MANILA THIRD SEWERAGE PROJECT

Nippon Jogesuido Sekkei Co. Ltd. (NJS)
in association with
CEST, Inc.
Mott MacDonald

11 February 2005

Engr. Leonor C. Cleofas
Manager,
Eng'g and Project Management Department
MWSS Building Complex
Katipunan Road, Balara, Quezon City

SUBJECT: Final Report – East Concession Area Master Plan Update

Dear Engr. Cleofas:

We have the pleasure to submit herewith the remaining three (3) copies of the Final Report of the East Concession Area Master Plan Update. With the submission of these copies, in addition to the two (2) copies that were submitted on 04 February 2005, a total of five (5) copies of the Final Report have been submitted.

Your kind attention will be highly appreciated.

Thank you.

Very truly yours,

Rocco M. Palazzolo
Project Manager

cc:
Ms. Lala Fabella
Manager, Wastewater Department, MWCI

PREFACE

Contents and Organization of the Report

This Draft Final Report presents the results of the Master Plan Update study for the development period (2008 - 2025) for the Metro Manila East Concession Area that was performed during October, November and December 2004. This preface provides a description of the report organization; to assist the reader in understanding the presentation of the data and evaluations, as well as in locating specific information within the report.

Section 1 Introduction

An introduction to the background of the project is presented in Section 1. A general description of the roles of Manila Water and Sewerage System (MWSS) and Manila Water Company Incorporated (MWCI), and the history of World Bank financial assistance under the Manila Second Sewerage Project (MSSP) and the Manila Third Sewerage Project (MTSP) are also presented in this section.

The Concession Agreement that serves as the framework for this Master Plan Update is introduced in this section. The implementation of the MTSP components, as the next step in the development of sewerage facilities during the development period up to 2025, is also discussed.

The Consulting Services that culminated in the issuance of the August 2004 version of the Master Plan Update, and the supplemental Consulting Services that were performed in preparation of this December 2004 version of the Master Plan Update to respond to comments from the World Bank (WB) are also discussed.

Section 2 Status of Water Supply, Sewerage and Sanitation Systems in East Concession Area

A description of the present status of the water supply, sewerage networks and sanitation systems in the East Concession Area is presented in Section 2. The 1997 Concession Agreement service targets and 2003 Rate Rebasing service targets for sewerage and sanitation are presented in this section.

The program for sewerage development and ongoing sewerage and sanitation projects are presented in this section. A detailed discussion of the evolution and details of MTSP components is also presented in this section.

Section 3 Fundamentals for Master Plan Update

The service areas, population projections, land use, drainage sub-catchment boundaries, water demand, sewage volume, septage volume, and pollutant loads are described in Section 3. The data presented in this section serve as the basis for preliminary design development of the sewerage and sanitation alternatives that are presented in Section 6.

Water quality projections in the major rivers for 2025, assuming there are no pollution control projects, are presented in this section. These base line (without project) projections serve as a basis for developing estimates of the benefits derived from project implementation in Section 7.

Section 4 Preliminary Design Criteria

The design criteria that were used in the development of the alternatives are presented in Section 4. Design criteria for sewers, pump stations, and sewage, sludge and septage treatment are presented.

Section 5 Cost Database

Cost information that was used in the preparation of capital and operation & maintenance costs for the various alternatives are presented in Section 5. Cost information is presented for pump stations, sewage treatment plants, sludge dewatering, and gravity sewers and force mains for different pipe materials and diameter. Operational costs for the facilities are also included in this section.

Section 6 Alternative Development

The alternatives for extending the sewerage system in the Eastern Concession Area during the development period up to 2025 are presented in Section 6. A general description of the alternatives, the reasons for selection of the alternatives, and a description of the differences between the alternatives are presented in this section.

In this section each alternative is described in detail; including presentation of the population served, projected sewage flows, details of the system requirements, detailed cost estimates, and the implementation schedule. Drawings showing the layout of the sewer systems for each of the alternatives are presented in Appendix B. The evaluation of these alternatives in presented in Section 9.

Section 7 Benefit Assessment

The types of benefits that will be realized by the implementation of sewerage and sanitation improvements are identified in Section 7. The benefits include environmental benefits, improved quality of life, water quality improvement, property value increases, and increased tourism. Quantification of each of these types of benefits is presented in this section, including projections of water quality in the major rivers for comparison with the base line (without project) projections in Section 3.

Section 8 Economic and Financial Analysis of Alternatives

An economic analysis of the alternatives, to evaluate the impact of each of the alternatives on the economy as a whole, as a measure of economic viability is presented in Section 8. This analysis is based on the cost estimates and implementation schedules presented in Section 6 and the quantification of benefits presented in Section 7. The Environmental Internal Rate of Return (EIRR) for each of the alternatives is presented in Section 8.

A financial analysis of the alternatives, to evaluate the financial viability of each of the alternatives, is presented in Section 8. The financial analysis is based on the cost estimates and implementation schedules presented in Section 6.

The financial analysis focused on the incremental tariff increase that would be required for implementation of each of the alternatives, as well as the affordability of each alternative. The incremental tariff increase and a comparison of the impact of the tariff on the monthly average water bill for each of the alternatives is presented in Section 8.

Section 9 Alternative Evaluation

The evaluation of the alternatives is presented in Section 9. This evaluation includes prioritization of the catchment areas, identification of implementation issues, and integration of proposed MTSP facilities into the expanded system. The alternatives were evaluated by comparing the costs, tariff impact, implementability (in terms of availability of sites for sewage treatment plants and traffic disruption), and benefits that would be realized by implementation. Recommendations are presented in Section 10, based on the evaluation of alternatives in Section 9.

Section 10 Conclusions and Recommendations

A summary of the evaluation of alternatives, including a summary table comparing the alternatives is presented in Section 10. Conclusions and recommendations, based in the evaluation of alternatives, are presented. Finally, considerations for the Master Plan for the next development period (2025 – 2050) are presented.

Appendices

Appendix A – List of Existing Sewerage Systems

Appendix B – Catchment Area and Sewerage Plans

Appendix C – Land Use for Cities/Municipalities

Appendix D – Water Consumption, Sewage and Septage Volume Calculations

Appendix E – Sewage/Septage Treatment Plant Sites

Appendix F – Relevant Septage Data

Appendix G – Biochemical Oxygen Demand for Rivers

Appendix H – Cost Estimates

Appendix I – References

MANILA THIRD SEWERAGE PROJECT

MASTER PLAN UPDATE
FINAL REPORT

TABLE OF CONTENTS

Page

APPENDICES

SECTION 1

Introduction

SECTION 1 INTRODUCTION

1.1 Background of the Study

The present population of Metro Manila was estimated to be more than 10 million based on the results of the Population Census conducted in 2000. The increasing population and urbanization of Metro Manila and the adjacent Provinces of Rizal and Cavite brings to the fore pollution problems. Among urban problems, sewerage and sanitation is the one of the serious issues requiring prompt measures.

In Metro Manila, the population connected to a sewerage treatment plant is nil. Although around 85% of them have septic tanks, maintenance is not satisfactory. Leaching capacity of them is quite unreliable, and therefore overflow from septic tanks is quite common together with direct discharge of sullage. This situation has led to the serious pollution of Metro Manila's waterways.

In the face of serious pollution status of public water bodies, several studies had been conducted and implementation of projects had been proposed. The implementation of the project, however, coincided with the onset of economic difficulties in the Philippines so that some of the components were not completed and others failed to have the anticipated impact.

In 1996, and with the improved economic situation in the Philippines, the World Bank resumed its assistance to the MWSS for the improvement of the general environmental conditions in by expanding MWSS septage management program. Manila Second Sewerage Project (MSSP) focuses on the provision of a septage management program and a rehabilitation/upgrading of existing sewerage system.

The start of MSSP implementation coincided with the privatization of the MWSS in August 1997, the MWSS privatization led to the operation of two concessionaires: Manila Water Company (MWCI) in the East Zone and the Maynilad Water Services (MWSI) in the West Zone. Under the terms of the Concession Agreements, MWCI and MWSI took over the implementation of MSSP.

MWSS implemented the first Rate Rebasing under the Concession Agreement in 2003, to develop an action plan relating to service targets. The 2003 Rate Rebasing service targets were developed and mutually agreed. In general, the sewerage targets were reduced and the sanitation targets were increased. Importantly, the MWSS agreed that combined sewers can be utilized as a means of achieving the sewerage targets, whereas prior to 2003 only separate sewers with direct connections were allowed.

In the middle of 2003, MWSS and MWCI commenced the feasibility study on Manila Third Sewerage Project (MTSP) to be implemented after MSSP under financing aid of the World Bank. MTSP also focuses on the provision of a septage management program, rehabilitation/upgrading of existing sewerage systems, and provision of several sewage treatment plants with interceptors.

MTSP was developed to comply with the 2003 Rate Rebasing targets for sewerage and sanitation, in particular with the service targets for 2010. Components of MTSP include combined sewerage systems and sewage treatment plants (STPs) and septage treatment plants (SPTPs). Given that the sewerage service targets are distributed across the East Concession Area, it was essential that components be developed in various municipalities. The sewerage components of MTSP will allow piloting of combined sewerage systems in different urban settings to determine community acceptance, validate implementability, refine costs, and determine effectiveness by measuring the benefits of the investments.

The septage treatment facilities not only meet the 2010 sanitation targets, they will continue to serve the East Concession Area in the future and are considered part of the long term strategy for sanitation. The combined sewerage systems that will be developed under MTSP, will ultimately be integrated into the system serving the overall catchment areas in which they are located. After the economic life of the STPs that are constructed under MTSP is completed, some of the STPs that are developed under MTSP will be converted to pump stations when the combined sewer system is developed to serve the larger catchment area. The Taguig primary treatment plants and lagoon systems will serve until the sewerage system is developed in the larger catchment area. At that time, the primary treatment plants will be upgraded to secondary treatment plants and the use of the ponds will be discontinued.

MTSP was developed as the next phase (following on from MSSP) in the development of the overall sewerage and sanitation system for the Eastern Concession Area in a phased manner that is affordable to the community served. The lessons that will be learned from this first attempt at development of combined sewerage systems will be used to refine and optimize the systems that will be implemented in subsequent phases.

1.2 Scope of Consulting Services

In accordance with the letter dated 28 November 2003 from MWSS to the MTSP Consultants, a study was conducted to update the sewerage and sanitation master plan for the East Concession within the context of achieving the original sewerage and sanitation targets in the 1997 Concession Agreement (CA) between MWSS and MWCI, as well as the new sewerage targets in the 2003 Rate Rebasing (RR). In particular, the master plan update included an evaluation in terms of technical, economic, environmental and social feasibility and acceptability of the decentralized sewerage approach currently being adopted under MSSP and proposed to be continued under the MTSP.

The Master Plan Update (Draft Final Report) was issued in August 2004. The report demonstrated that a system comprised of separate sewers and sewage treatment plants throughout the East Concession Area where sewerage targets had been established in the 1997 CA would be unaffordable due to the unacceptable tariff increment that would be required, as well as difficult to implement because of technical constraints such as traffic disruption that would occur during construction. The report also presented two alternative approaches to meeting the 2003 Rate Rebasing (RR) targets for sewerage using separate sewer systems at limited locations.

1.6 Supplemental Consulting Services

As stated above, the Master Plan Update (August 2004) was developed within the context of sewerage and sanitation targets in the Concession Agreement for East Concession Area. This agreement details the sewerage and sanitation targets for the concession period, up to 2023, which are part of the contractual obligations of MWSS and MWCI. Under the 2003 RR, MWCI proposed development of combined interceptor sewers as an approach to achieving the sewerage targets, because major excavations for separate sewer systems would be socially and economically unacceptable, particularly in highly built-up or densely populated areas. MWSS has accepted this approach. The MTSP is being developed as a means of achieving the sewerage targets for 2010, through use of a mixture of separate sewer systems and combined systems with interceptors.

In response to comments on the Master Plan Update received from the World Bank, the MTSP consultants conducted this study for MWSS/MWCI to include a broader range of alternatives for separate and combined systems. While the Master Plan Update (August 2004) addressed sewerage system expansion to achieve either the 1997 CA targets or the 2003 Rate Rebasing targets, this report addresses providing coverage throughout the service area over an extended time schedule, since the sewerage targets will be re-assessed in 2008 and every five years thereafter, throughout the concession period.

The alternatives for development of sewerage systems throughout the service area may be unaffordable if implemented between 2008 and 2025, but could be implemented affordably in stages by extending the development time horizon. The MTSP components will be integrated into the expanded system. This report should serve as part of basis for establishing the 2008 Rate Rebasing targets. Lessens learned through the implementation of the MTSP components should also be considered in the 2008 Rate Rebasing. The report also presents considerations for the next development period, between 2025 and 2050.

SECTION 2

Present Status of Water Supply, Sewerage / Sanitation Systems in East Concession Area

SECTION 2 STATUS OF WATER SUPPLY, SEWERAGE AND SANITATION SYSTEMS IN EAST CONCESSION AREA

2.1 Background

The National Capital Region, more popularly known as Metropolitan Manila (Metro Manila), lies at the western part of the Philippine archipelago. It is bounded by the province of Bulacan in the north, the province of Rizal in the east, Manila Bay in the west and Laguna de Bay, and Cavite and Laguna in the south. It consists of four municipalities namely, Taguig, Navotas, San Juan, and Pateros and thirteen cities including Quezon City, Manila, Caloocan, Pasig, Valenzuela, Las Pinas, Paranaque, Makati, Marikina, Muntinlupa, Pasay, Malabon and Mandaluyong. Its 2000 population was recorded at 9.9 million.

Metro Manila is the political, educational, and economic center of the Philippines as evidenced by the presence of 90% of the biggest corporations in the country. It engages 60% of the country's non-agricultural work force and contributes 90% to the total internal revenue of the country.

Against the background of industrialization and economic activity are rising prices of goods, peso depreciation, increasing poverty level, deficiencies in basic services and environmental degradation. Air and water quality in the region is in critical condition. The two main rivers in the metropolis - Marikina River and Pasig River, have been pronounced biologically dead. The Pasig River, once renowned for its pristine waters and aquatic resources, is now one of the world's most polluted river systems with dissolved oxygen levels dropping to zero for most of the year. Total coliform levels exceed standards of the Department of Environment and Natural Resources (DENR) by several thousands.

Findings of the Department of Environment and Natural Resources (DENR) point to domestic wastewater as the primary source of water pollution. According to the DENR, 75% of the pollution loading into the Pasig River comes from domestic wastewater. Industrial and commercial effluents contribute 25% to the pollution of the Pasig River. These facts directly correlate to the slow development of sewerage and sanitation compared with the provision of water supply to the populace.

New laws have been enacted to abate pollution and attempt to establish balance between development and use of natural resources. Pending enforcement of these laws, public and private sectors alike must work together to close the gap between availability of water supply services and sewerage and sanitation infrastructures/services. Innovative and cost-effective solutions must be explored based on a review of capabilities and constraints with the ultimate goal of protecting public health and improving environmental conditions.

2.1.1 Development of Sewerage and Sanitation

(1) MWSS System and Mandate

The water system of Metro Manila, at 125 years, is one of the oldest in Asia. The first system in 1878 consisted of a 15-million liter per day (MLD) pumping station and reservoir with water coming from the Marikina River and delivered to a population of 300,000. Over the years, infrastructure was developed and installed to augment the water system and expand coverage. Subsequently, institutions were created and made responsible for the operation, maintenance and management of the system.

In June 1971, Republic Act No. 6234 dissolved the previously established National Water and Sewerage Administration (NAWASA) and created the present Metropolitan Waterworks and Sewerage System (MWSS) which was given the mandate and jurisdiction over all waterworks and sewerage systems in a service area that includes the NCR, the entire province of Rizal and part of the province of Cavite, a territory of more than 2,000 km^2.

By the early 1980's, the Metro Manila area was experiencing increased industrialization and sustained population growth. Development of water supply facilities heightened while government itself admitted that existing sanitation and sewerage facilities remained unsatisfactory and inadequate to meet necessary health and environmental standards.

The existing sewerage facilities of MWSS are confined to some areas in the city of Manila and parts of Makati. Most households and firms utilize their own septic tanks or communal septic tanks while those who live in slum areas without public sewers or drains rely on rudimentary latrines without formal drainage facilities.

A number of master plans have been conceived since 1969 in order to address the sewerage and sanitation requirements of the metropolis. However, none of these master plans was fully implemented in view of technical, financial and institutional constraints. Retarded sewerage and sanitation development contributed to the rapid deterioration of natural water systems in the region.

In the 1990's, the government seriously considered privatizing the water sector, in view of increasing population and its need for basic services, the need to rehabilitate and expand deteriorating water and sewerage systems in addition to the growing financial requirements of MWSS which had, by then, grown inefficient.

(2) Public-Private Partnership

In August of 1997, the MWSS entered into 25-year Concession Agreement(s) with two private concessionaires to handle the east and west zones of its service area. The bidding process resulted in the Manila Water Company, Inc. winning the concession for the East Zone while Maynilad Water Services, Inc. won the West Zone. The decision to introduce public-private partnership was motivated by a commitment to improve the operational efficiency and service standard of MWSS through system rehabilitation and expansion, raise financial resources for investments and end government subsidies while minimizing the tariff impact on consumers. Prior to privatization, the MWSS service was characterized by low water pressure, high rates of non-revenue water, intermittent supply and low coverage levels on water supply, sewerage and sanitation.

The concessionary form of private sector participation was chosen in order to promote competition and generate yardstick information. A residual MWSS (MWSS Corporate Office) was retained to carry out limited management and facilitation roles such as administration and management of retained assets, administration of existing loans, provision of bulk water and development of new water sources.

A separate MWSS Regulatory Office (MWSS-RO) was established to monitor and/or enforce compliance to the Concession Agreement(s), review water supply and sewerage rates and respond to complaints against the concessionaires. Other agencies also play a role in regulating concessionaires' performance. For the regulation of water quality, the responsibility is divided between the Department of Health (DOH) for drinking water and the Department of Environment and Natural Resources (DENR) for the regulation of sewerage discharges.

In terms of service obligations, the concessionaires had to abide by the targets set in the 1997 Concession Agreements (CA). The Concession Agreements allow for a periodic assessment and correction/revision of targets and tariffs through the Rate Rebasing mechanism conducted every five years.

Per the 1997 CA, the concessionaires were required to expand coverage of water supply, sewerage, and sanitation services, provide 24-hour water supply to all connections not later than June 2000, maintain water pressure at 16 PSI by 2007 for all connections, and meet the national health and environmental standards on quality of drinking water, wastewater discharge, and industrial effluents.

As a whole, the concessionaires are expected to increase population coverage of water service so that by the year 2001, the most heavily populated inner cities of Metro Manila - -Manila, Pasay, Quezon, Caloocan, Mandaluyong, San Juan -- as well as Cavite City, are fully covered with water supply.

The coverage targets for sewerage and sanitation services are based on households connected to the MWSS water system. As a whole, coverage for sewer connection was scheduled to increase slowly from 7% at the beginning of the concession period to 14% in 2001 and 18% in 2006, after which sanitation services, defined as the desludging of septic tanks every 5 to 7 years, would be the more common method of addressing domestic sewage problems. Target coverage of sanitation services was originally scheduled to decrease over time from about 41% in 2001 down to 24% by 2021 as sewer coverage increases. Although coverage is not complete, at least 90% of households in nearly all of the municipalities in the NCR were intended to be provided with either sewerage or sanitation services.

