | 1 11 | 38,952 | 46,647 | 12.63 | 0 00 | 83.50 | 128 | 153 | 60.11 |
| Phasi Charoen | Bang Chak | 102504 | 1.40 | 0.39 | 5,730 | 20,563 | 4.17 | 72 13 | 27 87 | 21 | 76 | 59.45 |
| | Bang Duan | 102507 | 4 25 | 1 19 | 8,964 | 31,974 | 2 51 | 71 97 | 28 03 | 40 | 143 | 82 67 |
| | Bang Khae | 102505 | 8 00 | 4.04 | 6,150 | 12,183 | 4 96 | 49 52 | 50 48 | 35 | 69 | 67.19 |
| | Bang Khae Nua | 102506 | 13 52 | 5.45 | 5,259 | 13,053 | 6 33 | 59.71 | 40 29 | 44 | 109 | 82 92 |
| | Bang Phai | 102508 | 15 96 | 5.14 | 2,425 | 6,606 | 5 91 | 67.81 | 32 17 | 44 | 136 | 69.35 |
| | Bang Wa | 102501 | 5 53 | 2 79 | 8,405 | 16,646 | 3.82 | 49 50 | 50 50 | 34 | 67 | 51.39 |
| | Bang Wack | 102509 | 2 90 | 1 20 | 7,859 | 18,983 | 4.48 | 56 03 | 43.40 | 50 | 121 | 72 69 |
| | Khlong Kwang | 102502 | 2 63 | 0 87 | 3,486 | 10,484 | 4.74 | 65.74 | 33 25 | 24 | 73 | 60 30 |
| | Khuhasawan | 102503 | 0.71 | 0.47 | 12,981 | 19,694 | 1 25 | 30.61 | 65.93 | 54 | 82 | 94 33 |
| | Pak Khlong Pasicharoen | 102510 | 1.72 | 1 62 | 15,585 | 16,550 | -0 16 | 3.35 | 94.17 | 80 | 85 | 78 19 |
| Phaya Thai | Samsen Nai | 102301 | 9.07 | 8 87 | 27,997 | 28,644 | 2 94 | 0 00 | 97.74 | 107 | 109 | 74 80 |
| Phra Khanong | Bang Chak | 102401 | 15 19 | 14 54 | 8,751 | 9,139 | 6 28 | 1.45 | 95.76 | 132 | 138 | 80 92 |
| | Bang Na | 102402 | 18 75 | 14.74 | 6,580 | 8,501 | 5 04 | 18 75 | 78 58 | 112 | 143 | 78 08 |
| Phra Nakhon | Ban Phan Thom | 100106 | 0 41 | 0 39 | 32,382 | 33,535 | -0.49 | 0 00 | 95.56 | 144 | 149 | 75 35 |
| | Bang Khun Phrom | 100105 | 0.45 | 0.44 | 20,438 | 20,837 | 0 59 | 0 00 | 98 09 | 74 | 76 | 57.13 |
| | Bowon Niwet | 100104 | 0.49 | 0.46 | 23,051 | 24,594 | 1 53 | 0 00 | 93 73 | 139 | 149 | 51.77 |
| | Chana Songkhram | 100102 | 0.35 | 0 28 | 14,025 | 17,529 | -0 99 | 0 00 | 80 01 | 134 | 142 | 46 10 |
| | Phra Borom Maha Ratchawang | 100107 | 1 53 | 0 81 | 6,051 | 11,460 | 0.98 | 0 00 | 52 80 | 66 | 125 | 15 86 |
| | San Ran Rat | 100111 | 0 22 | 0 16 | 30,880 | 43,285 | -0.90 | 0 00 | 71 34 | 81 | 114 | 38 72 |
| | San Chao Phor Sua | 100110 | 0.15 | 0 14 | 41,594 | 44,118 | 0 56 | 0.00 | 94.28 | 111 | 117 | 65.09 |
| | Sao Chingcha | 100112 | 0 16 | 0 13 | 33,898 | 41,760 | 0 32 | 0 00 | 81.27 | 130 | 160 | 59.16 |
| | Talad Yot | 100103 | 0 19 | 0.17 | 34,011 | 37,635 | -0.12 | 0 00 | 90.37 | 122 | 135 | 79.19 |
| | Wang Burapha Phirom | 100108 | 0 70 | 0 57 | 29,945 | 37,068 | 1 51 | 0 00 | 80 92 | 135 | 166 | 24.20 |
| | Wat Ratchabophit | 100109 | 0 22 | 0 21 | 28,357 | 31,000 | 1 36 | 0 00 | 92.26 | 162 | 175 | 52.39 |
| | Wat Sam Phraya | 100101 | 0 52 | 0 38 | 14,756 | 16,028 | -1 00 | 0 00 | 73.35 | 71 | 97 | 52 24 |
| Pom Prap Sattrupha | Ban Baht | 102204 | 0.40 | 0.38 | 79,786 | 84,544 | 19 87 | 0 00 | 94.37 | 111 | 118 | 13 61 |
| | Khong Mahanark | 102202 | 0 58 | 0 54 | 84,842 | 91,297 | 22 31 | 2 87 | 92 93 | 97 | 104 | 66.12 |
| | Pomprab Satruphe | 102205 | 0 59 | 0 59 | 94,052 | 94,065 | 15 57 | 0 00 | 99 99 | 165 | 165 | 55.35 |
| | Wat Debsirin | 102203 | 0.43 | 0.43 | 77,014 | 77,145 | 21.41 | 0 00 | 99 83 | 168 | 168 | 61.67 |
| | Wat Soammanut | 102201 | 0.45 | 0 44 | 65,443 | 67,109 | 19 27 | 0 00 | 97 52 | 146 | 150 | 38 89 |
| Prawet | Dok Mai | 102102 | 14.95 | 4 67 | 1,400 | 4,483 | 12 43 | 68.78 | 31 22 | 65 | 207 | 85.12 |