The period before 2003 were characterized by upheavals that impact on the 2003 rate rebasing exercise. It was at this time when the worst El Niño phenomenon happened resulting to a water crisis; the peso lost value to the USD; and a change in administration at the highest level of government transpired. These circumstances, along with an in-depth assessment of the system inherited from MWSS, compromised the capabilities of the two concessionaires to meet all of the 1997 CA targets and commitments.

New strategies and business plans were explored and discussed with the MWSS-RO which eventually resulted to a relaxation of the original CA targets. MWSI was granted a deferment in complying with its obligations in view of its financial difficulties. MWCI commitments on water availability, pressure and coverage for water supply, sewerage and sanitation were rewritten taking into consideration technical and financial feasibility.

2.2 Water Supply Systems

The East concession area covers an area of 1,499 sq. km and consists of 22 cities and municipalities in Metro Manila and Rizal. These include the cities of Makati, Mandaluyong, Marikina, Pasig, Taguig, parts of Manila and Quezon City; and the municipalities of Pateros, San Juan in Metro Manila, the towns of Baras, Jala-Jala, Morong, Pililia, Tanay and Teresa, which area collectively called Rizal Water Districts Association "RIZWADA"; Angono, Antipolo, Baras, Binangonan, Cainta, Cardona, Rodriguez and San Mateo in Rizal province.

The population in the East concession area is currently 5.4 million, and expected to reach 6.4 million in 2010 and 8.5 million in 2022 or at the end of the concession period.

During the last five years, MWCI highlighted various improvements in the area of water supply as follows:

- It has expanded its water coverage from 67% to 89%;
- Improved the availability of 24-hour water service from 26% to 83% of the population connected to the Central Distribution System (CDS); and
- Reduced non-revenue water (NRW) from 63% in 1997 to 44% as of November 2004.

2.2.1 Water Service Coverage

MWCI has installed 170 kilometers of new distribution lines, more than 100,000 new household connections and upgraded its distribution system since 1997. Consequently, around 4 million to date have access to potable water directly from the tap, which is a significant improvement from 3 million people served in August 1997.

Currently, there are more than 440,000 households connected to the MWCI water system. Billed volume has also tremendously increased by more than 70% from 440 MLD in 1997 to 758 MLD. The current water supply service area is shown in Figure 2.2.1.

2.2.2 Water Service Coverage Expansion

The Tubig para sa Barangay (TPSB) project is the key program to serve the depressed sectors of the society and as a counterpart program on health is the sanitation for low income communities under the MTSP.

While the Company has significantly increased its water service coverage, some areas within the Central Distribution System (CDS) remained unserved. The expansion of the water supply sources and continuous reduction of non-revenue water, which significantly accounts to high dilution of wastewater, will boost water supply coverage and at the same time sustain thrust on the equitable water supply distribution.

2.3 Sewerage Systems

Immediately after privatization of the operations of MWSS, the following sewerage and sanitation facilities were handed over to MWCI:

a) Magallanes STP in Makati City;
b) Karangalan Bio-module STP in Pasig;
c) Phil-Am Imhoff Tank in Quezon City;
d) Thirty-one (31) CST's in Quezon City; and
e) Two (2) CST's in Antipolo City

2.3.1 Boundary Issue

The Magallanes Village, Makati City falls within the MWSI service area boundary. As a result of which water and sewer O & M and billing of households and business are being undertaken by the MWSI, but the STP is being operated and maintained by MWCI. The same is true for Santa Ana, Manila, wherein it falls within MWCI service area boundary. Both water and sewer O & M and billing is undertaken by MWCI but the sewer force mains and lift station are being operated by MWSI.

2.3.2 Acquisition of Private Sewerage Systems

It has also been part of MWCI's sewerage strategy to acquire the operation and maintenance of private sewerage systems in residential and commercial development areas. These sewerage systems mostly discharge into CST's and where necessary, rehabilitation or upgrade of the system is being undertaken. Most of these CST's are presently being upgraded into STP's and implemented under the MSSP Community Sanitation Program (CSP). The following presents the different existing systems being operated and maintained by MWCI:

<u>Pasig City</u> - MWCI operates the CST's at Valle Verde Homes and Karangalan Village, Caniogan Bliss, Kaimitoville., Eusebio Bliss. Karangalan Village CST is being upgraded into STP under MSSP. The upgrading works are scheduled to be completed in 2004.

<u>Quezon City</u> - MWCI will take over the operation and maintenance of: Eastwood City, Araneta Center, others.

<u>Mandaluyong</u> – Coronado Bliss and Mandaluyong MRH. Both CST's are being upgraded into STP under the MSSP program.

<u>Makati</u> - Magallanes STP, Guadalupe Bliss, Tejeros Bliss, San Lorenzo Village, San Miguel Village, Coryville. Magallanes STP has been rehabilitated and expanded under MSSP and commissioned in March 2004 while Guadalupe and Tejeros Bliss are being implemented under MSSP.

<u>Taguig</u> - Diego Silang, Bagong Lipunan, Centennial Village, C5 MRB, Fortville, Lakeview Manors, Diego Silang-Bagong Lipunan, Maharlika Village , Centennial Village. All these sites except Diego Silang are currently implemented under the MSSP.

The complete list of the existing sewerage systems under the MWCI jurisdiction are presented in Appendix A. Figure 2.3.1 shows locations of the existing sewerage systems in the East Concession area.

2.4 Sanitation Systems

The NSO 2000 Census of Population and Housing shows that about 85% of households in the NCR part of the east concession area have access to a septic tank. The same reference indicates that around 72% of the households in Rizal Province have septic tanks. As shown in Table 2.4.1, the estimated number of households in the east concession area with septic tanks in Year 2000 is around 830,000.

Based on the Rate Rebasing Charging Year 2003 Report, the whole east concession area, except for the City of Manila, and the towns of Baras, Jala-Jala, Morong, Pililia, Tanay, and Teresa, will be covered by MWCI's sanitation services. Therefore, 8 LGUs in the NCR and 8 LGUs in Rizal Province shall benefit from sanitation services to be provided by MWCI. In these LGUs, the estimated number of households with septic tanks in Year 2000 is placed at around 770,000.

Table 2.4.1 Estimated Number of Households with Septic Tanks in Year 2000

City/Municipality/ Province	NSO 2000 CPH Data		% Households with Septic Tanks[1,2]	% Concession Coverage[3]	Estimated No. of Households with Septic Tanks in Concession Area (Yr 2000)
	Total Households[1]	No. of Households with Septic Tanks[1,2]			
NCR					
Makati	103,981	91,890	88%	88%	80,900
Manila	333,547	294,902	88%	8%	23,600
Mandaluyong	59,682	52,284	88%	100%	52,284
Marikina	80,160	70,111	87%	100%	70,111
Pasig	107,835	93,541	87%	100%	93,541
Quezon	480,624	408,548	85%	37%	151,200
Taguig	102,723	70,239	68%	100%	70,239
San Juan	24,605	22,887	93%	100%	22,887
Pateros	12,029	10,921	91%	100%	10,921
Sub-total:	1,305,186	1,115,323	85%		575,683
Province of Rizal[4]	356,578[5]	256,683[5]	72%	99%	254,100
Total:	1,661,764	1,372,006	83%		829,783

Reference: National Statistics Office (NSO), 2000 Census of Population and Housing (CPH)

Notes: [1]covers the whole city (concession covers only part of the Cities of Manila, Quezon, and Makati)
[2]NSO data includes households with sewers (applicable in the Cities of Manila, Quezon and Makati)
[3]Based on Rate Rebasing Charging Year 2003 Report (Population Projections)
[4]No municipal breakdown available
[5]Covers the whole province of Rizal

Many septic tanks are not accessible for desludging, either because the tanks have no proper manholes, structures have been built over the tanks, or the tanks are located in areas with roads that are very narrow or impassable by any type of vehicle. The 1991 Manila Second Sewerage Project (MSSP) Feasibility Study (James Montgomery, 1991) cited a 1980 report (title not indicated), which estimated accessibility in the cities of Manila, Quezon, Caloocan, and Pasay at around 60%, and 90% for the rest of the NCR. The said study itself assumed septic tank accessibility at around 74% for the whole MWSS service area, and the gross septic tank volume was placed at around 6 m^3.

Many of the septic tanks, especially in the NCR, have no absorption fields since there are limited open areas in the highly built up study area. Some of the septic tanks have a final stage chamber that is unlined at the bottom, allowing some, albeit limited, degree of percolation. In most cases, the septic tank effluent is directed to the storm drainage system. Data on septage quality is presented in Appendix F.

Presently, MWCI is providing sanitation services by desludging septic tanks in the East Concession Area, complementing a number of private desludging companies. MWCI presently has a fleet of one 5 m^3 and fourteen 10 m^3 vacuum trucks. The existing fleet is relatively new. One half was delivered in 2001 and the other half in 2004. Through an ADB loan, MWCI is increasing their fleet by six 5 m^3 and thirty 10 m^3 trucks. Delivery will take place in Years 2005-2006.

MWCI schedules the desludging services for a certain area. Provision of such services is coordinated with the Barangay. The proposed schedule for desludging is informed to the households. Also, the households are asked whether they wish to avail of the services or not. Around 80% of the households have indicated their desire to avail of the desludging service.

At present, septage collection is reported at around 200 m^3/d. The collected septage is transported and discharged to an Imhoff tank located in Phil-Am Village in Quezon City. The Imhoff tank serves as temporary storage for septage, as private haul contractors of MWCI come to collect the septage, and transport it to lahar areas in Pampanga and Tarlac.

The septage is spread over lahar areas, which are later on planted with sugarcane. A research study by the Sugar Regulatory Administration (E.B. Estanislao et al, 2002) reported increased cane tonnage by 46-74% as a result of septage application ranging from 40 to 120 tons per hectare.

Under the initiative of the Pasig River Rehabilitation Commission (PRRC) and through an ADB loan, MWCI is presently tendering the contract for the construction of a 600 m^3/d septage treatment plant (SPTP) in Antipolo City. The project is expected to be operational by the last quarter of 2006.

In this facility, septage will be screened, degritted, and dewatered to around 20% dry solids (DS) content, and stabilized with lime to reduce odors, the levels of pathogenic organisms, and potential for putrefaction of the septage. The dewatered sludge product will be used as soil conditioner in nearby areas. Filtrate from the dewatering process will be treated in a biological treatment plant to meet Class C of DENR Effluent Standards.

Under the Manila Third Sewerage Project (MTSP), two SPTPs serving the National Capital Region (NCR) part of the east concession area are proposed to be constructed. A 586 m^3/d northern facility will serve Quezon City, Marikina City and San Juan, while a 814 m^3/d southern SPTP will serve the cities of Mandaluyong, Pasig, Makati and Taguig, as well as the town of Pateros. The north SPTP will be located in Payatas, Quezon City, while the south SPTP will be constructed in the Taguig Industrial Complex. Procurement of around 60 units of 5 and 10 m^3 capacity vacuum trucks will also be made under the MTSP.

2.5 1997 Concession Agreement Sewage and Sanitation Targets

The original CA targets on sewerage service for the East Zone envision the construction of large, centralized sewage treatment plants (STPs) serving large populations in Makati, Quezon City, Taguig, and Pasig. In June 1999, a project development team headed by a technical consultant was formed to prepare a sewerage master plan based on the CA targets. The team identified the scale of sewage collection network and location and sizing of STPs needed to meet these targets. The team also prepared the corresponding financial models of capital expenditure up to year 2021.

The long-term sewerage strategy calls for many small to medium treatment works in Quezon City, Pasig, Makati, and Taguig. A trunk sewer system will be laid in San Juan, Mandaluyong and Pasig, with a large plant either in Pasig or further down South. Sewage treatment capacity build-up should reach 666 m^3/d by 2021, or about 17 times the current treatment capacity of MWCI. Sewer trunk mains should reach a total length of 1,400 kilometers or about 7.5 times the current sewer network layout.

Implementation of all of the components in the 1999 sewerage master plan would amount to Ps 41 billion, excluding land costs for STP sites. Considering land acquisition for 47 hectares, this cost could increase to as high as Ps 50 billion. This total cost is based on 100% sewer connections, with a 10% allowance for contingency, inflation and estimated allowance for error. This amount is the lowest base case figure for the overall sewerage strategy.

Due to the high capital cost, MWCI has calculated that implementation of components to meet the original sewerage targets would result in an incremental increase in the tariff of Ps $10/m^3$. This is viewed by MWCI to be socially and politically unacceptable. In addition, technical issues such as unavailability of land for treatment plant sites and traffic congestion pose significant constraints to implementation of such a large sewerage program in the service coverage area.

Table 2.5.1 shows sewerage and sanitation targets set by the 1997 Concession Agreement. Percentages of the sewerage target are applied for served population of water supply.

Table 2.5.1 Sewerage and Sanitation Targets in 1997 Concession Agreement

City/ Municipality	Sewer Coverage Targets (Schedule3)					Sanitation Coverage Targets (Schedule4)				
	2001	2006	2011	2016	2021	2001	2006	2011	2016	2021
Quezon City	0%	0%	83%	87%	98%	24%	21%	16%	12%	2%
Mandaluyong	0%	0%	100%	100%	100%	0%	0%	0%	0%	0%
Makati	22%	52%	100%	100%	100%	0%	0%	0%	0%	0%
Marikina	0%	0%	0%	0%	0%	63%	79%	73%	64%	60%
Pasig	0%	41%	68%	68%	68%	83%	58%	32%	27%	25%
Pateros	0%	60%	100%	100%	99%	0%	0%	0%	0%	0%
San Juan	0%	0%	100%	100%	100%	0%	0%	0%	0%	0%
Taguig	0%	52%	75%	84%	100%	0%	0%	0%	0%	0%
Angono	0%	0%	0%	0%	0%	19%	30%	49%	44%	41%
Antipolo	0%	0%	0%	0%	0%	57%	53%	63%	50%	44%
Baras	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Binangonan	0%	0%	0%	0%	0%	12%	21%	26%	23%	22%
Cainta	0%	0%	0%	0%	0%	38%	40%	34%	28%	27%
Cardona	0%	0%	0%	0%	0%	10%	13%	12%	10%	10%
Jala-Jala	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Morong	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pililla	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Rodriguez	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
San Mateo	0%	0%	0%	0%	0%	66%	65%	58%	49%	44%
Tanay	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Taytay	0%	0%	0%	0%	0%	82%	78%	70%	60%	54%
Teresa	0%	0%	0%	0%	0%	25%	25%	23%	21%	20%

2.6 2003 Rate Rebasing Targets

The MWSS Board Resolution No. 512-2001 dated 12 October 2001 calls for the revision of the 1997 Concession Agreement Target in Article 3.1, "MWSS exercises its options to implement general Rate Rebasing on 01 January 2003, and in connection therewith shall: *"Enter into an agreement with MWCI within ninety (90) days from the effectivity of the amendments to the Concession Agreement, covering the action plan relating to service targets, including sewerage and water service targets to take into accounts such factors as: (a) sewer extension; (b) customer affordability; (c) magnitude of the works in the streets of the East Zone; and (d) absence of appropriate legislation to enforce the obligation to connect."*

In its 2003 Rate Rebasing submission, MWCI intends to maximize the sewerage service coverage at an efficient cost and with the least disruption to customers through decentralized approach; and to take over of the operation and maintenance of private sewerage systems. Table 2.6.1 shows the MWCI revised sewerage and sanitation targets as per the 2003 Rate Rebasing submission. These targets, along with appropriate tariff adjustments and changes in some contractual commitments, have been approved by the MWSS Board of Trustees.

Table 2.6.1 Sewerage and Sanitation Targets in 2003 Rate Rebasing Submission

City/Municipality		2001 Actual	2006	2011	2016	2021
National Capital Region (NCR)						
Mandaluyong	Sewerage	0%	0.5%	4%	10%	15%
	Sanitation	0%	99.5%	96%	90%	85%
Makati (Part)	Sewerage	22%	40%	38%	28%	23%
	Sanitation	0%	60%	62%	72%	77%
Quezon City (Part)	Sewerage	0%	13%	20%	16%	17%
	Sanitation	3.19%	87%	80%	84%	83%
Pasig	Sewerage	0%	9%	10%	12%	14%
	Sanitation	1.20%	91%	90%	88%	86%
San Juan	Sewerage	0%	0%	0%	18%	41%
	Sanitation	0%	100%	100%	82%	59%
Taguig	Sewerage	0%	5%	25%	26%	20%
	Sanitation	0%	95%	75%	74%	80%
Marikina	Sanitation		100%	100%	100%	100%
Pateros	Sanitation		100%	100%	100%	100%
Rizal						
Antipolo	Sanitation	0.54%	100%	100%	100%	100%
Cainta	Sanitation	0.18%	100%	100%	100%	100%
San Mateo	Sanitation	0.65%	100%	100%	100%	100%
Taytay	Sanitation	0%	100%	100%	100%	100%
Municipal Run Water System						
Angono	Sanitation	0%	100%	100%	100%	100%
Binangonan	Sanitation	0%	0%	0%	100%	100%
Cardona	Sanitation	0%	0%	0%	100%	100%
RIZWADA						
Baras	Sanitation	0.54%	0%	0%	100%	100%
Jala-jala	Sanitation	0.18%	0%	0%	100%	100%
Morong	Sanitation	0.65%	0%	0%	100%	100%
Pililia	Sanitation	0%	0%	0%	100%	100%
Tanay	Sanitation	0%	0%	0%	100%	100%
Teresa	Sanitation	0%	0%	0%	100%	100%

2.7 Sewerage Service Targets

Table 2.7.1 and 2.7.2 show the target population for sewerage services based on the 1997 Concession Agreement (CA) and the 2003 Rate Rebasing (RR) Submission, respectively. Potential sewage generation and projected sewage flow are calculated for the above targets. The results are shown in Table D.8 and Table D.9 in Appendix D.

Table 2.7.1 Sewerage Population Coverage by Municipality – 1997 Concession Agreement

	Target Population Provided With Sewerage Services				
Year	2005	2010	2015	2020	2025
Mandaluyong	0	255,938	256,183	250,194	235,878
Makati *	181,502	377,304	406,415	419,680	410,431
Quezon *	0	693,566	768,184	886,522	875,731
Pasig	202,361	356,744	374,348	381,806	376,658
Pateros	35,243	58,606	57,356	54,843	52,497
San Juan	0	104,234	96,146	87,857	79,633
Taguig	297,140	521,626	690,655	942,277	1,055,587
Cainta	0	0	0	40,874	44,601
Taytay	0	0	0	73,903	88,465
Total	716,246	2,368,018	2,649,287	3,137,955	3,219,481

*: Part in MWCI service coverage only (assumed based on proportion of population)

Table 2.7.2 Sewerage Population Coverage by Municipality – 2003 Rate Rebasing

	Target Population Provided With Sewerage Services				
Year	2005	2010	2015	2020	2025
Mandaluyong	1,273	10,238	25,618	37,529	35,382
Makati *	139,617	143,375	113,796	96,526	94,399
Quezon *	100,438	167,124	141,275	153,784	151,912
Pasig	43,088	52,462	66,061	78,607	77,547
Pateros	0	0	0	0	0
San Juan	0	0	17,306	36,021	32,650
Taguig	11,428	104,325	213,774	188,455	211,117
Cainta	0	0	0	0	0
Taytay	0	0	0	0	0
Total	295,844	477,525	577,831	590,924	603,008

*: Part in MWCI service coverage only (assumed based on proportion of population)

2.8 Sanitation Service Targets

Table 2.8.1 and 2.8.2 show the target population for sanitation services based on the 1997 Concession Agreement (CA) and the 2003 Rate Rebasing (RR) Submission, respectively. Based on the 1997 CA, around 2 million residents in the east concession area will be provided with sanitation services by Year 2021. On the other hand, the 2003 RR sets much higher targets for sanitation services, and the target served population by 2025 is around 6.2 million. The population to be served specifically with septic tank desludging services will be limited by the actual population with accessible septic tanks. Based on the 2000 Census of Population and Housing, around 83% of the households in the NCR have septic tanks. Accessibility is assumed at 80%, reflecting the ratio of participating households, based on MWCI surveys. Potential septage generation and target septage volumes are calculated for the above targets. The results are shown in Table D.12 and Table D.13 in Appendix D.

Table 2.8.1 Sanitation Population Coverage by Municipality - 1997 Concession Agreement

	Target Population Provided With Sanitation Services				
Year	2005	2010	2015	2020	2025
Mandaluyong	0	0	0	0	0
Makati *	0	0	0	0	0
Quezon *	163,885	133,700	105,956	18,092	17,872
Pasig	286,267	167,879	148,638	140,370	138,477
Pateros	0	0	0	0	0
San Juan	0	0	0	0	0
Taguig	0	0	0	0	0
Marikina	299,128	298,747	279,785	270,939	269,442
Cainta	75,384	74,287	72,033	78,828	86,017
Taytay	178,843	212,638	237,970	266,051	318,474
Angono	22,336	54,706	71,151	85,759	105,298
Antipolo	236,542	465,221	553,189	697,060	901,382
Baras	0	0	0	0	0
Binangonan	36,001	56,950	63,250	74,088	85,452
Cardona	2,840	3,146	3,119	3,709	4,071
Jala-Jala	0	0	0	0	0
Morong	0	0	0	0	0
Pililia	0	0	0	0	0
Rodriguez	0	0	0	0	0
San Mateo	89,666	110,394	125,686	138,616	163,556
Tanay	0	0	0	0	0
Teresa	2,519	4,150	5,630	7,348	8,565
Total	1,393,411	1,581,817	1,666,408	1,780,860	2,098,604

*: Part in MWCI service coverage only

Table 2.8.2 Sanitation Population Coverage by Municipality – 2003 Rate Rebasing

	Target Population Provided With Sanitation Services				
Year	2005	2010	2015	2020	2025
Mandaluyong	253,296	245,701	230,565	212,665	200,497
Makati *	209,425	233,928	292,618	323,153	316,032
Quezon *	672,161	668,498	741,695	750,830	741,690
Pasig	435,669	472,161	484,450	482,872	476,362
Pateros	58,738	58,606	57,356	55,397	53,027
San Juan	111,379	104,234	78,839	51,836	46,983
Taguig	217,141	312,976	608,434	753,821	844,470
Marikina	378,643	409,242	437,165	451,566	449,069
Cainta	164,902	204,304	257,261	291,957	318,581
Taytay	91,715	151,884	277,632	492,688	589,766
Angono	23,266	37,595	97,024	209,167	256,824
Antipolo	164,429	427,521	896,749	1,584,228	2,048,595
Baras	0	0	9,060	27,431	32,150
Binangonan	0	0	113,234	336,762	388,416
Cardona	0	0	17,012	37,086	40,706
Jala-Jala	0	0	9,954	23,404	26,935
Morong	0	0	10,108	35,411	39,795
Pililia	0	0	0	0	0
Rodriguez	49,089	131,765	181,294	230,179	271,350
San Mateo	96,564	180,818	256,502	315,036	371,718
Tanay	0	0	31,308	76,098	86,805
Teresa	0	0	13,404	36,739	42,823
Total	2,926,416	3,639,232	5,101,667	6,778,324	7,642,597

2.9 Sewerage Development for East Concession Area

2.9.1 Constraints on Expansion and Project Implementation

In past studies on sewerage, four major factors have been identified as inhibitors to the implementation of sewerage and sanitation projects. These are: (1) lack of available land, (2) disruption during construction, (3) tariff affordability and willingness-to-pay, and (4) problems in encouraging sewer connections.

The availability of land for sewage treatment plants (STPs) comes out as the primary limiting factor to implementation. A visit on the parcels of land previously identified for sewerage purposes revealed that they are now occupied and/or developed or otherwise allocated for specific purposes. Depending on location, cost for land acquisition could take up as much as 40% of the total project cost. The current average population density of 15,617 persons/square kilometer in Metro Manila reinforces land as a limiting factor in any project.

If land for STPs were available, disruption in terms of social and economic practices is a concern. By experience, a water service connection is enjoyed only 2 weeks upon payment of a connection fee. This timetable includes permits processing and civil works on minor roads. The civil works required to install centralized sewerage networks would involve the excavation of major and minor thoroughfares. Traffic, disruption and permit processing for huge sewerage systems could tie a project to years of implementation depending on its size.

Often, the direct beneficiary of sewerage projects is the environment. Unlike water supply projects from which immediate benefits are felt, the advantages of sewerage and sanitation projects to the populace are unseen and indirect. Hence, convincing people to connect, for a fee with corresponding additional sewer charges, is difficult. This has been learned from the experiences of MWCI & MWSI in implementing sewerage projects.

The above difficulties are further magnified when centralized sewerage systems are contemplated. In developing projects, MWCI and MWSI only have to consider compliance to the Concession Agreement targets. The challenges stated above point to the need for exploring innovative solutions and alternatives such as decentralization and combined systems that should be designed to consider the specifics of particular locations and communities while considering total project feasibility.

2.9.2 Combined Sewer Systems

In the 1997 Concession Agreement, services targets were based on installation of separate sewer systems and direct connections to the sewer system. As part of the 2003 Rate Rebasing (RR) Submission, MWCI requested that MWSS allow implementation of combined sewer systems to achieve the sewerage targets. The MWSS has agreed to a new policy under which combined sewer systems without direct connections can be used as a means to achieve the sewerage targets. In addition to the construction of the combined sewer systems and associated STPs, a program of intensive septage collection and treatment will be continued.

2.9.3 Tariff Structure

The current tariff structure has three components: a base rate that all customers pay on a metered water use basis, an environmental surcharge of 10% of the base rate that all customers pay on a metered water use basis, and a sewerage surcharge of 50% of the base rate that customers with direct sewer connections pay based on metered water consumption.

To eliminate the disincentive for customers to connect to the sewer system, and given the policy of the acceptance of combined sewer systems as a means of achieving the sewerage targets, as well as the projects being executed by MWCI some of which involve combined sewer systems with intensive septage collection and treatment; MWCI will seek a revision of the tariff structure that will eliminate the sewer surcharge and increase the percentage of the environmental surcharge. The incremental percentage will be used for implementation of sewerage and sanitation improvements that will improve environmental quality in Metro Manila.

2.9.4 Ongoing Sewerage and Sanitation Projects

Various funding institutions have previously supported the MWSS for its sewerage and sanitation initiatives. The Japan International Cooperation Agency (JICA), Asian Development Bank (ADB) and the World Bank (WB) have contributed in the conduct of studies and project implementation. Implemented and ongoing projects focus on the improvement of existing systems and septage management.

(1) Manila Second Sewerage Project (MSSP)

In 1980, the World Bank financed the Manila Sewerage and Sanitation Project along with the Asian Development Bank. The start of the project coincided with the onset of economic difficulties in the Philippines so that some components were not completed and others failed to have the anticipated impact.

In 1996, with the improved economic situation in the Philippines, the World Bank resumed its assistance to the MWSS for the improvement of the general environmental conditions in Metro Manila. The US$ 57 million Manila Second Sewerage Project (MSSP) was finalized in June 1996. This was ultimately amended and reduced to US$ 36.1 million due to the savings from the devaluation of the peso, among others.

The MSSP has the ultimate objectives of (1) reducing the pollution of Metro Manila waterways and Manila Bay, (2) reducing the health hazards associated with human exposure to sewage in Metro Manila, and (3) establishing a gradual low-cost improvement of sewerage services in Metro Manila by expanding MWSS' septage management program. The MSSP focuses on the provision of a septage management program and a rehabilitation/upgrading of existing sewerage systems.

The concessionaires will accomplish their respective MSSP commitments before the loan expiry in December 2004. Notable project components include the construction of package STPs in the East Zone and the construction of a septage treatment plant for the West Zone.

(2) Pasig River Rehabilitation Project (PRRP) – Sanitation Component

The Sanitation Component of the Pasig River Rehabilitation Project (PRRP) is part of a US$ 175 million ADB policy and investment loan aimed at promoting policy reforms and physical improvements to enhance the water quality of the Pasig River, its tributaries and esteros, to Class C (define) standards by 2014.

Project components include: (a) establishment and development of ten meter wide environmental preservation areas (EPA) along the riverbanks, (b) upgrade of infrastructure and the provision of municipal services and facilities in urban renewal areas (URA) adjacent to the EPAs, (c) elimination of illegal dumping of municipal solid waste into the river system and the (d) Sanitation Component.

The Sanitation Component, which will be implemented by MWSS and MWCI, will involve the provision of septic tank maintenance services through the procurement of 36 vacuum tankers and the construction of a 600 m^3/d septage treatment plant to reduce the volume of untreated sewage being discharged into the Pasig River. With this project, approximately 37,000 septic tanks will be emptied annually. This amounts to a reduction in BOD loading of 16 tons/d. The SPTP is expected to operate in 2007.

(3) Lessons Learned from Ongoing Sewerage and Sanitation Projects

Close coordination with LGUs, housing agencies and the beneficiary communities impact positively on project implementation. Intensive and regular consultations with affected communities are necessary to ensure cooperation during implementation and payment of corresponding fees for connection to the sewer system as well as for sewer charges. However, proper consultation does not ensure willingness to pay for connection fee and/or sewer charges.

Case 1 - MSSP Community Sanitation Project (MCSP)

The MCSP involved the construction of 26 on-site STPs. The facilities in the communities subject of this component are unable to meet the DENR effluent quality standards and directly contribute to the pollution of inland rivers and waterways. During project conceptualization, the communities were properly consulted and provided project details. Memoranda of Agreement (MOA) were executed for easements on the lots for the STPs as well as sewer charging. However, even with due consultation, six out of 26 projects were cancelled. At the time when construction was about to commence, the communities reneged on the MOAs due to the issue on sewer charging.

Case 2 - MSSP-4

One of MWSI's MSSP commitments is the installation of about 10,000 new sewer service connections, the cost of which shall be chargeable to the loan. From October 2001 to present, MWSI was able to implement less than 1,000 stub-outs for connections. Again, sewer charges coupled with absence of direct benefits are the people's main contention for not connecting.

Case 3 - Pateros Sewer System

Pateros is the smallest municipality in Metro Manila with an approximate land area of 120 hectares. Its economy consists of small commercial establishments and home-based industries. The majority of its population belongs to the low-middle income classes.

In 2001, MWCI proposed to install a separate sewer system for the municipality of Pateros and portions of Taguig. The proposal was in connection with the original CA sewer targets. The proposal was rejected by the LGU due to non-availability of land, possible traffic disruptions and issues on capacity to pay. The LGU instead, suggested that MWCI focus on the improvement and provision of low-cost sanitation services for pocket areas in the municipality that has little or no access to sanitation facilities.

Septage Sea Disposal Trial (2001-2002)

Innovative but environmentally sound and approved modes of disposal have to be taken while septage treatment plants are being developed. Regular septic tank emptying services is integral to fulfilling the health and environmental requirements of a city that uses septic tanks for the most part. Public's perception and the "Not In My Backyard" (NIMBY) principle are two of the most difficult issues that cannot be circumvented in any waste-related project.

In the absence of proper septage disposal facilities, the MSSP included a septage sea disposal trial. A total of 5,000 septic tanks were emptied for the duration of the trial, from May 2001 to June 2002. The trial ended without any deleterious effect to nature and society.

However, full operation of the septage sea disposal component did not push through due to social pressures from LGUs and an NGO. MWSS had to immediately cease the septage sea disposal operations, which were originally planned up to 2015. The issue even merited the World Bank's Inspection Panel which, after conducting preliminary dissection, recommended action plans on septage management.

The action plans included a septage management program with focus on the provision of sanitation services and the construction of septage treatment plants. These are considered in future sewerage and sanitation projects to be undertaken by MWSS.

In the meantime, septage disposal alternatives, such as application to lahar-laden areas, are being explored while development of land-based septage treatment plants is ongoing.

(4) Manila Third Sewerage Project (MTSP)

Objectives

In line with the objective of MSSP to assist MWSS in the development of follow-up sewerage projects, MWCI proposed the Manila Third Sewerage Project (MTSP) for World Bank funding. The MTSP is a follow-up to the MSSP and has the ultimate objective of improving sewerage and sanitation conditions in the East Zone concession area.

Project Conceptualization

Conceptualization of the MTSP components took into account the limitations and lessons learned from implementing past projects on sewerage and sanitation. Such limitations and lessons as well as the MWCI Concession Agreement targets ruled the selection of the project area and the nature of the project to be executed.

The conceptualization stage was guided by the following:

- *Concession Agreement Targets*

As stated previously, the 1997 Concession Agreement had service targets for sewerage that would have been unaffordable and technically difficult to implement. Also, the service targets that were established were distributed over a number of different municipalities throughout the concession area, leading to an inherently decentralized approach. Importantly, MWSS agreed to accept combined sewer systems in terms of achieving the sewerage service targets. MTSP was formulated within the context of the 2003 Rate Rebasing as a means of achieving the 2010 targets for sewerage and sanitation.

- *Land Availability*

Recognizing land as a major limitation in project implementation, MWSS and MWCI took a close look at the land availability in the areas where the MWSS set new sewerage targets. The elected representatives of the LGUs, as administrators of cities and municipalities, played a big role in identifying possible sites for sewerage facilities. Possible linkages with existing and future projects of different agencies such as the National Housing Authority, the Department of Public Works and Highways, the LLDA and the PRRP were also explored.

- *Applicable Concepts*

Previous master plans pointed to the use of combined sewerage systems as the means to expand sewer coverage at the least cost and minimum disruption. This was heavily considered in conceptualizing the MTSP.

Programs to address the sanitation requirements of low-income groups and the portion of the population that has no access to basic sanitation facilities were also explored.

- *Social Acceptability*

Technical and financially feasible projects do not get implemented if they are socially unacceptable. Hence, social indicators will be obtained prior to implementation of projects conceived for MTSP.

Selection Criteria and Methodology

The following describes in detail how the components of MTSP were finalized.

- *Concession Agreement Targets*

  The 2003 Rate Rebasing established targets for sewerage and sanitation that reduced the sewerage targets and increased the sanitation targets. The 2003 Rate Rebasing established targets for different municipalities within the service area. The sewerage targets could be met through development and upgrading of separate sewerage systems in some areas by converting community septic tanks to STPs and development of combined systems with STPs in low income and heavily developed areas, as well as development of septage treatment facilities. Given the contractual obligations of MWCI and MWSS under the Concession Agreement with the revised targets, MTSP was developed as a means of achieving the 2010 service targets. Since the service targets are distributed throughout the service area, it was necessary to develop a variety of components in several municipalities. Also, since septage collection and treatment is necessary to meet the sanitation service targets, the septage treatment facility is a necessary component of MTSP. Alternatives evaluated during the development of the component included the number of plants necessary, the potential locations of the plants and the treatment processes.

- *Availability and Land Criteria*

Both sewage and septage treatment plants require land that are preferably far from residential communities to avoid nuisance that may be caused by the plant's odor or noise emissions. These criteria should be considered without prejudice to the requirement of accessibility to tankers, for septage treatment plants. Distance and accessibility has to be weighed against cost for transport or pumping of septage and sewage, respectively.

The ideal site for either sewage treatment plants or septage treatment plants should be close to main drainage channels or receiving water bodies. It should also be free from informal settlers. It should not be the subject of any pending legal case on ownership or jurisdiction.

Precluding the above criteria, the availability of land for treatment plants dictates project area selection. Aerial photographs of Metro Manila, the latest of which were taken in 1996, give a glimpse of the city's landscape. These pictures indicate that vacant tracts with sizes ranging from one to five hectares are concentrated in Taguig.

An investigation of the present status of the identified vacant spaces revealed that the parcels have now been developed into commercial or industrial complexes. Some have been encroached upon by informal settlers or developed into housing projects by the LGUs or the National Housing Authority (NHA).

In view of these developments, the Project Development Team consulted with the administration of each LGU in the East Zone to determine projects and locations that could be relevant to the improvement of sewerage and sanitation services. From these consultations, MWSS-MWCI learned of the DPWH Flood Control Project in Taguig and the EPA component of the PRRP. Part of PRRP's activities is the conversion of the EPAs into river parks. The management of the river parks, from pre- to post-construction phase is in the hands of the LGUs.

The proponents also made consultations with agencies tasked to develop housing projects (NHA, Bases Conversion Development Authority, Housing and Urban Development Coordinating Council, Home Guaranty Corporation) to determine the required water and wastewater services for their existing and planned projects. This opened up the concept of sewerage projects for low- to middle-income communities assisted by the housing agencies. In this case, the housing authorities are willing to allocate land for sewerage purposes.

- *Catchment Area Selection*

The types of sewage collection networks that will be installed through MTSP will be site-specific. Combined sewer systems are proposed for highly built-up or densely populated areas where major or minor excavations will be socially and economically unacceptable. The scope of the catchment area of each MTSP component are influenced by topography, the layout and status of existing drainage channels, and the size of available land for the STP.

A survey of the drainage outfalls along the stretches of the Pasig River and the Marikina River was conducted by the MWSS-MWCI Project Team in 2001 and 2004, respectively.

This was plotted and superimposed on a map showing previously identified vacant, feasible STP locations. The survey showed that some main drainage outfalls are near the intended PRRP river parks which are possible locations of underground STPs. An in-depth analysis of the drainage systems leading to the main drainage outfalls helped in delineating the boundaries for the Riverbanks STP component.

Allowable treatment capacity per a given land area also delimits a catchment area. This, along with consideration of disruptions due to major excavation, is a significant factor in determining the catchment areas for each of the communal septic tanks considered for upgrade in *the Upgrade of Existing Sanitation Systems* component.

The catchment area for the Taguig Sewerage System is largely influenced by the scope of the DPWH Flood Control Project whose major consideration are the river channels, existing drainage systems and the seasonal variation in elevations of the Laguna Lake.

- *Health/Environmental Impact*

MTSP was initially formulated to arrest direct discharges of untreated wastewater to water bodies. Hence, an immediate approach is the survey of drainage outfalls to the Pasig and Marikina Rivers. However, the results of a survey conducted late 2003 on some MTSP project areas show that designing the components should consider prioritizing human benefits over environmental benefits, in some cases.