| | Nong Bon | 102103 | 12 89 | 8 10 | 3,579 | 5,690 | 5 64 | 36 61 | 62 90 | 89 | 141 | 86.60 |
| | Prawet | 102101 | 37 64 | 13 51 | 2,558 | 7,128 | 7 01 | 62 43 | 35 89 | 66 | 184 | 92 25 |
| Ratburana | Bang Mot | 102904 | 11 41 | 3.30 | 4,778 | 16,511 | 10 65 | 70 17 | 28 94 | 26 | 91 | 61.74 |
| | Bang Pakok | 102903 | 8 04 | 4.59 | 11,771 | 20,613 | 5 81 | 36.20 | 57.11 | 37 | 64 | 66 18 |
| | Ratburana | 102901 | 5 61 | 4 02 | 15,583 | 21,780 | -29 29 | 84.41 | 71.55 | 54 | 75 | 66 15 |
| | Thung Khru | 102902 | 21 66 | 3 37 | 2,219 | 14,267 | 10 30 | 84.44 | 15.55 | 8 | 52 | 67.38 |
| Ratchathewi | Makkasan | 102804 | 2 47 | 2 39 | 22,893 | 23,717 | 13.35 | 0.00 | 96.53 | 92 | 95 | 70 03 |
| | Thanon Phaya Thai | 102801 | 1 25 | 1 25 | 27,152 | 27,251 | 19 55 | 0 00 | 99.64 | 116 | 116 | 60 61 |
| | Thanon Phetcha Buri | 102802 | 0.99 | 0 85 | 49,346 | 57,013 | 13.26 | 9.91 | 86.55 | 79 | 91 | 61.58 |
| | Thung Phaya Thai | 102803 | 2 51 | 2 37 | 47,900 | 50,737 | 31 68 | 2.43 | 94.41 | 72 | 76 | 65 16 |
| Samphanthawong | Chakkrawat | 103202 | 0 51 | 0 44 | 42,914 | 50,164 | 11 29 | 0 00 | 85.55 | 124 | 145 | 54 20 |
| | Sam Phanthawong | 103203 | 0.49 | 0.44 | 39,792 | 43,898 | 11 94 | 0 00 | 90 83 | 130 | 143 | 44 30 |
| | Talat Noi | 103201 | 0 41 | 0 35 | 78,650 | 90,409 | 15.14 | 0 00 | 87 00 | 72 | 82 | 32 23 |
| Sathon | Thung Mahamek | 103302 | 2.91 | 2.91 | 10,582 | 10,582 | 1 56 | 0 00 | 100 00 | 107 | 107 | 74 63 |
| | Thung Wardon | 103303 | 2 52 | 2 42 | 25,501 | 26,511 | 1 55 | 3 81 | 96 19 | 75 | 78 | 55.74 |
| | Yannawa | 103301 | 1 83 | 1 68 | 23,015 | 25,055 | -0 12 | 0 00 | 91 86 | 83 | 95 | 66.53 |
| Suan Luang | Suan Luang | 103831 | 20.74 | 14 25 | 7,806 | 11,358 | 7.45 | 29.35 | 68.72 | 83 | 128 | 87.65 |
| Taling Chan | Bang Chuak Nang | 100805 | 6.95 | 0.71 | 1,455 | 14,167 | 8 20 | 87.66 | 10 27 | 15 | 149 | 49 85 |
| | Bang Phrom | 100806 | 5.13 | 0 66 | 3,267 | 25,206 | 7.09 | 84.61 | 12 96 | 22 | 168 | 63 93 |
| | Bang Ramat | 100807 | 15 36 | 3 21 | 1,444 | 6,916 | 8.37 | 78.58 | 20 88 | 26 | 126 | 73.35 |
| | Chim Phli | 100802 | 15.49 | 6 00 | 2,631 | 6,795 | 10.72 | 60 60 | 38 72 | 46 | 119 | 63 35 |
| | Khlong Chak Phra | 100801 | 2 54 | 1.42 | 5,455 | 9,751 | 9.14 | 39.40 | 55 95 | 39 | 70 | 53 81 |
| | Sala Thammasop | 100808 | 19 53 | 3.94 | 1,146 | 5,681 | 14.91 | 79 83 | 20 18 | 30 | 149 | 67.58 |
| | Taling Chan | 100803 | 6 01 | 3 83 | 5,429 | 8,519 | 6 63 | 33 20 | 63.72 | 37 | 58 | 66.33 |
| | Thawi Watthana | 100804 | 16 60 | 1.92 | 787 | 6,801 | 9.42 | 88.42 | 11.58 | 25 | 216 | 67 94 |
| Thonburi | Bang Yirua | 100901 | 1 19 | 1.17 | 47,978 | 48,846 | 0.07 | 0 00 | 98 22 | 76 | 77 | 66 54 |
| | Bukkhalo | 100903 | 4 30 | 3.90 | 34,548 | 38,054 | 2 38 | 1 61 | 90 79 | 77 | 85 | 70 94 |
| | Hiranruchi | 100905 | 0 66 | 0 65 | 40,244 | 41,079 | 1 52 | 0 00 | 97.97 | 90 | 92 | 87 27 |
| | Talat Phlu | 100902 | 1 24 | 1 09 | 32,607 | 37,129 | 0.45 | 0 00 | 87 82 | 65 | 73 | 51 80 |
| | Wat Kaidaya | 100904 | 0.75 | 0 65 | 32,042 | 36,783 | 4.34 | 0 00 | 87.11 | 56 | 64 | 37 65 |
| Yan Nawa | Bang Phong Pang | 102702 | 4.96 | 3.74 | 12,220 | 16,229 | 6 73 | 7.59 | 75 30 | 57 | 76 | 62 07 |
| | Chong Nonsi | 102701 | 7.44 | 6 54 | 12,384 | 14,083 | 9.49 | 2 01 | 87.93 | 71 | 81 | 59 30 |
| Grand Total | BMA | | 1,578.91 | 541.02 | | | | | | | | |