- *Financial and Economic Considerations*

MTSP affected communities are in the low- to middle-income brackets. The impact of the sewer charges which the sewered communities will pay once the STPs operate is considered in finalizing the list of project components especially for the *Sanitation for Low-Income Communities component.*

<u>**Description and Development of MTSP Components**</u>

The MTSP will have the following thrusts.

Sewerage systems and treatment will involve the construction of sewer networks and treatment plants in several locations in the MWCI concession area. Some of the STPs will treat combined sewage and drainage flows. Existing communal septic tanks servicing population already paying the sewer charges will also be upgraded to secondary level of treatment.

Septage management will include the construction of septage treatment plants to process septage from domestic septic tanks and the procurement of vacuum desludging tankers.

The technical assistance component will focus on information and education campaigns on proper liquid waste disposal and environment preservation and the preparation of follow-up programs on sewerage and sanitation, with emphasis on low-cost sanitation systems.

The narrative below details the evolution of each component of the MTSP from its conception in 2003. The development of each component takes into account discussions with the World Bank, LGUs and technical experts.

- *Taguig Sewerage System*

Taguig is a low- to middle-income municipality with an area of 47.88 km^2 and a population of about 467,000 as of 2000. It is traversed by creeks that lead to the Laguna de Bay on the municipality's southeastern boundary. The municipality's general topography slopes towards the lake. Available parcels of land are also concentrated near the lakeshore. Design for sewerage projects draws on these characteristics.

Taguig experiences floods lasting for at least three months when the Laguna de Bay swells during rainy season. The Department of Public Works and Highways with the assistance of JICA conducted a study for the control of flooding in the municipality and nearby affected areas. The study led to the proposed Laguna Lakeshore Dike Project which consists of the construction of four (4) drainage/flood retention ponds adjacent to the Laguna de Bay and an earthen dike. Floodwater will be held and pumped out of the ponds during heavy storm events. The feasibility study for the Laguna Lakeshore Dike Project involved a scheme where the ponds may be used for wastewater treatment during dry season.

Originally, this component dwelled on using the ponds as oxidation ponds for six months of the year. Off line STPs were intended in 2014 to coincide with increased development in the area. This option involves risks on sludge accumulation, compliance to effluent quality standards and major dependencies on the operation of the pumping stations and floodgates. The feasibility study for this component also evaluated combined and separate sewer systems for the service area. Combined system with drainage upgrading came out as the more feasible option.

To reduce the risks associated with the use of the ponds as on line treatment, off line primary treatment and the use of the ponds for polishing was explored. Although this option would entail acquisition of significant tracts of land, an in-depth analysis of technical and financial factors shows this to be the more practicable alternative to realize the impacts intended by this component.

- *Riverbanks Wastewater Treatment Plants*

The base case scenario for sewer coverage in the East Zone looks at separate sewer systems as the mode for expansion. High cost and the constraints previously discussed discourages implementation of networks of separate sewers and directs attention to the development of combined systems, taking advantage of existing drainage networks.

In Metro Manila, jurisdiction over drainage systems varies depending on size, location and ownership, if installed as sponsored projects. There is no master layout that should have catalogued the existing drainage systems. Physical inspection is the only resort to determine catchment boundaries and volumes. Hence, the project proponents did intensive surveys on land and via river systems to identify drainage outfalls of significant flows, determine catchment boundaries and relate available land to the location of major outfalls.

Finally, this component was packaged to involve the construction of three underground STPs along the riverbanks of Pasig River, located in Makati, Mandaluyong, and Pasig. Sewage will be intercepted and collected from existing drainage lines in these areas for treatment before discharge to Pasig River. Rehabilitation and upgrade of the drainage outfalls and lines will be included in the project.

Recent developments and major changes involve the Makati (Poblacion) system for which the STP will no longer be co-located beneath an existing park. The Poblacion system will involve the construction of a STP over a portion of the flood retention pond of the Metropolitan Manila Development Authority (MMDA) adjacent to the Pasig River. This, along with flows from the original catchment of the Poblacion system which will be pumped to pond, will be treated at the elevated STP before discharge to the Pasig River.

- *Quezon City-Marikina Sewerage System*

The development of this component used the same principles as the Riverbanks STPs component.

This project will utilize portions of the legal easement for Marikina River. Main drainage collector pipes which collect combined sewage and drainage from communities in Quezon City and Marikina will be connected to a STP to be constructed to treat the dry weather drainage/sewage flow.

At the start this component considered serving only the Sitio Olandes and Blue Ridge communities. The coverage area of this component has also been improved over time.

- *Septage Treatment Plants*

This project is essential in providing sanitation services and proper septage disposal. In 2002, MWCI proposed the construction of the following SPTPs to serve areas on Rizal on the assumption that the STP under the ADB-assisted Pasig River Rehabilitation Project (PRRP) will be located in Taguig to serve majority of Metro Manila.

Location	Service Area
San Mateo, Rizal	Quezon City, San Mateo, Marikina and Rodriguez
Taytay, Rizal	Taytay, Cainta, Antipolo and Teresa
Binangonan, Rizal	Angono, Binangonan, Cardona, Morong, and Baras

This proposal was rendered useless when it was agreed that the PRRP SPTP be located in Antipolo. Metro Manila's demand for sanitation services was projected to grow from 1,019 m^3/d in 2005 to 1,400 m^3/d in 2025. This dictated the need for STP(s) to augment the PRRP SPTP treatment capacity. Location, in terms of cost and strategic operation, directed the eventual plan to construct two SPTPs with capacities of 586 m^3/d and 814 m^3/d in Payatas, Quezon City (North SPTP) and FTI Complex in Taguig (South SPTP), respectively.

The North SPTP will be located near a solid waste facility; the South SPTP will be located in a mixed-use industrial complex.

- ***Sanitation for Low-Income Communities***

  This component originally involved the construction of Communal Septic Tanks or STPs, as appropriate, and shallow, small-diameter sewer lines to serve some low-income communities in the East Zone which have inadequate sanitation facilities.

  The list has been narrowed down to two (Pinagsama, Taguig and East Bank, Taytay) in lieu of issues on willingness and capacity to pay for water and sewer charges. STPs will be constructed for these communities using combined systems with drainage upgrading. The feasibility of separate systems was also considered and found impractical and expensive.

- ***Upgrade of Existing Sanitation Systems***

  Quezon City has the biggest land area among the cities and municipalities in Metro Manila. Aside from the cities of Manila and Makati, parts Quezon City have existing sewerage systems consisting of sewer lines connected to communal septic tanks (CST). These 30 septic tanks were constructed in the 1950's and turned over to MWSS for operation and maintenance. These facilities do not meet regulatory standards on effluent quality.

  The original intent of this component was to upgrade the CSTs to STPs. Ten of the 30 CSTs are already being upgraded under the MSSP. This will ensure compliance with environmental standards for wastewater effluent.

  Only five CSTs were originally identified for upgrading under MTSP in view of accessibility and ownership issues. Some of the lots on which the CSTs are located are occupied by informal settlers or are now privately owned owing to circumstances beyond MWSS control.

  As a result of the discussions with the World Bank representatives and technical experts, this component has been improved and will now adopt a regional scheme where a number of CSTs will be linked and directed to one STP. Additional sewer lines is planned for installation in areas that could be connected to the existing sewer networks. From five CSTs, this component will now include treatment for the wastewater from seven CSTs and adjacent areas.

SECTION 3

Fundamentals for Master Plan Update

SECTION 3 FUNDAMENTALS FOR MASTER PLAN UPDATE

This section presents fundamentals, which are being applied to Master Plan Update.

3.1 Service Area

Service area of sewerage and sanitation area is the same as the service area of MWCI concessionary service area consisting of a part of NCR and Rizal province. Whole area, however, is not covered by sewerage system or septage management system from initial stage. The service area under both systems will be gradually widened in accordance with the schedule of service targets.

Table 3.1.1 MWCI Service Area

City / Municipality	Area (ha.) **
Mandaluyong	1,107
Makati *	2,475
Manila *	347
Marikina	2,265
Quezon *	5,979
Pasig	3,188
Pateros	195
San Juan	588
Taguig	2,752
Antipolo	30,610
Cainta	1,019
Rodriguez *	27,575
San Mateo	6,490
Taytay	3,364
Baras	2,340
Jala - Jala	4,930
Morong	3,760
Pililia	7,390
Tanay	24,340
Teresa	1,860
Angono	2,600
Binangonan	7,270
Cardona	3,120
Total	145,564

*: Part in MWCI service coverage only (MTSP)
**: NCR; MMEIRS Data, Rizal; Rizal Prov. Gov. Website

3.2 Population Projection

Current and future population was projected based on the results of national population census conducted by National Statistics Office (NSO) in 2000. The NSO has not yet issued the new population projection based on the NSO 2000 Census data. For updating the master plan, the consultants projected the population up to 2025 following the same methodology applied to the NSO 1995 projection based on the 2000 Census data.

The results of the population projection are presented in Table 3.2.1. Population density of each municipality is calculated for Year 2005, 2010, 2015, 2020 and 2025 and shown in Figure 3.2.1 and 3.2.2.

Table 3.2.1 2000 to 2025 Population Projections per City/Municipality (Year 2005 - 2005)

Municipality	Area (ha.) **	p/ha 2000	Year 1980	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Municipality
Mandaluyong	2,600	107	205,366	248,143	285,872	278,474	279,455	270,589	279,626	279,583	279,439	278,396	277,300	276,162	274,968	273,731	Mandaluyong
Makati *	2,640	149	329,405	400,602	426,522	393,262	398,445	402,431	406,274	409,694	413,557	415,787	417,857	419,846	421,708	423,461	Makati *
Manila *	323	413	137,613	135,144	139,175	133,443	132,756	131,685	130,589	129,477	126,340	126,816	125,295	123,784	122,276	120,775	Manila *
Marikina	2,150	182	211,613	310,227	355,988	391,170	398,060	403,784	409,388	414,887	420,247	424,244	428,125	431,906	435,559	439,101	Marikina
Quezon *	5,714	142	433,702	621,157	737,488	808,665	821,471	831,843	841,944	851,811	861,372	868,124	874,632	880,929	886,960	892,758	Quezon *
Pasig	3,100	163	268,570	397,679	469,435	505,058	512,879	519,176	525,303	531,281	537,066	541,099	544,979	548,726	552,308	555,745	Pasig
Pateros	210	273	40,288	51,409	55,094	57,407	57,839	58,095	58,329	58,545	58,738	58,739	58,726	58,701	58,660	58,606	Pateros
San Juan	1,072	110	130,088	126,854	123,755	117,680	116,883	115,752	114,605	113,449	112,277	110,772	109,276	107,795	106,322	104,863	San Juan
Taguig	3,370	139	134,137	266,637	380,023	467,375	490,560	513,093	536,222	559,967	584,278	607,395	630,997	655,009	679,649	704,662	Taguig
Antipolo	30,610	15	69,812	210,588	344,219	470,866	507,819	546,072	585,357	625,830	667,324	716,315	766,621	818,329	871,218	925,370	Antipolo
Cainta	1,019	238	59,025	126,839	200,796	242,511	250,167	257,435	264,205	270,575	276,495	284,565	292,142	299,284	305,938	312,162	Cainta
Rodriguez *	27,575	4	36,901	59,130	69,970	101,527	106,880	112,215	117,476	122,694	127,837	134,118	140,326	146,478	152,535	158,514	Rodriguez *
San Mateo	6,490	21	51,910	82,310	98,846	135,603	142,786	149,949	157,015	164,026	170,940	179,378	187,722	195,995	204,143	212,191	San Mateo
Taytay	3,364	59	75,328	112,403	144,206	198,183	209,469	220,800	232,059	243,309	254,480	267,997	281,455	294,885	308,206	321,448	Taytay
Baras	2,340	10	11,196	16,880	19,985	24,514	25,767	27,013	28,237	29,448	30,638	32,097	33,535	34,956	36,351	37,725	Baras
Jala - Jala	4,930	5	11,945	16,318	19,799	23,280	24,353	25,410	26,438	27,444	28,423	29,642	30,832	31,996	33,128	34,231	Jala - Jala
Morong	3,760	11	24,858	32,165	35,913	42,489	44,171	45,804	47,386	48,873	50,314	52,163	53,940	55,656	57,297	58,872	Morong
Pililla	7,390	6	23,222	32,771	36,942	45,275	47,380	49,455	51,474	53,453	55,378	57,774	60,114	62,407	64,636	66,811	Pililla
Tanay	24,340	3	40,443	58,410	68,922	78,223	81,639	84,986	88,222	91,375	94,422	98,255	101,977	105,602	109,105	112,502	Tanay
Teresa	1,860	16	14,781	20,645	23,817	29,745	31,221	32,683	34,117	35,530	36,915	38,620	40,296	41,947	43,564	45,151	Teresa
Angono	2,600	29	26,511	46,014	59,222	74,668	79,447	84,296	89,173	94,069	99,048	104,967	110,926	116,935	122,962	129,018	Angono
Binangonan	7,270	26	80,980	127,561	140,174	187,691	196,458	205,100	213,515	221,766	229,798	239,785	249,544	259,109	268,415	277,499	Binangonan
Cardona	3,120	13	24,503	32,962	35,368	39,003	40,297	41,531	42,687	43,782	44,806	46,181	47,479	48,709	49,862	50,948	Cardona
+																	
Total			2,442,197	3,532,847	4,271,531	4,846,112	4,906,201	5,138,196	5,279,622	5,421,199	5,562,130	5,713,209	5,864,097	6,015,235	6,165,771	6,316,145	Total

*: Part in MWCI service coverage only (MTSP)

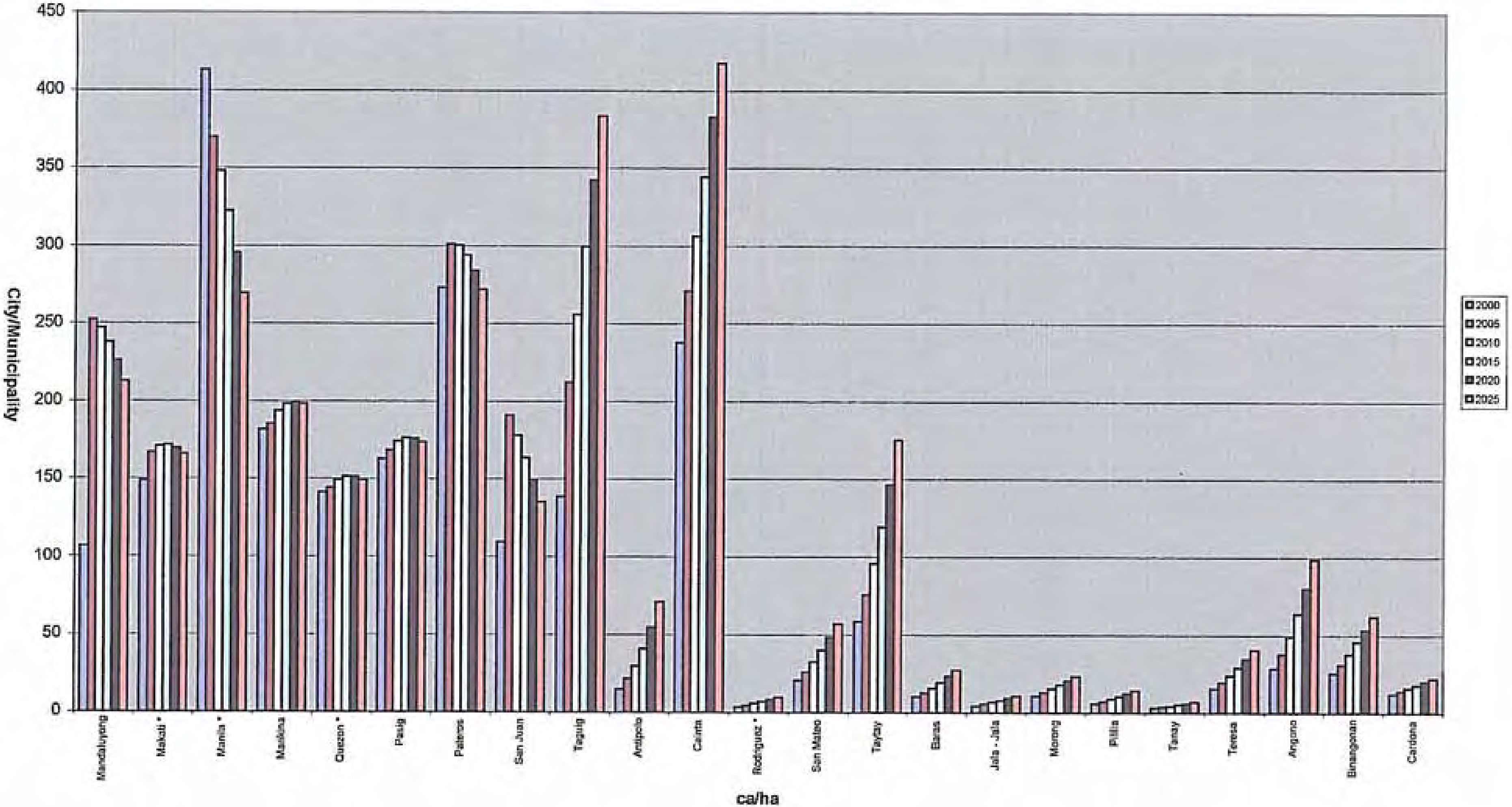
**: NCR; MMEIRS Data, Rizal; Rizal Prov. Gov. Website