BEIP-GIS

# EXISTING CONDITIONS (BASIC DATA)

PACIFIC CONSULTANTS INTERNATIONAL
SUURI-KEIKAKU CO., LTD.




1 Phra Nakhon
2 Pom Prap
3 Samphanthawong
4 Bang Rak
5 Ratchathewi
6 Khlong San
7 Pathum Wan
8 Bangkok Noi
9 Bangkok Yai

# Bangkok Metropolitan Area Base Map

## Legend

- Roads
- Railways
- Chaopraya River
- Khlongs
- BMA Boundary
- District Boundary

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KILOMETERS

THE STUDY
ON
URBAN ENVIRONMENTAL IMPROVEMENT PROGRAM
IN
BANGKOK METROPOLITAN AREA (BEIP)

BANGKOK METROPOLITAN ADMINISTRATION(BMA)
THE GOVERNMENT OF THE KINGDOM OF THAILAND

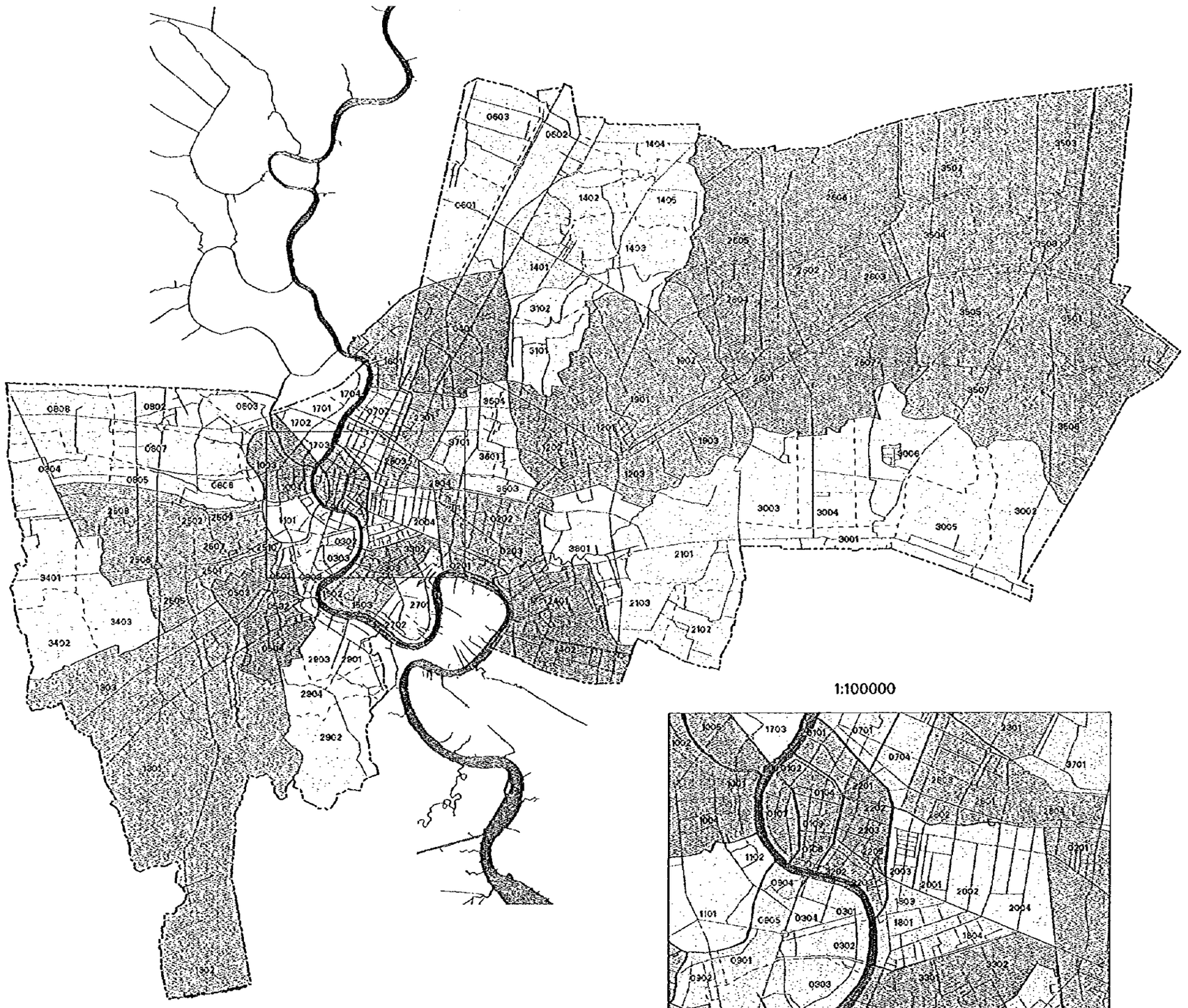
JICA JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

A-2

# Administrative Boundary

## Legend

1 Phra Nakhon
2 Khlong Toei
3 Khlong San
4 Chatu Chak
5 Jomtong
6 Don Muang
7 Dusit
8 Taling Chan
9 Thonburi
10 Bangkok Noi
11 Bangkok Yai
12 Bang Kapi
13 Bang Khun Thian
14 Bang Khen
15 Bang Kho Laem
16 Bang Sue
17 Bang Phlat
18 Bang Rak
19 Bung Kum
20 Pathumwan
21 Prawet
22 Pom Prap Sattruphai
23 Phaya Thai
24 Phra Khanong
25 Phasi Charoen
26 Minburi
27 Yan Nawa
28 Ratchathewi
29 Ratburana
30 Latkrabang
31 Lat Phrao
32 Samphanthawong
33 Sathon
34 Nong Khaem
35 Nong Chok
36 Huai Khwang
37 Din Daeng
38 Suan Luang



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KILOMETERS

THE STUDY
ON
URBAN ENVIRONMENTAL IMPROVEMENT PROGRAM
IN
BANGKOK METROPOLITAN AREA (BEIP)

BANGKOK METROPOLITAN ADMINISTRATION(BMA)
THE GOVERNMENT OF THE KINGDOM OF THAILAND

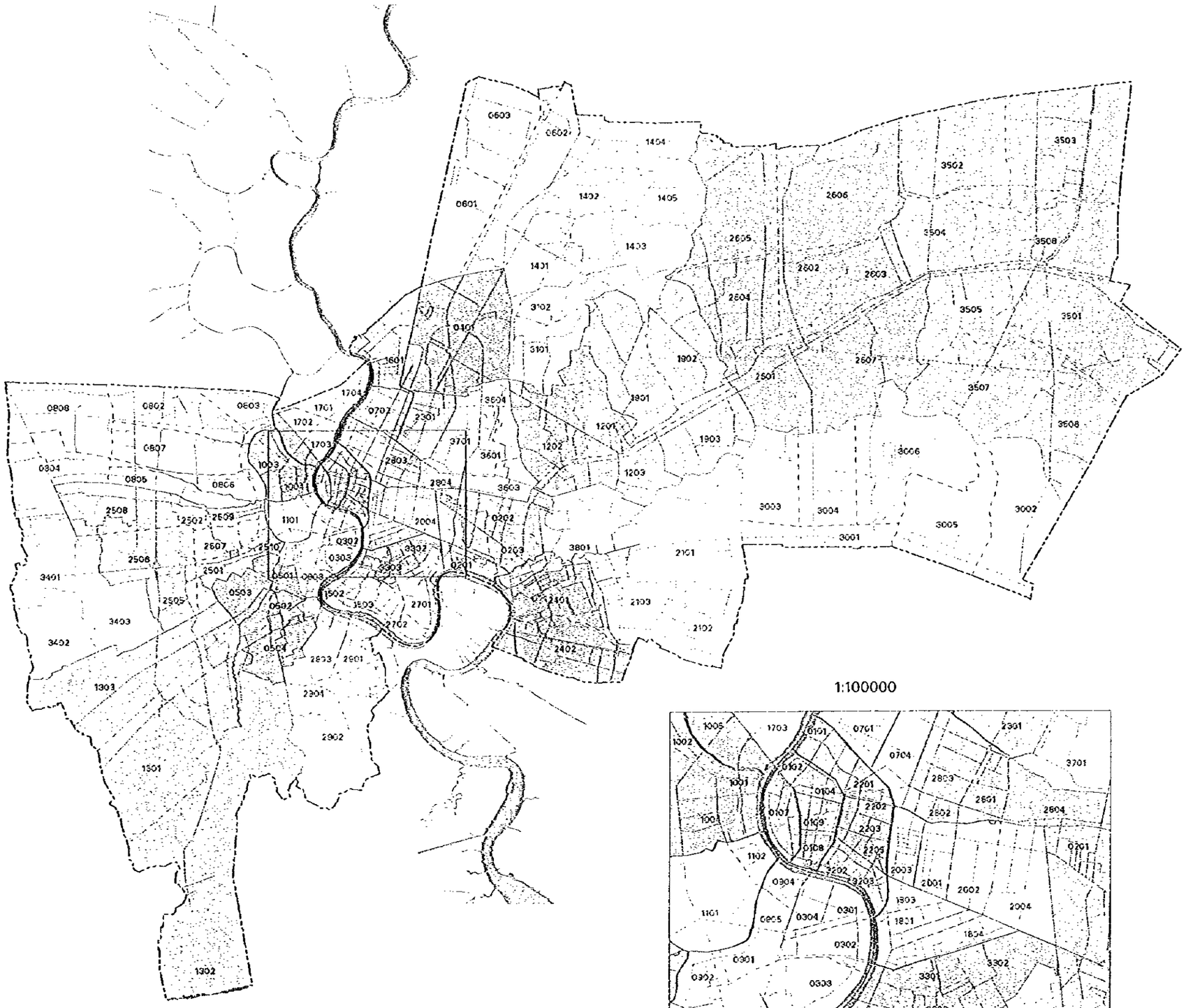
JICA JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

A-2

# Administrative Boundary

## Legend

1 Phra Nakhon
2 Khlong Toei
3 Khlong San
4 Chatu Chak
5 Jomtong
6 Don Muang
7 Dusit
8 Taling Chan
9 Thonburi
10 Bangkok Noi
11 Bangkok Yai
12 Bang Kapi
13 Bang Khun Thian
14 Bang Khen
15 Bang Kho Laem
16 Bang Sue
17 Bang Phlat
18 Bang Rak
19 Bung Kum
20 Pathumwan
21 Prawet
22 Pom Prap Sattruphai
23 Phaya Thai
24 Phra Khanong
25 Phasi Charoen
26 Minburi
27 Yan Nawa
28 Ratchathewi
29 Ratburana
30 Latkrabang
31 Lat Phrao
32 Samphanthawong
33 Sathon
34 Nong Khaem
35 Nong Chok
36 Huai Khwang
37 Din Daeng
38 Suan Luang