Municipality	Area (ha.) **	p/ha 2025	Year 2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Municipality
Mandaluyong	2,600	91	271,670	269,519	267,430	265,353	263,292	260,609	257,957	255,336	252,748	250,194	247,237	244,326	241,462	238,646	235,878	Mandaluyong
Makati *	2,640	155	423,606	424,097	424,337	424,529	424,676	423,743	422,774	421,772	420,739	419,680	417,854	416,014	414,161	412,299	410,431	Makati *
Manila *	323	289	118,920	117,101	115,318	113,572	111,863	109,920	108,023	106,170	104,361	102,596	100,695	98,843	97,040	95,284	93,574	Manila *
Marikina	2,150	209	441,178	443,188	445,132	447,014	448,835	449,497	450,098	450,642	451,130	451,566	451,152	450,692	450,189	449,647	449,069	Marikina
Quezon *	5,714	156	895,581	898,272	900,837	903,281	905,611	905,615	905,510	905,305	905,004	904,614	902,940	900,395	898,187	895,920	893,603	Quezon *
Pasig	3,100	179	557,329	558,833	560,260	561,612	562,895	562,734	562,507	562,220	561,876	561,479	560,039	558,558	557,040	555,489	553,909	Pasig
Pateros	210	253	58,361	58,113	57,863	57,610	57,356	56,962	56,568	56,176	55,785	55,397	54,914	54,435	53,960	53,491	53,027	Pateros
San Juan	1,072	74	103,181	101,378	99,693	98,045	96,435	94,631	92,871	91,156	89,485	87,857	86,119	84,428	82,784	81,186	79,633	San Juan
Taguig	3,370	313	727,896	751,521	775,531	799,920	824,683	847,737	871,032	894,560	918,311	942,277	964,734	987,304	1,009,976	1,032,740	1,055,587	Taguig
Antipolo	30,610	71	985,549	1,049,229	1,116,591	1,187,826	1,263,134	1,338,540	1,417,937	1,501,515	1,589,468	1,682,002	1,771,673	1,865,938	1,964,303	2,067,333	2,175,029	Antipolo
Cainta	1,019	417	319,528	327,096	334,872	342,868	351,090	358,430	365,965	373,706	381,660	389,837	396,577	403,495	410,597	417,891	425,387	Cainta
Rodriguez *	27,575	10	165,217	172,179	179,411	186,925	194,730	202,208	209,951	217,970	226,275	234,877	242,766	250,903	259,296	267,954	276,888	Rodriguez *
San Mateo	6,490	57	221,209	230,579	240,314	250,428	260,938	271,011	281,443	292,249	303,441	315,036	325,677	336,654	347,978	359,662	371,718	San Mateo
Taytay	3,364	175	336,240	351,650	367,702	384,423	401,841	418,676	436,153	454,296	473,132	492,688	510,840	529,603	548,996	569,043	589,766	Taytay
Baras	2,340	28	39,266	40,860	42,527	44,250	46,038	47,745	49,511	51,338	53,229	55,186	56,972	58,812	60,709	62,665	64,681	Baras
Jala - Jala	4,930	11	35,478	36,769	38,104	39,465	40,914	42,261	43,652	45,086	46,567	48,096	49,466	50,875	52,325	53,816	55,351	Jala - Jala
Morong	3,760	23	60,670	62,540	64,460	66,439	68,480	70,366	72,306	74,303	76,358	78,475	80,316	82,207	84,148	86,142	88,190	Morong
Pililla	7,390	15	69,269	71,812	74,443	77,167	79,986	82,645	85,390	88,223	91,148	94,169	96,880	99,669	102,539	105,491	108,531	Pililla
Tanay	24,340	7	116,360	120,345	124,462	128,716	133,112	137,227	141,469	145,841	150,349	154,997	159,123	163,362	167,720	172,199	176,806	Tanay
Teresa	1,860	41	46,936	48,786	50,705	52,694	54,757	56,718	58,746	60,842	63,010	65,252	67,267	69,383	71,542	73,767	76,059	Teresa
Angono	2,600	99	135,758	142,815	150,201	157,933	166,024	173,947	182,209	190,823	199,804	209,167	218,010	227,184	236,703	246,579	256,824	Angono
Binangonan	7,270	62	287,757	298,373	309,360	320,732	332,505	343,618	355,090	366,931	379,158	391,784	403,128	414,797	426,803	439,159	451,878	Binangonan
Cardona	3,120	23	52,222	53,531	54,877	56,262	57,687	58,969	60,285	61,638	63,028	64,457	65,651	66,876	68,133	69,423	70,749	Cardona
Total			6,469,263	6,629,592	6,794,429	6,967,084	7,146,880	7,313,808	7,487,448	7,668,097	7,856,067	8,051,682	8,229,850	8,414,750	8,606,649	8,805,827	9,012,571	Total

*: Part in MWCI service coverage only (MTSP)

**: NCR; MMEIRS Data, Rizal; Rizal Prov. Gov. Website

Fig. 3.2.1 Population Density Projections (2000 - 2025)



3.4 Catchments

Metro Manila area is divided into drainage sub-catchments as shown in Figure 3.4.2. Catchment boundaries are adopted from 1996 JICA Master Plan, which is based on the 1990 study on flood control and drainage project in Metro Manila commissioned by JICA. Areas of sub-catchments are measured on the latest CAD maps and presented in Figure 3.4.1.

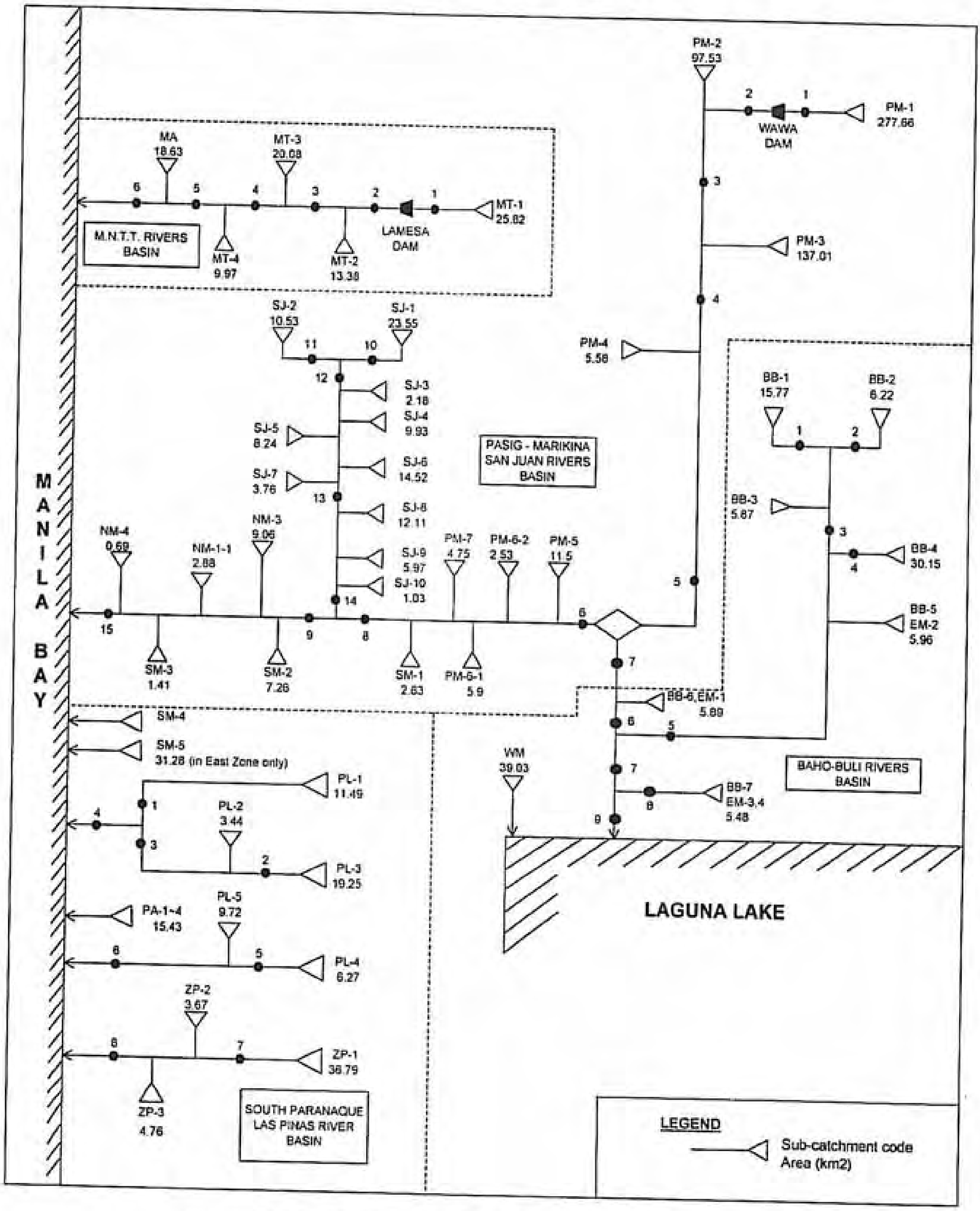


Figure 3.4.1 Drainage Sub-catchments in Metro Manila

decreasing. Considering this situation, the base rate was assumed as same as the recent 5 year average growth rate at -1.99%.

(4) Antipolo

In order to avoid extraordinary projection under NSO projection method, the base rate was assumed to be same as the recent 5 year average growth rate at 0.94%. Even with this rate, population will increase about 7% per annum for first 5 years up to 2005.

(5) Cainta

In order to avoid extraordinary projection under NSO projection method, the base rate was reduced to -3.5%. This rate provides a population increase at about 2.7% per annum for first 5 years up to 2005. In this projection, the population will exceed 425,000 in 2025 with a population density at 417 persons per hectare, which is almost equal to the present population density of Manila City.

3.3 Land Use

3.3.1 General

Land use plans, or CLUPs, were obtained from planning and development offices of eight (8) cities and towns that are, as per the concession agreement and/or the 2003 rate rebasing document, covered in the sewerage development targets of MWCI, or included in present sewerage development programs of MWCI. It is noted that the land areas are inconsistent among the different data/documents collected from the LGUs themselves, the MMDA, the Rizal Provincial Government, etc. For the sewerage planning in this Master Plan, areas will be based on official NAMRIA maps.

In many of the cities, particularly in the NCR area, the approved/proposed land use provides for an increase in residential and commercial areas, and a decrease in industrial areas. This implies that in the future, industrial activity will be less, and the ratio of industrial water needs and wastewater production to that for residential and commercial uses will be less. Per the approved/proposed land use plans, both residential development and commercial activity are expected to increase, and as such, the ratio of water needs and wastewater production between the two can be assumed to remain the same. Land conversion, particularly of industrial areas to residential/commercial areas, and the creation of new developments, provide for an opportunity to put in new infrastructure, including sewerage systems. However, on the negative side, there may also be more NIMBY resistance to the putting-up of sewerage systems, particularly sewage treatment plants (STPs) in these new residential/commercial areas. In general, industrial zones are considered to be "compatible" with STP operations; for residential/commercial areas, some level of public resistance is expected.

The PRRC plans for the development of linear parks along 10-m easements along Pasig and Marikina River are supported by the concerned LGUs (e.g. Pasig, Makati, Mandaluyong, Marikina), which have enacted new land use/zoning plans and ordinances allocating space for such easements. These easements can be considered for the installation of interceptors /trunk sewers, and even small STPs, if these are included in the strategy evaluated to be most viable.

3.3.2 Quezon City

The present land use plan for the City was approved in 2002, and is shown in Table 3.3.1.

Table 3.3.1 Quezon City Land Use

Classification	Actual Land Use, 1995 Area (ha)	Land Use, Approved 2002 Area (ha)
Residential	6,350	7,429
Commercial	580	1,291
Industrial	769	954
Institutional	928	1,153
Open Space and Reservoir	2,700	na
Utility	225	2,600*
Socialized	na	74
Special Dev't. Zone	na	261
Parks/Recreational	na	437
Cemeteries	71	213
Roads and Waterways	na	1,698
Military	205	na
Vacant	4,284	na
Total	16,112	16,112

Source: Quezon City Planning and Development Office
Note: *area for UTILITY in proposed land use deemed miscalculated

In the present land use, residential area slightly increased by 17% as compared to the actual residential area in 1995. Commercial area significantly increased from 580 ha (1195 actual) to an allotment of 1,291 ha in the present land use. This is brought about by several proposed new commercial areas as shown in Table 3.3.2. Notwithstanding conversion of some industrial areas, most of the existing industrial areas will remain. Existing institutional areas shall be maintained.

Table 3.3.2 Major Urban Development Projects of Quezon City

Project	Description/Remarks
North Triangle Business District Development	Mixed Use Development incorporating the Mass Rail Transit with Business and Residential Development
CBD Development Program (Metro Centro Quezon City Dev't. Program)	Revitalization of the Cubao Business District to fully utilize its potential as the new entertainment and retail center and major transport hub
Eastwood City Cyberpark	Special economic zone dedicated to local and international information technology where IT based services and products for export are located and integrated with residential, recreational and commercial facilities
Balintawak Urban Development Zone	Regeneration of old industrial sites through mixed-use development
Payatas Urban Development Zone	Rehabilitation of the dumpsite and its immediate surroundings incorporating an ecological solid waste management facility, livelihood projects, and low-cost housing
NGC Development Program	Another mixed-use development project integrating the National Government Offices with residential and commercial activities
Development of Jacinto Steel Property .	Located at the junction of Quirino Highway and Regalado Ave. Property is ideal for mixed-use development.
Development of Quezon Institute Property	Mixed-use development integrating the existing institutional areas with medium-rise commercial and residential buildings.
Development of East Triangle Area	Mixed-use development incorporating commercial and ecopark activities with the present institutional uses.

Source: Quezon City Planning and Development Office

3.3.3 Marikina

As shown in Table 3.3.3, comparing the actual land use in 1999 and the approved land use for the medium-term (2010), there are no substantial changes between the two, except for the mixed-use zone, which will be re-classified to a commercial zone. As per Marikina's CLUP, industrial activities will be concentrated in parts of Barangay Parang and parts of Barangay Marikina Heights. Marikina's Central Business District, where the Riverbanks Mall is presently located, shall continue to be developed. This district is dubbed the Business, Food and Finance Triangle, a "commercial center development which integrates intelligent business, residential, shopping and leisure facilities."

Table 3.3.3 Marikina City Land Use

Classification	Actual Land Use, 1999	Land Use, Approved, 2000
	Area (ha)	Area (ha)
Residential	813.06	801.45
Commercial	132.82	243.81
Industrial	280.57	295.65
Institutional	72.60	95.23
Parks/Open Spaces/Recreation	61.91	50.08
Mixed Use Zone	155.22	0.00
Cemeteries	37.89	37.89
Cultural Heritage	0.25	0.25
Area For Priority Development	179.02	179.02
Socialized Housing	40.96	41.28
Agricultural	1.90	1.90
Roads	373.80	403.44
Total	2,150.00	2,150.00

Source: Marikina City Planning and Development Office

3.3.4 San Juan

There are no major spatial changes in the land use for San Juan, i.e., the relative location of the different land uses will remain the same. There are however some changes in the area allocations for the different land uses. Per the approved and actual land use shown in Table 3.3.4, there will be a slight decrease in residential land area. This is consistent with the projected decrease in population in San Juan. Commercial area will significantly increase by more than 80%. On the other hand, allocation for industrial area will drop to about 5 ha, or less than a percent of the total land area of San Juan.

Table 3.3.4 San Juan Municipality Land Use

Classification	Actual Land Use, 2001	Land Use, Approved, 2003
	Area (ha)	Area (ha)
Residential	377.5	354.0
Commercial	52.8	98.9
Industrial	29.8	5.1
Institutional	40.5	41.8
Other Areas	93.6	94.4
Total	594.2	594.2

Source: San Juan Municipal Planning and Development Office

3.3.5 Mandaluyong

Major land use changes as reflected in the City's 2001 land use plan are: an increase in residential and commercial areas, and a corresponding decrease in institutional and industrial areas. The area bounded by Shaw Blvd., Mandaluyong-Pasig boundary, Pasig River and EDSA, shall be converted from a Medium Intensity Industrial Zone into a Central Business District which will cater mainly to commercial activities. This area shall be contiguous with the Ortigas Business District. Some pockets of industrial land along Pasig River and at the east part of the City shall also be converted to residential areas.

A major development project within the City is the planned redevelopment of the DSWD property in Addition Hills into a Planned Unit Development (PUD), the core of which shall be for new residential units. Institutions therein (e.g., the National Center for Mental Health, the Correctional Institute for Women) shall be relocated, explaining the decrease in institutional area with the implementation of the new land use.

Lastly, it is noted that new city zoning ordinances specify a ten-meter easement along Pasig and San Juan Rivers, which in turn will be reserved for linear parks and beautification projects.

Table 3.3.5 Mandaluyong City Land Use

Classification	Actual Land Use, 2000	Land Use, Approved 2000
	Area (ha)	Area (ha)
Residential	383.94	490.40
Commercial	191.91	221.92
Industrial	67.58	19.84
Institutional	111.16	35.04
Parks/Recreation	368.61	109.92
Road Networks		129.70
Cemetery		8.64
Vacant		110.56
Total	1,123.2	1,126.02

Source: Mandaluyong City Planning and Development Office

3.3.6 Makati

There is minimal change expected in the land use of Makati, as seen from the 1998 actual land use and the land use approved in 2001. Notwithstanding, densities will increase to cope with the population increase. The highest densities are allowed, as before, in the core commercial/mixed areas of the CBD.

Consistent with present trends, industrial activity is expected to decrease and the approved land use in fact allots no area for industrial use. To quote the Makati CLUP: "no land area has been designated for traditional manufacturing activity, although small scale, non-pollutive and IT industries are allowed in some of the residential areas. Similarly, IT and related industries are encouraged in commercial land areas."

Table 3.3.6 Makati City Land Use

Classification	Actual Land Use, 1998	Land Use, Approved 2001
	Area (ha)	Area (ha)
Residential	1,031	1,183
Commercial	416	556
Institutional	390	339
Industrial	39	0
Park/Open Space	34	67
Recreational	158	97
Roads	668	493
Total	2,736	2,736

Source: Makati City Planning and Development Office

3.3.7 Pasig

The new land use plan calls for the conversion of industrial areas to commercial areas. Complementing the re-classification of industrial areas in Mandaluyong adjacent to the Mandaluyong-Pasig boundary, industrial areas in Barangay Capitolyo will also be converted to commercial areas. Of a larger scale, industrial areas in Manggahan, Rosario and Ugong along Marikina River, are proposed to be converted to mixed-use and commercial zones. Most of the open spaces will be used-up and allocated for residential, commercial, mixed-use, and industrial use.

Similar to Mandaluyong City, the new land use calls for the development of a 10-m river easement along Pasig River and Marikina Rivers.

Table 3.3.7 Pasig City Land Use

Classification	Actual Land Use, 2000	Land Use, Approved 2002
	Area (ha)	Area (ha)
Residential	1,865	2,015
Commercial	220	680
Industrial	470	215
Institutional	31	25
Mixed-Use	na	120
Agricultural	24	na
Parks/Recreational	25	45
Open Spaces	466	na
Total	3,100	3,100

Source: Pasig City Planning and Development Office
Note: na means such classification was not adopted

3.3.8 Taguig

As per the approved land use, there will be a significant increase in residential areas in Taguig City. With the completion of the Flood Control Dike, flood-prone areas like Calzada, Palingon, and Napindan will be developed into residential zones. Other new development areas are the Global City, a Planned Unit Development (PUD) and the DMCI property in Bambang and Hagonoy which is proposed to be developed into a mixed-use zone which will include medium to high-density residential units, high-intensity commercial, and institutional, recreational, and green areas.

The C-6 will provide direct access and serve as a catalyst to the new development areas along the lakeshore.

Table 3.3.8 Taguig City Land Use

Classification	Actual Land Use, 2000	Land Use, Approved 2003
	Area (ha)	Area (ha)
Residential	1,986.37	3,128.63
Commercial	62.63	136.60
Mixed Use	na	275.47
Industrial	183.80	436.12
Institutional	191.51	152.94
Agricultural	982.52	Na
Parks/Open Spaces	159.29	157.02
Recreational	na	73.06
Cemetery	108.01	46.29
Planned Unit Development	751.07	Na
Military	113.01	58.54
Sports Complex	na	62.17
Transit Terminal	na	11.07
Total	4,538.20	4,538.20

Source: Taguig City Planning and Development Office
Note: na means such classification was not adopted

3.3.9 Pateros

In the new land use plan for Pateros, priority was given to the expansion of the commercial/mixed use zone. For this, out of the total 29 hectares of vacant and agricultural lands available for development, 17 hectares was re-classified as commercial area, an increase of about 17%.

Allocations for residential and institutional uses remain almost the same.