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KILOMETERS

THE STUDY
ON
URBAN ENVIRONMENTAL IMPROVEMENT PROGRAM
IN
BANGKOK METROPOLITAN AREA (BEIP)

BANGKOK METROPOLITAN ADMINISTRATION(BMA)
THE GOVERNMENT OF THE KINGDOM OF THAILAND

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

# Sub-district Name List

| | Sub-district Code | Sub-district Name |
|---|---|---|
| 1 | 102506 | Bang Khae Nua |
| 2 | 102501 | Bang Wa |
| 3 | 102505 | Bang Khae |
| 4 | 102507 | Bang Duan |
| 5 | 102508 | Bang Phai |
| 6 | 102510 | Pak Khlong Pasicharoen |
| 7 | 102509 | Bang Waek |
| 8 | 102503 | Khuhasawan |
| 9 | 102502 | Khlong Kwang |
| 10 | 102504 | Bang Chak |
| 11 | 100201 | Klong Toei |
| 12 | 100202 | Klong Tan |
| 13 | 100203 | Phra Khanong |
| 14 | 101402 | Khlong Thanon |
| 15 | 101401 | Anusawari |
| 16 | 101404 | Sai Mai |
| 17 | 101403 | Tha Raeng |
| 18 | 101405 | O-ngoen |
| 19 | 101202 | Wang Thong Lang |
| 20 | 101201 | Khlong Chan |
| 21 | 101203 | Hua Mak |
| 22 | 100603 | Si Kan |
| 23 | 100601 | Thong Song Hong |
| 24 | 100602 | Talat Bang Khen |
| 25 | 100903 | Bukkhalo |
| 26 | 100901 | Bang Yirua |
| 27 | 100902 | Talat Phlu |
| 28 | 100905 | Hirunruchi |
| 29 | 100904 | Wat Kanlaya |
| 30 | 101901 | Khlong Kum |
| 31 | 101903 | Saphan Sung |
| 32 | 101902 | Khanna Yao |
| 33 | 102401 | Bang Chak |
| 34 | 102402 | Bang Na |
| 35 | 102301 | Samsen Nai |
| 36 | 100401 | Lat Yao |
| 37 | 101004 | Ban chang Lo |
| 38 | 101003 | Bang Khun Si |
| 39 | 101001 | Sirirat |
| 40 | 101005 | Arun Amarin |
| 41 | 101002 | Bang Khun Non |
| 42 | 101601 | Bang Sue |
| 43 | 100702 | Thanon Nakhon Chaisi |
| 44 | 100701 | Dusit |
| 45 | 100703 | Wachira Phayabarn |
| 46 | 100704 | Suan Chitlada |
| 47 | 100705 | Si Yak Mahanak |
| 48 | 103701 | Din Daeng |
| 49 | 102903 | Bang Pakok |
| 50 | 102901 | Ratburana |
| 51 | 102904 | Bang Mot |
| 52 | 102902 | Thung Khru |
| 53 | 100501 | Bang Kho |
| 54 | 100502 | Chom Thong |
| 55 | 100503 | Bang Khun Thian |
| 56 | 100504 | Bang Mot |
| 57 | 101703 | Bang Yikhan |
| 58 | 101701 | Bang Phlat |
| 59 | 101704 | Bang O |
| 60 | 101702 | Bang Pamru |
| 61 | 101503 | Bang Khlo |
| 62 | 101501 | Wat Praya Kri |
| 63 | 101502 | Bang Kho laem |
| 64 | 101301 | Samae Dam |
| 65 | 101303 | Bang Bon |
| 66 | 101302 | Tha Kham |
| 67 | 103101 | Lat Phrao |
| 68 | 103102 | Chorakhe Bua |
| 69 | 100303 | Bang Lam Phu Lang |
| 70 | 100301 | Klong San |
| 71 | 100302 | Klong Ton Sai |
| 72 | 100304 | Somdet Chaophraya |
| 73 | 100802 | Chim Phli |
| 74 | 100803 | Taling Chan |
| 75 | 100807 | Bang Ramat |
| 76 | 100808 | Sala Thammasop |
| 77 | 100806 | Bang Phrom |
| 78 | 100801 | Khlong Chak Phra |
| 79 | 100804 | Thawi Watthana |
| 80 | 100805 | Bang Chuak Nang |
| 81 | 103303 | Thung Watdon |
| 82 | 103301 | Yannawa |
| 83 | 103302 | Thung Mahamek |
| 84 | 102002 | Pathumwan |
| 85 | 102003 | Rong Muang |
| 86 | 102004 | Suan Lumphini |
| 87 | 102001 | Wang Mai |
| 88 | 102601 | Minburi |
| 89 | 102604 | Bang Chan |
| 90 | 102607 | Sansaep |
| 91 | 102606 | Samwa Tawanok |
| 92 | 102603 | Sai Kongdin Tai |
| 93 | 102605 | Samwa Tawantok |
| 94 | 102602 | Sai Kongdin |
| 95 | 102101 | Prawet |
| 96 | 102103 | Nong Bon |
| 97 | 102102 | Dok Mai |
| 98 | 102803 | Thung Phaya Thai |
| 99 | 102804 | Makkasan |
| 100 | 102802 | Thanon Phetcha Buri |
| 101 | 102801 | Thanon Phaya Thai |
| 102 | 103801 | Suan Luang |
| 103 | 103401 | Nong Khang Phlu |
| 104 | 103403 | Lak Song |
| 105 | 103402 | Nong Khaem |
| 106 | 101101 | Wat Tha Phra |
| 107 | 101102 | Wat Arun |
| 108 | 102701 | Chong Nonsi |
| 109 | 102702 | Bang Phong Pang |
| 110 | 100108 | Wang Burapha Phirom |
| 111 | 100106 | Ban Phan Thom |
| 112 | 100104 | Bowon Niwet |
| 113 | 100107 | Phra Borom Maha Ratchawang |
| 114 | 100105 | Bang Khun Phrom |
| 115 | 100111 | Sam Ran Rat |
| 116 | 100101 | Wat Sam Phraya |
| 117 | 100109 | Wat Ratchabophit |
| 118 | 100103 | Talad Yot |
| 119 | 100110 | San Chao Phor Sua |
| 120 | 100112 | Sao Chingcha |
| 121 | 100102 | Chana Songkhrarm |
| 122 | 103604 | Samsen Nok |
| 123 | 103601 | Hual Khawang |
| 124 | 103603 | Bang Kapi |
| 125 | 102205 | Pomprab Satrupihe |
| 126 | 102202 | Klong Mahanark |
| 127 | 102203 | Wat Debsirin |
| 128 | 102204 | Ban Baht |
| 129 | 102201 | Wat Soammanut |
| 130 | 103001 | Lat Krabang |
| 131 | 103003 | Khlong Song Tonnun |
| 132 | 103005 | Thap Yao |
| 133 | 103006 | Lam Prathiu |
| 134 | 103002 | Khum Thong |
| 135 | 103004 | Khlong Sam Prawet |
| 136 | 101803 | Maha Phuttharam |
| 137 | 101801 | Si Phraya |
| 138 | 101804 | Si Lom |
| 139 | 101805 | Surawong |
| 140 | 101802 | Bang Rak |
| 141 | 103501 | Krathum Rai |
| 142 | 103505 | Khok Faet |
| 143 | 103508 | nong Chok |
| 144 | 103507 | Lam Phak Chi |
| 145 | 103502 | Khlong Sip |
| 146 | 103504 | Khu Fang Nua |
| 147 | 103503 | Khlong Sip Song |
| 148 | 103506 | Lam Toi Ting |
| 149 | 103203 | Sam Phanthawong |
| 150 | 103202 | Chakkrawat |
| 151 | 103201 | Talat Noi |