Table 3.3.9 Pateros Municipality Land Use

Classification	Actual Land Use, 2000	Land Use, Approved 2002
	Area (ha)	Area (ha)
Residential (inclusive of informal settlers)	111.03	114.88
Commercial	16.19	33.52
Institutional	8.85	10.31
Parks & Open Spaces	3.49	5.05
Vacant Lands	20.57	-
Agricultural Lands	5.55	-
Roads (& Rivers)	19.31	21.23
Total	184.99	184.99

Source: Pateros Municipal Planning and Development Office

3.3.10 Taytay

Similar to the other cities/towns evaluated in this section, the approved land use apportions larger residential and commercial areas. However, it is the only LGU that is expecting a marked increase in industrial activity, as the allocated industrial area is increased by around 65%, if compared to the actual land use in 1999.

In general, existing land uses will be retained. New residential, industrial and institutional areas will be apportioned from open spaces.

Table 3.3.10 Taytay Municipality Land Use

Classification	Actual Land Use, 1999	Land Use*, Approved, 2001
	Area (ha)	Area (ha)
Residential	1,191.67	1,500
Institutional	28.79	17
Industrial	117.19	310
Commercial	38.02	50
Mixed-Use Development	121.59	835
Agricultural	209.72	
Agri-Business	3.30	
Quarry	9.43	
Vacant Lands	156.42	
Open Spaces	835.05	
Open Dumpsite	0.69	
Total	2,711.87	2,711.87

Source: Taytay Municipal Planning and Development Office
*based on rough measurements of proposed land use map

3.3.11 Cainta

Cainta aims to support the town's role as a satellite town of Metro Manila, by intensifying both commercial and industrial activities in the town. Comparing the 1995 actual land use and proposed land use, the total area for residential areas will remain almost the same. On the other hand, commercial and industrial areas will increase: the latter by ten-fold and the former by around 30%. Commercial areas will be located linearly along the main roads, i.e., along A. Bonifacio, Sumulong Highway, and Felix, Ortigas and Marcos Avenues. Expanding industrial use areas, an industrial zone south of the Manggahan Floodway is proposed for non-pollutive and non-hazardous manufacturing industries.

Table 3.3.11 Cainta Municipality Land Use

Classification	Actual Land Use, 1995	Land Use, Proposed 2000
	Area (ha)	Area (ha)
Residential	2,493	2,507
Commercial	43	433
Industrial	258	334
Institutional	13	41
Others	1,492	984
Total	4,299	4,299

Source: Cainta Municipal Planning and Development

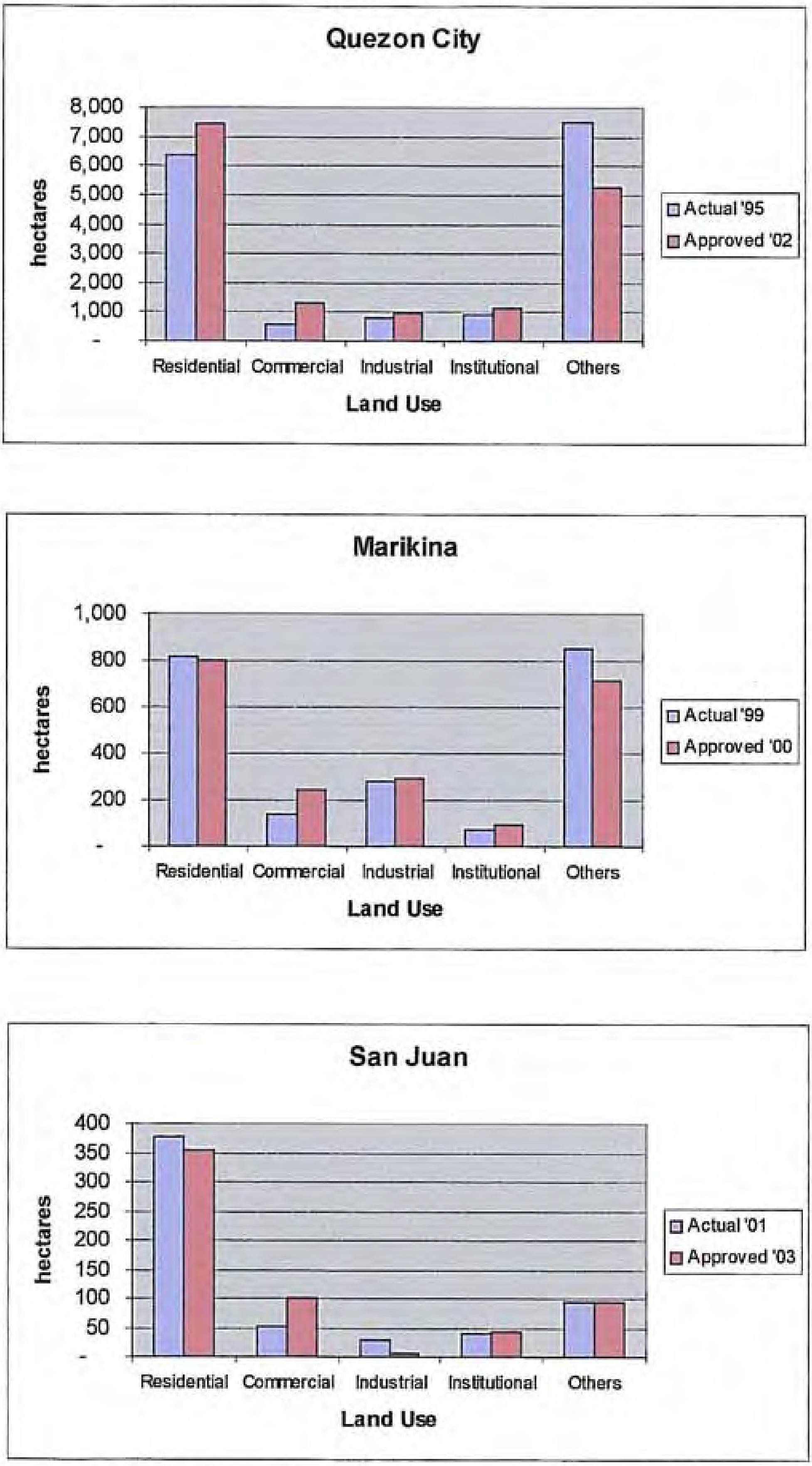
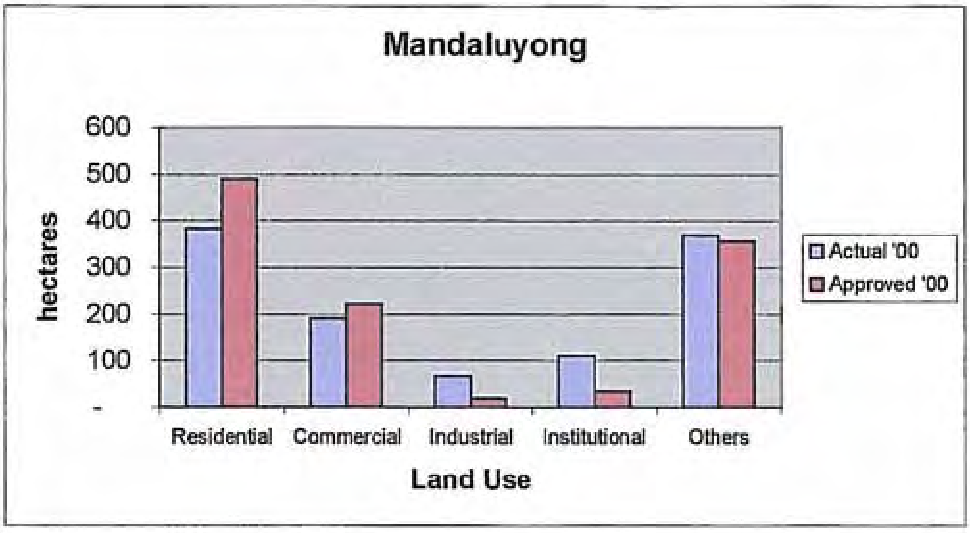
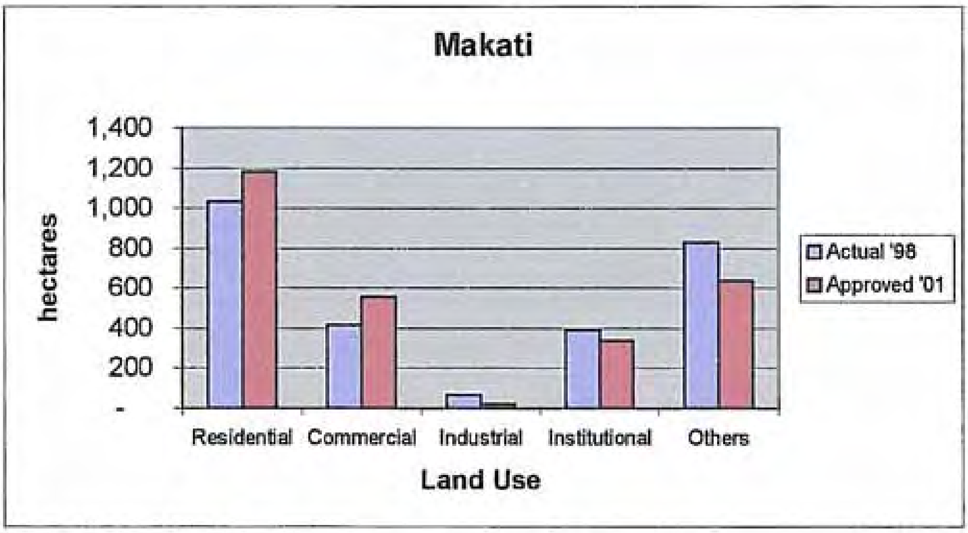


Figure 3.3.1(a) Actual and Proposed/Approved Land Use





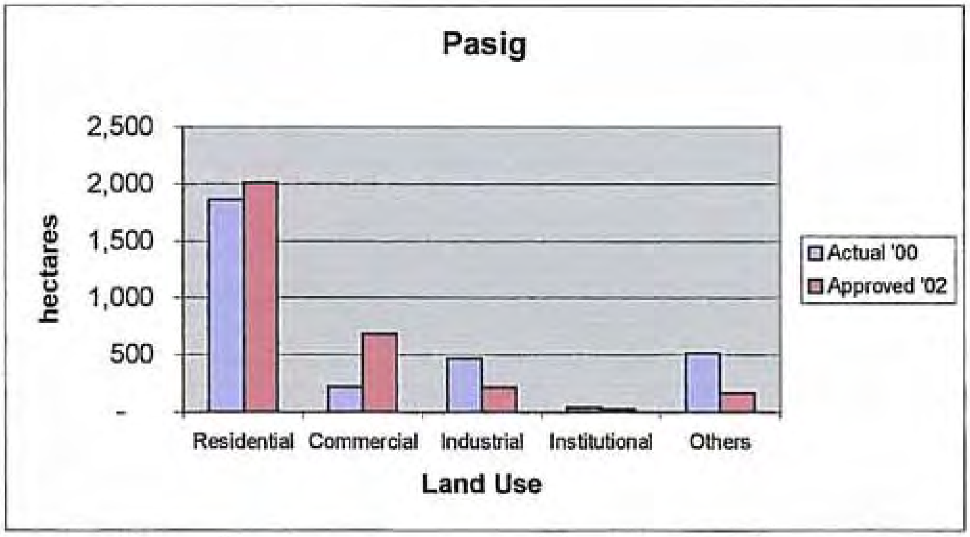
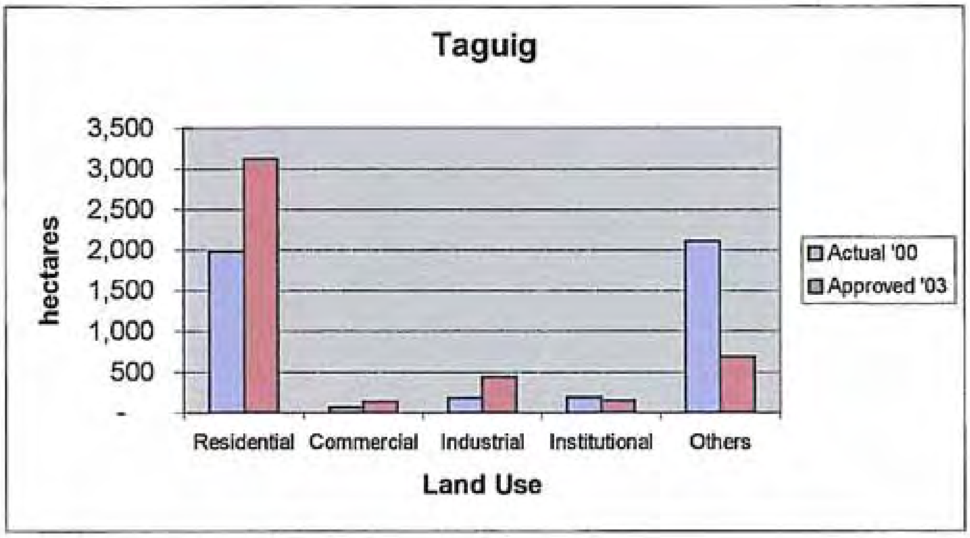
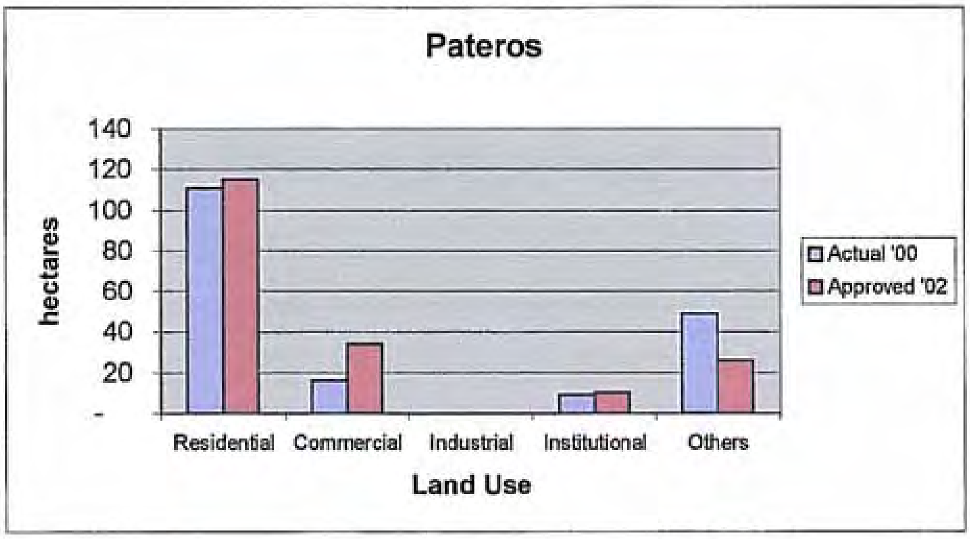


Figure 3.3.1(b) Actual and Proposed/Approved Land Use





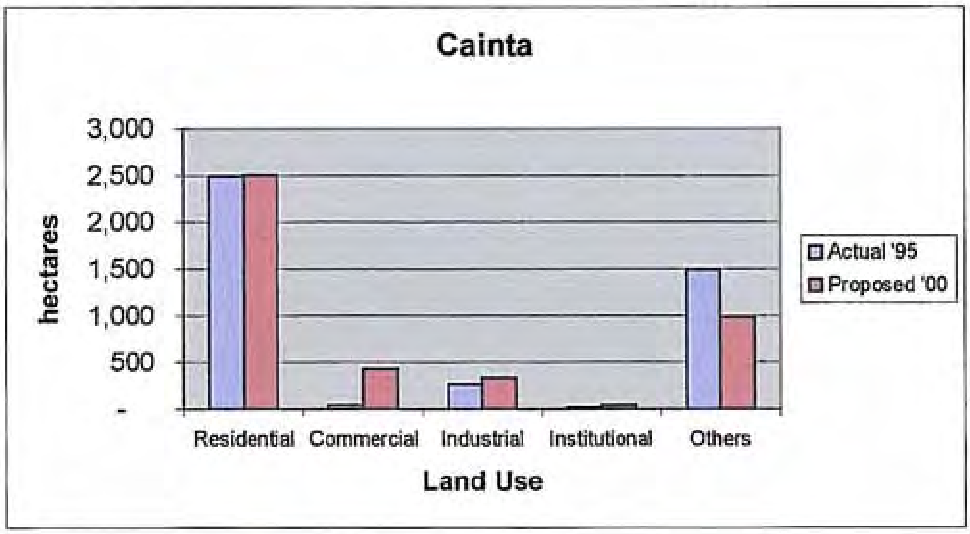


Figure 3.3.1(c) Actual and Proposed/Approved Land Use

3.2.1 Methodology

(1) Population Projections for Cities and Municipalities

The ratio method was applied to estimate the future population of cities and municipalities. Projection procedure is as follows:

1) All cities and municipalities comprising a province were classified according to the trend of their population ratios to the population of their respective provinces as observed in the 1980, 1990, 1995 and 2000 censuses. The four classifications are the following:

   Type I – cities/municipalities that showed unidirectional trend in their ratios (either increasing or decreasing) throughout the observation period)
   Type II – cities/municipalities that had unidirectional trend only during the last two intercensal periods.
   Type III – cities/municipalities that had unidirectional trend only during the first two intercensal periods.
   Type IV – cities/ municipalities with erratic trends.

2) For each type of city/municipality, the initial rates (r) at which the ratios will change were computed as follows:

   (i) For a Type I city / municipality, the initial rate of change is equal to the geometric mean of the observed annual rates of change of the ratios for the three intercensal periods.
   $r = \sqrt[3]{(r_{80-90})(r_{90-95})(r_{95-00})}$
   (ii) For a Type II city / municipality, the initial rate of change is equal to the geometric mean of the observed annual rates of change of the ratios during the last two intercensal periods.
   $r = \sqrt[3]{(r_{90-95})(r_{95-00})}$
   (iii) For a Type III city / municipality, the initial rate of change is equal to the geometric mean of the observed annual rates of change of the ratios during the first two intercensal periods.
   $r = \sqrt[3]{(r_{80-90})(r_{90-95})}$
   (iv) For a Type IV city / municipality, the initial rate of change is equal to one half the rate of change of the ratios during the last intercensal period .
   $r = r_{95\text{-}00} / 2$

3) It was assumed that for all cities/municipalities, r would gradually reduce so that they would all become zero around 95 years from the base year, which is 2000. Based on this assumption, a schedule of ratios was derived for each projection year using the following formula:

$$R_1 = R_0 (1 + r - r/95)$$
$$R_k = R_o (1 + r - r/95)(1 + r - 2r/95)\cdots(1 + r - kr/95)$$
or
$$R_k = R_o \prod_{i}^{k}(1+r-kr/95)$$

where: R_0 = ratio of the population of city / municipality to that of the province in 2000

R_k = ratio of the population of city / municipality to that of the province for the k[th] year from 2000, and
r = initial rate of change in the ratios.

4) Projected ratios are finally adjusted such that the ratios of all cities / municipalities comprising a province sum up to 1.0.

5) Population in each year was derived by multiplying projected ratio by projected population of respective province.

(2) Population Projections for Provinces (NCR and Rizal)

Population projection for provinces based on the 1995 Census data was established for the years up to 2020 by NSO. Consultants revised its projection based on the 2000 Census data as follows:

1) Derived annual population increasing rates of projected population each year based on the 1995 Census data.

2) By applying derived increasing rates to the population of the 2000 Census data, populations of each year were projected up to 2020.

3) For the years between 2021 and 2025, by applying decreased increasing rates, which are 70% and 90% of the rates for previous 5 years for NCR and Rizal respectively, the stabilization of population increase is expected in the future.

3.2.2 Refinements to the Population Projection in Selected Cities/Municipalities

The projected populations following aforementioned methodology were obtained through mathematical computation without any consideration on the current conditions of specific cities/municipalities. Because of this, computed results showed several skewed results for several cities/municipalities. In order to eliminate such projections, the following adjustments were applied for Makati, Manila, San Juan, Antipolo and Cainta.

(1) Makati

Based on the NSO projection method, Makati has a negative growth rate of population ratio in NCR at -1.8%. As the city with business and commercial center of the country, however, Makati will continue its development. Considering the situation, the base rate was assumed at 0%. This rate results in a slight population increase up to 2015.

(2) Manila

Based on the NSO projection method, Manila has a negative growth rate of population ratio in NCR at -2.5%. The trend shows a stabilization tendency, though it will be negative. Considering this situation, the base rate was assumed as same as the recent 5 year average growth rate at -1.83%.

(3) San Juan

Based on the NSO projection method, San Juan has a negative growth rate of population ratio in NCR at -2.9%. The trend shows a stabilization tendency, though its population is still

3.5 Sewage/Septage Volume

3.5.1 Water Consumption

Early in the year 2003, MWCI and JICA Water Resource Study presented water demand projection respectively. MWCI employed their projection for Rate Rebasing in 2003 after comparison of both projections. Since the MWCI projection (Rate Rebasing Submission – Charging Year 2003) was made as a practical plan considering capacity of MWCI development plan, it was applied for sewage volume projection in this study.

(1) Per Capita Water Consumption

Based on the actual billed volume and served population for the year 2001, MWCI calculated per capita consumption ranging of 71 to 293 lpcd with an average of 131 lpcd, as presented in Table 3.5.1. MWCI expects per capita consumption will increase after improvement of water supply constraints to 198 lpcd in average by the end of concession. By 2015, per capita consumption is estimated under suppressed condition due to lack of water.

Table 3.5.1 Per Capita Water Consumption Projected by MWCI

Municipality	2001	2005	2010	2015	2020	2025
Mandaluyong	131	141	143	163	211	216
Makati *	293	316	320	321	365	375
Manila *	110	118	120	140	166	165
Marikina	129	139	141	148	205	204
Quezon *	244	263	267	262	310	307
Pasig	141	152	154	158	199	204
Pateros	71	85	86	128	166	170
San Juan	215	231	234	227	276	284
Taguig	135	145	147	153	193	196
Antipolo	83	98	99	130	166	170
Cainta	197	212	215	169	222	227
Rodriguez *	80	108	109	147	166	171
San Mateo	90	114	116	147	166	171
Taytay	104	116	118	135	167	170
Baras	110	119	120	130	166	170
Jala - Jala	110	119	120	130	166	170
Morong	110	119	120	130	166	170
Pililia	110	119	120	130	166	170
Tanay	110	119	120	125	166	170
Teresa	110	119	120	133	166	170
Angono	110	119	120	128	166	170
Binangonan	110	119	120	130	166	170
Cardona	110	119	120	130	166	170
Average	131	144	146	156	194	198

Note: * East concession area covers only a part of the city.

(2) Profile of Water Consumption

Based on the historical data, it was assumed that the consumption profile has always been 60-40: 60% of total billed volume is consumed by domestic customers and 40% by commercial and industrial customers.

(3) Non-Revenue Water (NRW)

With expectation of effect by various activities for NRW decrease, MWCI projected that the ratio of NRW will be decreased to 30% of total water consumption.

(4) Annual Water Demand

As a result of projection, annual water demand is summarized as follows:

Table 3.5.2 Annual Water Demand Projected by MWCI

(MLD)

Year	Billed Volume			NRW	Total
	Domestic	C&I	Total	Volume	Demand
2002	468	287	755	882	1,637
2005	551	330	881	768	1,649
2010	769	445	1,214	716	1,930
2015	1,113	626	1,739	781	2,520
2020	1,571	877	2,448	1,049	3,497

3.5.2 Sewage Volume

The subject cities/municipalities for sewerage development involved in the planned service targets are; Mandaluyong, Makati (Part), Quezon City (Part), Pasig, Taguig and San Juan in the Rate Rebasing Submission, while those for CA are; Mandaluyong, Makati (Part), Quezon City (Part), Pasig, Pateros, Taguig, San Juan, Cainta and Taytay. In this section, sewage volume of cities / municipalities listed in CA is examined for further examination.

(1) Return Factor

The return factor, the ratio of discharged sewage against consumed water, was assumed at 70% in the MWCI Sewerage Strategy. Regarding this factor, WHO recommends 90%, while 100% is recommended in Japan, and 60 – 85% by Metcalf & Eddy, in which the low ratio is indicated for semi-dry climate area. There may be differences of the factors of cities / municipalities and subject areas due to variations of characteristics of housing and living life. In this study, it was uniformly applied to the sewerage service area for planning purpose, because prediction of future change of those characteristics is difficult, and all of sullage from habitants tends to be discharged to sewer system in the future gradually after development of sewerage system. Considering the wet monsoon climate in the Philippines, this factor is assumed at 80% for both of domestic and commercial wastewater.

(2) Infiltration

The infiltration varies depending on sewer pipe material, workmanship of piping work including sewer system and service connection, elevation of ground water. It also depends on diameter and length of sewer, which vary with size of lot, population density, and topographic condition.

In the FS of MTSP, an investigation on infiltration rate was conducted for 5 districts and the infiltration in each district under the dry weather was estimated ranging 3.4 to 72.5 $m^3/ha/d$ with a weighted average of 26.4 $m^3/ha/d$. It expects reduction of infiltration due to leakage reduction. Metcalf & Eddy (1981) stated infiltration might range from 0.2 to 28 $m^3/ha/d$. MWSS recommends using 17 $m^3/ha/d$ infiltration/inflow for sewer design. Comparing with these figures MTSP estimation results seem to be too large though they are almost on the same level. In Japan, it was recommended that 10 to 20 % of domestic and commercial wastewater might be estimated when actual survey result is not available.

Considering the above discussion, and expecting the reduction of infiltration by improvement of sewer system and reduction of water supply leakage in the future, the infiltration rate under the dry weather is assumed at 10 m^3/ha/d for the area with combined sewer system and 7.5 m^3/ha/d for separate sewer system area respectively, for planning purpose in this study.

(3) Domestic Wastewater

Domestic wastewater can be obtained by following calculation:

Domestic Wastewater (cum./d)
= Per Capita Water Consumption (lpcd) x Served Population x Return Factor / 1000

Computation results are presented in Appendix D Table D.1.

The served population excludes population served by non-MWCI piped supply, which is shown in Table D.2 in Appendix D.

(4) Commercial Wastewater

Commercial wastewater can be obtained by following calculation:

Commercial Wastewater (cum/d)
= Water Consumption (cum/d) x Return Factor
Water Consumption (cum/d)
= Domestic Water Consumption (cum/d) x Commercial water Consumption Ratio

Commercial water consumption is calculated following to the method applied in the Rate Rebasing Submission. The ratio to domestic water consumption, however, is adjusted based on the actual water billing record of the MWCI business areas and aerial proportion of each cities / municipalities to each business areas as follows:

Table 3.5.3 Proportion of Domestic and Commercial Water Consumption

	Domestic	Commercial	Total
Mandaluyong	65%	35%	100%
Makati(part)	60%	40%	100%
Quezon City (part)	65%	35%	100%
Pasig	70%	30%	100%
Pateros	80%	20%	100%
Taguig	80%	20%	100%
San Juan	65%	35%	100%
Cainta	80%	20%	100%
Taytay	80%	20%	100%

Computation results are presented in Appendix D Table D.3.

(5) Industrial Wastewater

Industrial wastewater is assumed not to be discharged to sewerage system.

(6) NRW Oriented Wastewater

Most of NRW oriented wastewater is the wastewater from illegal connection users. Assuming that the illegal connection users are few in the sewerage system developing area and wastewater discharged from them are negligible against total wastewater volume, wastewater of this category is ignored.

(7) Total Sewage Volume

Total sewage volume is comprised of domestic and commercial wastewater and infiltration. Computation results are presented in Table 3.5.4.

Table 3.5.4 Total Sewage Volume Projection

Municipality	Potential Domestic+Commercial Wastewater (m^3/d)				
Year	2005	2010	2015	2020	2025
Mandaluyong	48,493	48,177	52,820	64,973	62,707
Makati *	174,246	180,677	181,761	204,244	205,215
Quezon *	278,819	293,374	292,025	345,145	337,644
Pasig	93,296	97,811	101,643	127,696	129,140
Pateros	4,993	5,040	7,342	9,196	9,015
San Juan	31,921	30,201	26,942	29,844	27,835
Taguig	84,720	103,585	126,176	181,859	206,895
Cainta	58,617	67,115	59,334	86,544	96,563
Taytay	29,520	37,931	54,249	82,279	100,260
Total	1,006,184	1,109,863	1,254,117	1,670,119	1,828,922

*: Part in MWCI service coverage only (assumed based on proportion of population)

3.5.3 Septage Volume

(1) Number of Septic Tanks

Based on the 2000 Census of Housing, around 83% of the population in the NCR had individual septic tanks (ISTs) as summarized in Table 3.5.5. For the NCR, but with the exception of Taguig City, this proportion is assumed to remain constant up to the design year of 2025. For Taguig City, this proportion is projected to increase from 68% to around 80% by Year 2025. The increase is expected with the construction of new dwellings to cope with the considerable increase in population in the city.

In Rizal Province, the 2000 Census shows that around 72% of the households are connected to a septic tank. This proportion is expected to increase with the number of new dwellings, to 80%-85%.

Table 3.5.5 Year 2000 Census Septic Tank Data

City/Municipality	No. of Households with Septic Tanks	Total No. of Households	% of Households with Septic Tank
Mandaluyong	52,284	59,682	88%
Makati*	73,775	103,981	75%
Quezon City	408,548	480,624	85%
Pasig	93,541	107,835	87%
San Juan	22,887	24,605	93%
Taguig	70,239	102,723	68%
Marikina	70,111	80,160	87%
Pateros	10,921	12,029	91%
Municipalities in Rizal Province	256,736	356,578	72%

Source: 2000 Census of Housing
*Sewered households excluded

Based on the population projections presented in Section 3.2, an average household occupancy of 4.6 persons, and the projected number of households with septic tanks as discussed above, the total number of ISTs in the service area is projected as shown in Table D.4 in Appendix D. The number of ISTs in the east concession area is expected to increase to 1.28 million and 1.64 million, by Year 2015 and 2025, respectively.

Not all ISTs are accessible, either because the access roads to the houses are too narrow, or because of poor building practices such as construction of building extensions directly over the tanks. In the MSSP Feasibility Study, tank accessibility in Metro Manila was estimated to range from 60 to 90%. According to MWCI operations personnel, about 80% of people surveyed have expressed a willingness to have their ISTs desludged by the company. Consistent with the MTSP Feasibility Study, for the purposes of this study, it is assumed that 80% of the ISTs will be desludged, and the balance is either inaccessible or the owners are unwilling to participate in the desludging program. On this basis, the number of ISTs that can be desludged from the MWCI service area will amount to about 1.02 million and 1.31 million, in years 2015 and 2025 respectively.

(2) Potential Septage Volume for Collection

Assuming 80% accessibility, an average septic tank volume of 5.0 m^3 (as per MWCI operations personnel), a desludging interval of six years, and 300 effective operational/collection days per year, the potential daily septage collection is estimated to reach around 2,843 m^3 and 3,641 m^3 by 2015 and 2025, respectively, as shown in Table 3.5.8.

In Year 2015, around half of the septage will come from the NCR area, and the other half will be from Rizal Province. By Year 2025, the proportion of septage from towns in Rizal Province will increase to 58%.

Table 3.5.8 Potential Septage Volume for Collection by Sub-Area

East Concession Sub-Area	Septage Volume (m^3/day)				
	Year 2005	Year 2010	Year 2015	Year 2020	Year 2025
NCR	1,350	1,413	1,453	1,476	1,545
Rizal Province	754	1,028	1,390	1,725	2,095
Total	2,104	2,441	2,843	3,200	3,641

3.6 Pollution Load

Pollution loads discharged to the rivers in the East Concession Zone are originated mainly from domestic, commercial and industrial activities. Agricultural activities still take place especially in the eastern part of the zone. But agricultural fields are rapidly being replaced by residential and commercial developments, which form satellite cities or bed towns for the Metro Manila.

The current and future pollution loads in terms of organic matters (Biochemical Oxygen Demand: BOD) are discussed below.

3.6.1 Domestic Pollution Loads

The MTSP feasibility study discussed per capita pollution loads from sewage in its appendix. The recommended domestic BOD design loads are shown in Table 3.6.1.

Table 3.6.1 Domestic Per Capita Pollution Loads (g/capita/day)

Biochemical Oxygen Demand (BOD)	2004			2025		
	Toilet	Sullage	Total	Toilet	Sullage	Total
Low-Income	20	16	36	20	23	43
Middle-Income	20	30	50	20	30	50
High-Income	20	30	50	20	30	50

Domestic BOD loads in Year 2005 and in Year 2025 are calculated using the above per capita BOD loads. It is assumed that per capita pollution loads increase linearly from year 2004 to 2025. Composition of low, middle and high-income population was estimated based on "2000 Family Income and Expenditure Survey", shown in Table 3.6.2. Percentages of three income groups for each municipality are calculated from numbers of families in three income ranges, low (annual income less than 150,000 Pesos), middle (annual income from 150,000 to 500,000 Pesos) and high (annual income over 500,000 Pesos). 2025 projection assumes per capita BOD load of 50 g/capita/day for the entire population.

3.6.2 Commercial Pollution Loads

Commercial wastewater flow was calculated in Section 3.5. It is assumes that commercial wastewater has same strength of BOD as domestic wastewater. Thus, commercial BOD loads were calculated from domestic BOD generation applying proportion of commercial wastewater flow to domestic wastewater flow shown in Table D.3 in Appendix D.

Table 3.6.2 Annual Family Income in Metro Manila

Annual Family Income	Number of Families													
	Manila	Quezon City	Mandaluyong	San Juan	Marikina	Pasig	Makati	Pateros/Taguig	Caloocan	Valenzuela	Pasay	Malabon	Navotas	Rizal Province
Under 10,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10,000-19,999	-	-	-	-	-	-	-	-	952	-	215	-	-	-
20,000-29,999	-	719	-	-	-	415	-	-	861	-	-	-	832	500
30,000-39,999	649	-	326	124	1,059	-	-	-	-	374	-	958	611	2,700
40,000-49,999	3,817	3,247	-	-	544	-	225	1,104	5,069	-	180	1,269	1,222	4,017
50,000-59,999	6,661	2,223	326	124	-	-	266	2,203	2,740	1,346	829	2,504	2,664	8,570
60,000-79,999	16,534	22,238	2,422	271	2,005	3,789	2,604	5,197	11,484	7,259	5,280	7,648	4,795	23,887
80,000-99,999	25,902	24,925	4,748	915	8,129	6,388	3,160	8,442	31,664	13,038	6,564	12,005	7,693	24,899
100,000-149,999	58,155	101,288	16,745	4,067	22,814	22,852	14,724	33,643	62,742	27,945	20,132	22,172	14,689	46,113
150,000-249,999	98,116	137,336	22,898	7,053	24,313	40,453	23,384	45,301	74,893	33,184	34,019	23,794	13,580	40,931
250,000-499,999	87,202	106,484	11,447	6,789	18,740	28,858	33,095	18,349	44,455	23,258	20,113	9,966	7,173	23,057
500,000 and Over	32,603	51,684	4,222	4,711	6,907	15,233	25,227	552	15,991	5,528	1,753	2,748	611	3,352
Total	329,639	450,144	63,134	24,054	84,511	117,988	102,685	114,791	250,851	111,932	89,085	83,064	53,870	178,026
Percentage														
Low-Income	34%	34%	39%	23%	41%	28%	20%	44%	46%	45%	37%	56%	60%	62%
Middle-Income	56%	54%	54%	58%	51%	59%	55%	55%	48%	50%	61%	41%	39%	36%
High-Income	10%	11%	7%	20%	8%	13%	25%	0.5%	6%	5%	2%	3%	1%	2%
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: 2000 Family Income and Expenditures Survey

3.6.3 Industrial Pollution Loads

It is difficult to estimate accurately the current industrial pollution loads since no actual wastewater survey data is available. 1996 JICA Master Plan adopted industrial BOD discharge data from "Industrial Efficiency and Pollution Control Program (IEPC) commissioned by World Bank in 1992. IEPC report estimated that, in 1990, total 573 ton/day BOD was generated in Metro Manila, of which 304 ton/day was discharged to the rivers. BOD generation from industrial activities is assumed to stay at this level up to year 2025 since new major industrial development is likely to happen outside the Metro Manila. IEPC proposed a pollution abatement strategy that reduces the above BOD discharge to 130 ton/day in year 2025.

This study adopted the above IEPC projection. Industrial BOD discharge is assumed to decrease linearly from year 1995 (304 ton/day) to year 2025 (130 ton/day) then to stay at this level until 2025. The BOD discharges were distributed among sub-catchments as shown in Table 3.6.3, following 1996 JICA Master Plan.