A-3

# Traffic Analysis Zone

**(Bangkok Metropolitan Region)**

## Legend

- Bangkok Metropolitan Area
- Nakhon Patho
- Nonthaburi
- Patum Thani
- Samut Prakan
- Samut Sakhon
- BMR Boundary

N

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KILOMETERS

**Source: UTDM Boundary**

THE STUDY
ON
URBAN ENVIRONMENTAL IMPROVEMENT PROGRAM
IN
BANGKOK METROPOLITAN AREA (BEIP)

BANGKOK METROPOLITAN ADMINISTRATION(BMA)
THE GOVERNMENT OF THE KINGDOM OF THAILAND

JICA JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

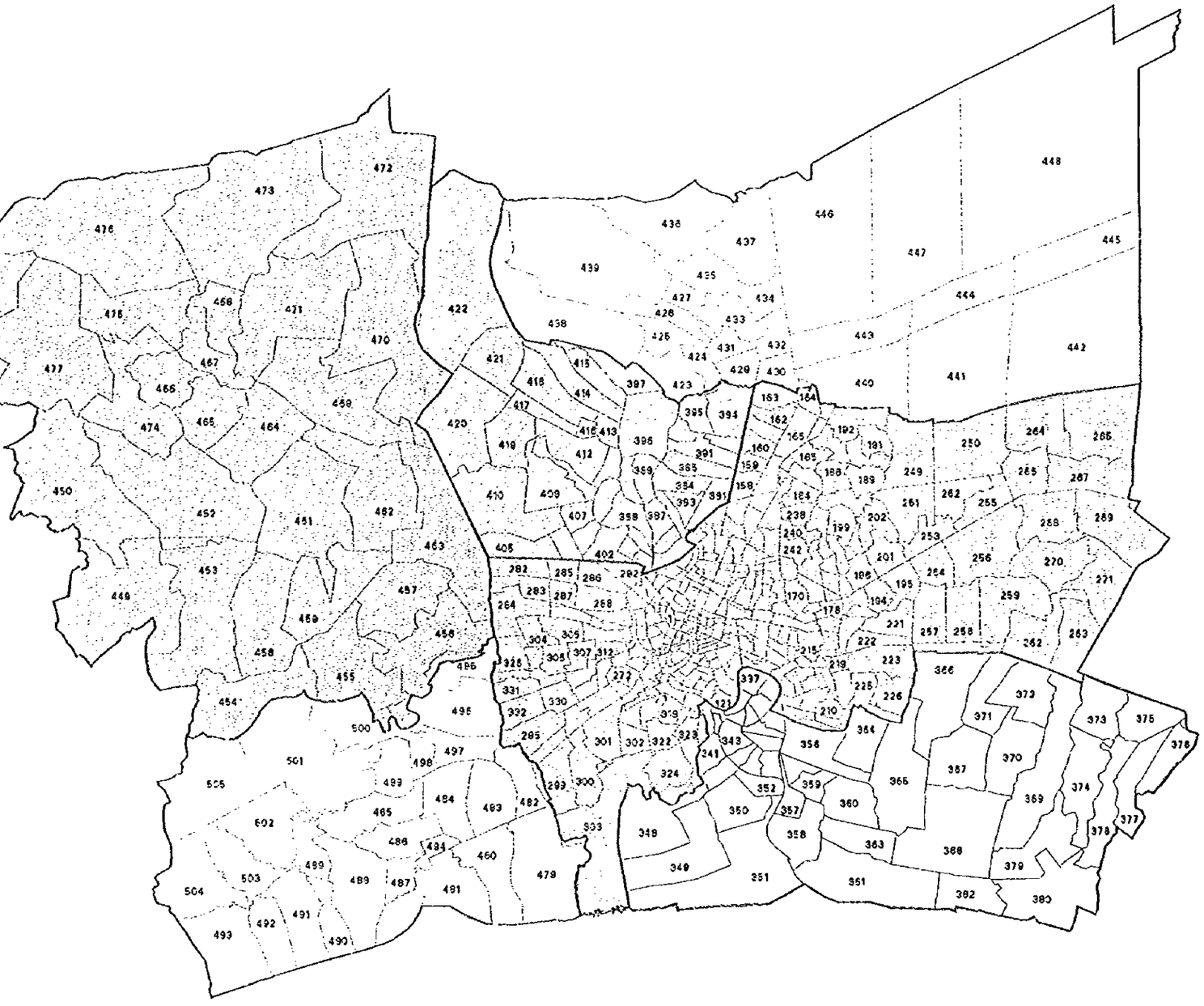
A-3

# Traffic Analysis Zone

**(Bangkok Metropolitan Region)**

## Legend

- Bangkok Metropolitan Area
- Nakhon Patho
- Nonthaburi
- Patum Thani
- Samut Prakan
- Samut Sakhon
- BMR Boundary



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SCALE 1:470000

5 0 5 10 15 20

KILOMETERS

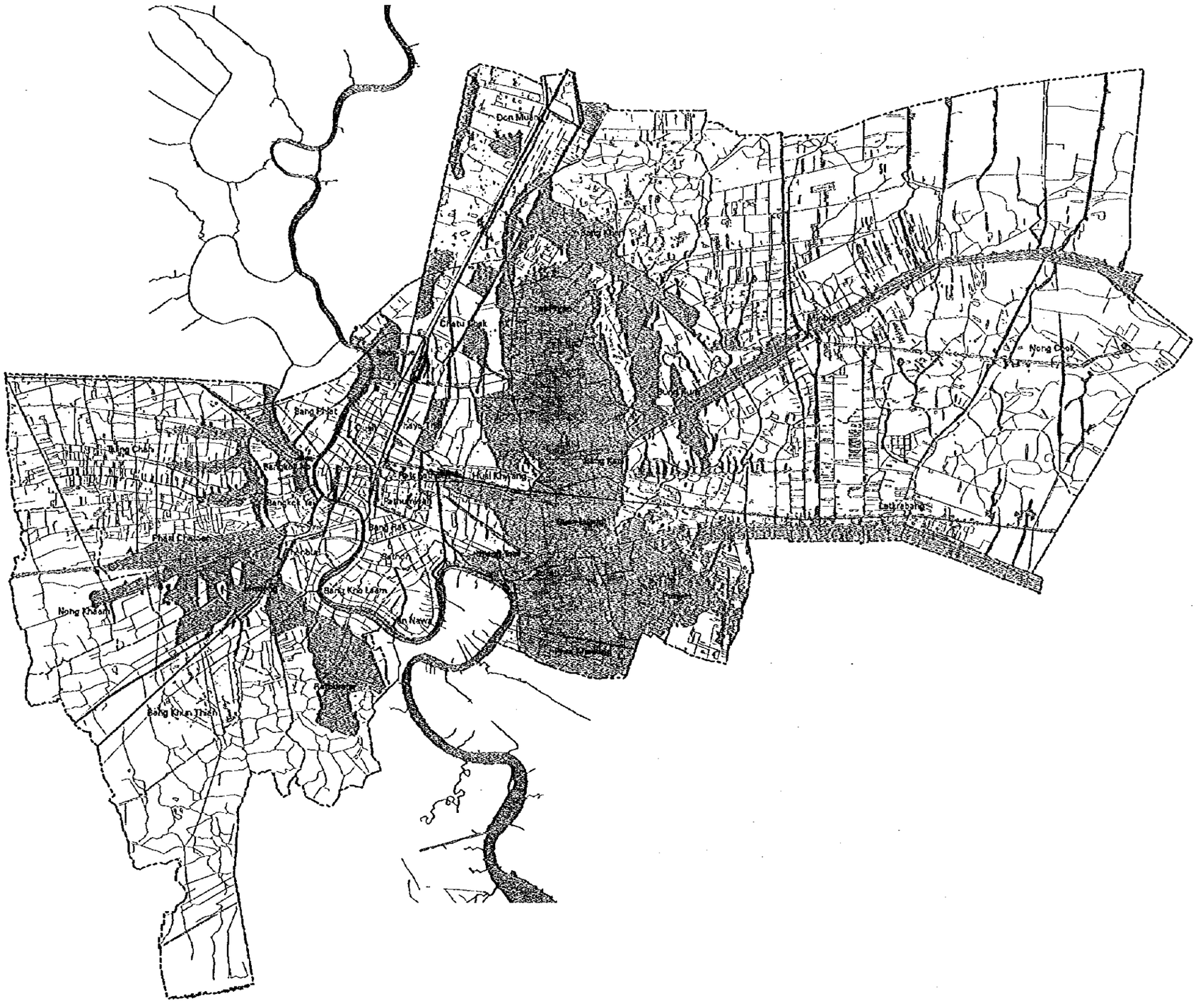
**Source: UTDM Boundary**

THE STUDY
ON
URBAN ENVIRONMENTAL IMPROVEMENT PROGRAM
IN
BANGKOK METROPOLITAN AREA (BEIP)

BANGKOK METROPOLITAN ADMINISTRATION(BMA)
THE GOVERNMENT OF THE KINGDOM OF THAILAND

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

# Inundated Area by 1983 Flood




Source: Flood Mitigation Study for Bangkok by JICA, 1985

## Legend

- Flooded Area in 1983
- Roads
- Chaopraya River
- Khlongs
- Railways
- BMA Boundary
- District boundary

N
W E
S

SCALE 1:235000

5 0 2 4 6 8 10

KILOMETERS

THE STUDY
ON
URBAN ENVIRONMENTAL IMPROVEMENT PROGRAM
IN
BANGKOK METROPOLITAN AREA (BEIP)

BANGKOK METROPOLITAN ADMINISTRATION(BMA)
THE GOVERNMENT OF THE KINGDOM OF THAILAND

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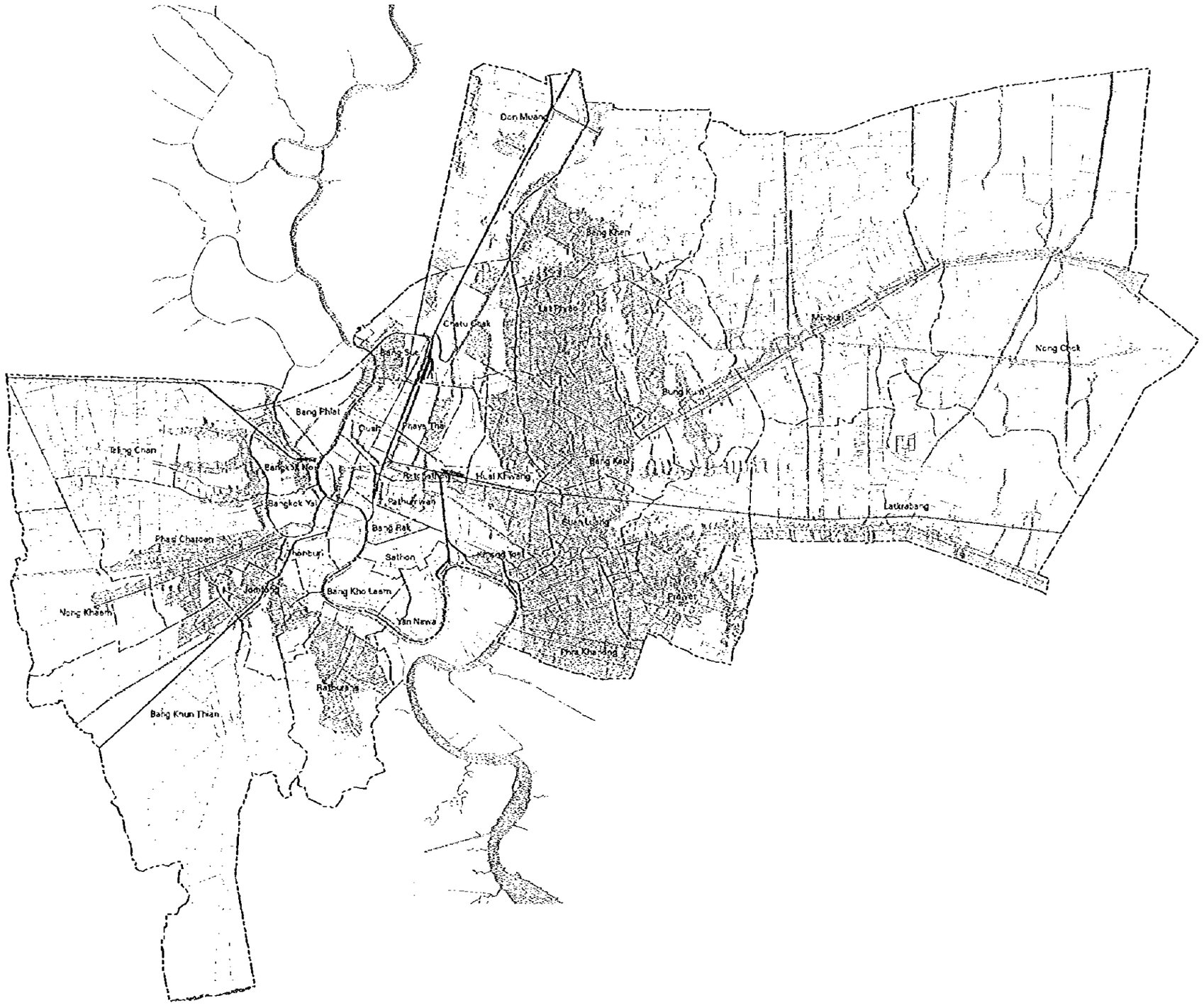


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**Source: Flood Mitigation Study for Bangkok by JICA, 1985**

# Simulated Land Subsidence Areas


## Legend (cm)

- ( > -50 )
- (-50 -> -75)
- (-75 -> -100)
- (-100 -> -125)
- (-125 -> -150)
- ( < -150)
- Roads
- Railways
- Chaopraya River
- Klongs
- BMA Boundary
- Buildup Area

N
W E
S

SCALE 1:235000

5 0 2 4 6 8 10

KILOMETERS

**Source: JICA Study for The Management of Groundwater and Land Subsidence in 1995**

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