Table 3.6.3 Industrial Pollution Load

Sub-catchment		BOD discharge (kg/day)						
	Year	1990	1995	2000	2005	2010	2015	2025
Marilao	ME-1							
	ME-2							
	ME-3							
	ME-4							
	ME-5	100	100	86	71	57	43	43
Meycauayan River	ME-6	3,098	3,098	2,655	2,212	1,770	1,327	1,327
	ME-7	1,102	1,102	945	787	630	472	472
Longos River	ME-8	6,046	6,046	5,182	4,318	3,454	2,590	2,590
	ME-9	6,254	6,254	5,360	4,466	3,573	2,679	2,679
Bulacan River	Direct	87,600	87,600	75,081	62,561	50,042	37,522	37,522
Novaliches	MT-1							
	MT-2							
	MT-3	100	100	86	71	57	43	43
Tullahan River	MT-4	8,100	8,100	6,942	5,785	4,627	3,470	3,470
Navotas/Caloocan	MA	14,300	14,300	12,256	10,213	8,169	6,125	6,125
Antipolo/San Mateo	PM-1	2,367	2,367	2,029	1,690	1,352	1,014	1,014
	PM-2	2,367	2,367	2,029	1,690	1,352	1,014	1,014
	PM-3	2,367	2,367	2,029	1,690	1,352	1,014	1,014
Marikina River	PM-4	8,800	8,800	7,542	6,285	5,027	3,769	3,769
San Juan	SJ-7	825	825	707	589	471	353	353
	SJ-8	2,805	2,805	2,404	2,003	1,602	1,201	1,201
	SJ-9	1,517	1,517	1,300	1,083	867	650	650
	SJ-10	253	253	217	181	145	108	108
Quezon City	SJ-1	3,787	3,787	3,246	2,705	2,163	1,622	1,622
	SJ-2	1,714	1,714	1,469	1,224	979	734	734
	SJ-3	355	355	304	254	203	152	152
	SJ-4	1,621	1,621	1,389	1,158	926	694	694
	SJ-5	1,341	1,341	1,149	958	766	574	574
	SJ-6	2,282	2,282	1,956	1,630	1,304	977	977

Table 3.6.3 Industrial Pollution Load (Continued)

Sub-catchment		BOD discharge (kg/day)						
	Year	1990	1995	2000	2005	2010	2015	2025
Pasig	PM-5	13,900	13,900	11,913	9,927	7,940	5,954	5,954
Mandaluyong	PM-6	8,983	8,983	7,699	6,416	5,132	3,848	3,848
	PM-7	8,983	8,983	7,699	6,416	5,132	3,848	3,848
	SM-1	8,983	8,983	7,699	6,416	5,132	3,848	3,848
	Direct	26,950	26,950	23,098	19,247	15,395	11,544	11,544
Manila	SM-2	3,350	3,350	2,871	2,392	1,914	1,435	1,435
	SM-3							
	NM-1-1	3,350	3,350	2,871	2,392	1,914	1,435	1,435
	NM-3	3,350	3,350	2,871	2,392	1,914	1,435	1,435
	NM-4							
	Direct	3,350	3,350	2,871	2,392	1,914	1,435	1,435
Makati	SM-5	2,200	2,200	1,886	1,571	1,257	942	942
Taguig River	WM	11,100	11,100	9,514	7,927	6,341	4,755	4,755
Parañaque River	PL-1	499	499	428	356	285	214	214
	PL-2	149	149	128	106	85	64	64
	PL-3	836	836	717	597	478	358	358
	PA-4	115	115	99	82	66	49	49
Zapote River	PL-4	337	337	289	241	193	144	144
	PL-5	522	522	447	373	298	224	224
	PA-1	475	475	407	339	271	203	203
	PA-2	130	130	111	93	74	56	56
	PA-3	83	83	71	59	47	36	36
	ZP-1							
	ZP-2	197	197	169	141	113	84	84
	ZP-3	256	256	219	183	146	110	110
Bacoor/Cavite								
Cainta/Sucat	BB-1	6,169	6,169	5,287	4,406	3,524	2,642	2,642
	BB-2	2,471	2,471	2,118	1,765	1,412	1,058	1,058
	BB-3	2,069	2,069	1,773	1,478	1,182	886	886
	BB-4	9,885	9,885	8,472	7,060	5,647	4,234	4,234
	BB-5	1,569	1,569	1,345	1,121	896	672	672
	BB-6	1,662	1,662	1,424	1,187	949	712	712
	BB-7	3,910	3,910	3,351	2,792	2,234	1,675	1,675
	EM-1	622	622	533	444	355	266	266
	EM-2	902	902	773	644	515	386	386
	EM-3	1,014	1,014	869	724	579	434	434
	EM-4	727	727	623	519	415	311	311
Muntinlupa/San Pedro		15,300	15,300	13,113	10,927	8,740	6,554	6,554
Total		**303,500**	**303,500**	**260,125**	**216,750**	**173,375**	**130,000**	**130,000**

3.6.4 Pollution Loads Generation

Domestic, commercial and industrial BOD generation in 2005 and 2025 are calculated for each sub-catchment. The results are shown in Table 3.6.4 and 3.6.5 respectively. Industrial pollution loads are based on BOD discharge since industrial loads are treated separately from domestic and commercial loads.

3.7 Water Quality Projection

3.7.1 Run-off Ratio

River flow is monitored at two locations in the Pasig river basin at San Rafael, Rodriquez in Wawa River and at Tanong, Marikina in Marikina River. Upstream catchment areas to these stations are 282 km^2 and 499 km^2. Latest monthly mean flow data available are shown in Table 3.7.1 and 3.7.2. Annual average flows were divided by catchment areas to give specific flow factors (SFF) of 0.057 $m^3/s/km^2$ and 0.13 $m^3/s/km^2$ respectively.

Table 3.7.1 Mean Monthly Discharge for Wawa River (m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	10.26	7.58	4.11	4.01	3.72		8.74	13.46	31.08	29.60	6.67	26.83
1999	7.60	3.54	4.67	6.03	9.88	13.71	29.76	23.68	11.58	10.63	9.93	9.94
2000	7.24	11.68	5.04	4.28	19.26	10.40	51.90	20.88	40.96	38.09	32.64	16.14
2001	4.01	0.59	0.70	0.72	17.69	12.66	37.36	58.39	25.74	13.69	18.70	11.75
2002	3.95	4.77	4.25	3.66	5.16	6.81	50.61	33.19	42.71	14.19	24.86	8.98
Average	6.61	5.63	3.75	3.74	11.14	10.90	35.67	29.92	30.41	21.24	18.56	14.73

Average Jan-Dec: 16.0 m^3/sec

Table 3.7.2 Mean Monthly Discharge for Marikina River (m^3/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1985									73.53	79.16	37.7	20.9
1986	12.79	8.56	7.6	6.4	9	6.9	86.18	195.29	251.8	159.23	119.39	58.14
1987	49.58	56.58	60.85	64.26	75.9	30.55	57.88	72.22	68.19	30.97	18.64	20.92
1988	17.00	11.38	5.50		18.50	10.61	19.44		24.96		191.85	87.20
1989	21.16	6.84	5.63	2.58	11.61	20.57	103.68	229.96	190.58	104.15	51.50	9.25
1990	0.86	0.88	1.05	0.28	4.53	13.01	85.50	298.28	306.05	129.26	138.18	96.76
1991	74.69	34.55	10.27	12.29	10.25	24.95	66.05	168.88	178.90	104.79	45.09	66.34
1992	73.80	33.65	10.13	9.83	10.09	18.84	51.60	132.42	192.93	129.36	76.97	66.97
Average	35.70	21.78	14.43	15.94	19.98	17.92	67.19	182.84	160.87	105.28	84.91	53.31

Average Jan-Dec: 65.0 m^3/sec

3.7.2 Pollution Load Reduction Factor

Septic tanks (individual and communal), sewage treatment plants and natural processes remove some of domestic and commercial pollution loads. The Malaysian survey showed that BOD was reduced by around 50% through natural purification processes as the wastewater flow through open drains (MTSP FS, 2004). This removal can be represented by a fractional reduction factor (RF). Estimated reduction factor for domestic pollution loads is 0.6 considering removal by septic tanks (10% removal) and chemical and biological decomposition processes in drains and streams (50% removal).

Industrial BOD is considered to have smaller reduction factor since most of the factories in the region discharge wastewater directly to the rivers. This study adopts reduction factor of 0.5 from chemical and biological decomposition processes in rivers for industrial loads.

3.7.3 Water Quality Projection

Average water quality of rivers are projected from pollution loads generation, specific flow factor and reduction factor using the formula:

BOD (mg/l) = {domestic + commercial BOD loads (kg/d) x (1- RF(0.6)) + industrial discharge (kg/d) x (1-Rf(0.5))}/(upstream catchment area (km^2) x SFF ($m^3/s/km^2$))

The projections for year 2005 and year 2025 are shown in Table 3.7.3 and 3.7.4 respectively. For 2025 projection, no new sewerage development is assumed to take place besides the industrial pollution abatement measures proposed by IEPC. Figure 3.7.1 and Figure 3.7.2 are graphical presentation of river BOD together with total BOD generation per sub-catchment. The projected BOD is generally higher than the sampling data obtained from DENR. This indicates that further pollution reduction may occur in rivers. The 2005 projection shows San Juan River and Baho-Buli rivers are most polluted in the East Concession Zone. The lower Pasig River has high BOD after receiving pollution loads from San Juan River. The same pollution trend is observed in the 2025 projection, although BOD levels are slightly higher than those in 2005.

The above water quality projection shows that San Juan River and Baho-Buli Rivers are identified as pollution "hot spots", which will be given priority in wastewater management initiatives.

Table 3.7.3 BOD Projection in East Concession Zone (Year 2005)

San Juan and Pasig-Marikina rivers

SFF= 0.057m3/s/km2 0.130m3/s/km2 Domestic Commercial BOD run-off ratio= 0.4 Industrial run-off ratio= 0.5

Point	Catchment Area km^2	River Flow m^3/sec	Dom.+Com. BOD input kg/day	Dom.+Com. BOD kg/day	Ind. BOD input kg/day	Industrial BOD kg/day	BOD run-off kg/day	Estimated BOD mg/l	Sampling Data mg/l
1	277.66	15.83	30,089	30,089	1,690	1,690	12,881	9	
2	277.66	15.83	0	30,089	0	1,690	12,881	9	
3	375.19	28.51	13,393	43,482	1,690	3,381	19,083	8	9
4	512.20	66.59	46,472	89,954	1,690	5,071	38,517	7	12
5	518.38	67.39	5,921	95,875	6,285	11,356	44,028	8	
6	518.38	67.39	0	95,875	0	11,356	44,028	8	13
7							0		
8	549.07	71.38	36,456	132,331	29,174	40,530	73,197	12	13
9	640.51	83.27	0	236,774	0	52,314	120,866	17	19
10	23.27	3.03	24,809	24,809	2,705	2,705	11,276	43	37
11	10.53	1.37	11,092	11,092	1,224	1,224	5,049	43	40
12	33.80	4.39	0	35,901	0	3,929	16,325	43	
13	71.75	9.33	40,697	76,598	4,588	8,516	34,898	43	31
14	91.44	11.89	27,845	104,443	3,267	11,784	47,669	46	34
15	661.81	86.04	61,960	298,734	7,177	59,491	149,239	20	16

Malabon-Tullahan rivers

SFF= 0.130m3/s/km2 Domestic Commercial BOD run-off ratio= 0.4 Industrial run-off ratio= 0.5

Point	Catchment Area km^2	River Flow m^3/sec	Dom.+Com. BOD input kg/day	Dom.+Com. BOD kg/day	Ind. BOD input kg/day	Industrial BOD kg/day	BOD run-off kg/day	Estimated BOD mg/l	Sampling Data mg/l
1	25.82	3.36	27,198	27,198		0	10,879	38	
2	25.82	3.36	0	27,198			10,879	38	16
3	39.20	5.10	14,094	41,292			16,517	38	25
4	59.28	7.71	21,065	62,357	71	71	24,979	38	27
5	69.25	9.00	8,992	71,349	5,785	5,856	31,468	40	20
6	87.88	11.42	23,566	94,915	10,213	16,069	46,001	47	17

Baho-Buli rivers

SFF= 0.130m3/s/km2 Domestic Commercial BOD run-off ratio= 0.4 Industrial run-off ratio= 0.5

Point	Catchment Area km^2	River Flow m^3/sec	Dom.+Com. BOD input kg/day	Dom.+Com. BOD kg/day	Ind. BOD input kg/day	Industrial BOD kg/day	BOD run-off kg/day	Estimated BOD mg/l	Sampling Data mg/l
1	16.55	2.15	13,720	13,720	4,406	4,406	7,691	41	
2	6.63	0.86	1,841	1,841	1,765	1,765	1,619	22	
3	28.73	3.73	5,453	21,014	1,478	7,648	12,230	38	
4	26.52	3.45	5,180	5,180	7,060	7,060	5,602	19	
5	61.88	8.04	1,194	27,388	1,121	15,828	18,869	27	
6	6.13	0.80	5,235	5,235	1,631	1,631	2,910	42	
7	68.01	8.84	0	32,623	0	17,459	21,779	29	
8	15.16	1.97	6,311	6,311	4,036	4,036	4,542	27	
9	83.17	10.81	0	38,934	0	21,495	26,321	28	

Table 3.7.4 BOD Projection in East Concession Zone (Year 2025)

San Juan and Pasig-Marikina rivers

SFF= 0.130m3/s/km2 — Domestic Commercial BOD run-off ratio= 0.4 — Industrial run-off ratio= 0.5

Point	Catchment Area km^2	Dom.+Com. BOD input kg/day	Dom.+Com. BOD input kg/day	Dom.+Com. BOD kg/day	Ind. BOD input kg/day	Industrial BOD kg/day	BOD run-off kg/day	Estimated BOD mg/l	Current BOD mg/l
1	277.66	36.10	104,046	104,046	1,014	1,014	42,125	14	
2	277.66	36.10	0	104,046	0	1,014	42,125	14	
3	375.19	48.77	34,913	138,959	1,014	2,028	56,598	13	9
4	512.20	66.59	79,372	218,331	1,014	3,042	88,853	15	12
5	518.38	67.39	6,892	225,223	3,769	6,811	93,495	16	
6	518.38	67.39	0	225,223	0	6,811	93,495	16	13
7							0		
8	549.07	71.38	38,389	263,612	17,498	24,308	117,599	19	13
9	640.51	83.27	0	376,729	0	31,376	166,380	23	19
10	23.27	3.03	28,333	28,333	1,622	1,622	12,144	46	37
11	10.53	1.37	12,667	12,667	734	734	5,434	46	40
12	33.80	4.39	0	41,000	0	2,356	17,578	46	
13	71.75	9.33	46,478	87,478	2,752	5,108	37,545	47	31
14	91.44	11.89	25,639	113,117	1,960	7,068	48,781	47	34
15	661.81	86.04	50,066	426,795	4,305	35,681	188,558	25	16

Malabon-Tullahan rivers

SFF= 0.130m3/s/km2 — Domestic Commercial BOD run-off ratio= 0.4 — Industrial run-off ratio= 0.5

Point	Catchment Area km^2	River Flow m^3/sec	Dom.+Com. BOD input kg/day	Dom.+Com. BOD kg/day	Ind. BOD input kg/day	Industrial BOD kg/day	BOD run-off kg/day	Estimated BOD mg/l	Current BOD mg/l
1	25.82	3.36	31,061	31,061		0	12,424	43	
2	25.82	3.36	0	31,061			12,424	43	16
3	39.20	5.10	16,096	47,157			18,863	43	25
4	59.28	7.71	25,523	72,680	43	43	29,093	44	27
5	69.25	9.00	12,810	85,489	3,470	3,512	35,952	46	20
6	87.88	11.42	31,525	117,014	6,125	9,638	51,624	52	17

Baho-Buli rivers

SFF= 0.130m3/s/km2 — Domestic Commercial BOD run-off ratio= 0.4 — Industrial run-off ratio= 0.5

Point	Catchment Area km^2	River Flow m^3/sec	Dom.+Com. BOD input kg/day	Dom.+Com. BOD kg/day	Ind. BOD input kg/day	Industrial BOD kg/day	BOD run-off kg/day	Estimated BOD mg/l	Current BOD mg/l
1	16.55	2.15	17,269	17,269	2,642	2,642	8,229	44	
2	6.63	0.86	3,656	3,656	1,058	1,058	1,991	27	
3	28.73	3.73	6,505	27,429	886	4,587	13,265	41	
4	26.52	3.45	14,768	14,768	4,234	4,234	8,024	27	
5	61.88	8.04	2,201	44,399	672	9,493	22,506	32	
6	6.13	0.80	6,294	6,294	978	978	3,007	44	
7	68.01	8.84	0	50,693	0	10,472	25,513	33	
8	15.16	1.97	16,234	16,234	2,421	2,421	7,704	45	
9	83.17	10.81	0	66,927	0	12,892	33,217	36	

Figure 3.7.1 Projected BOD of Rivers in East Concession Zone (2005)

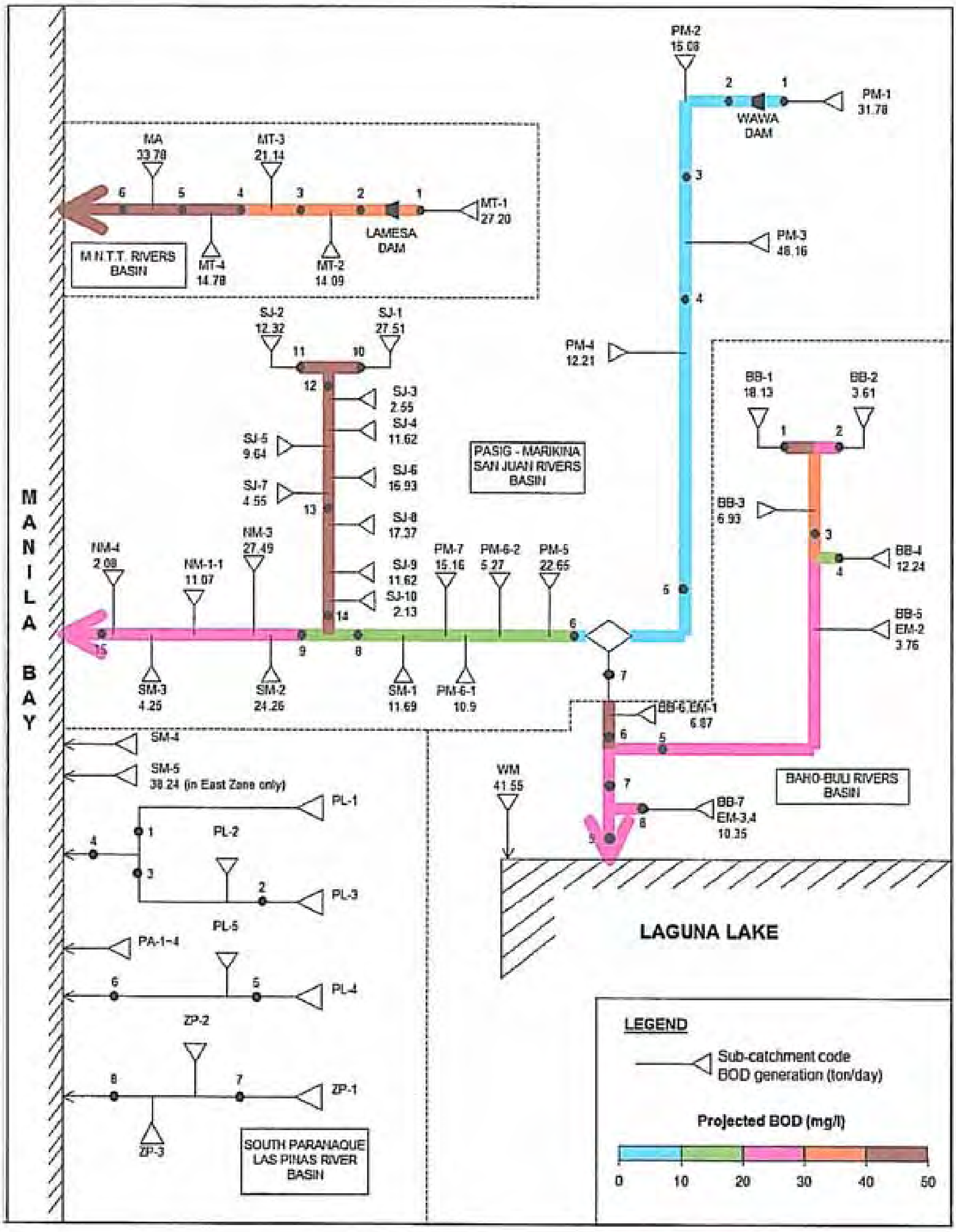
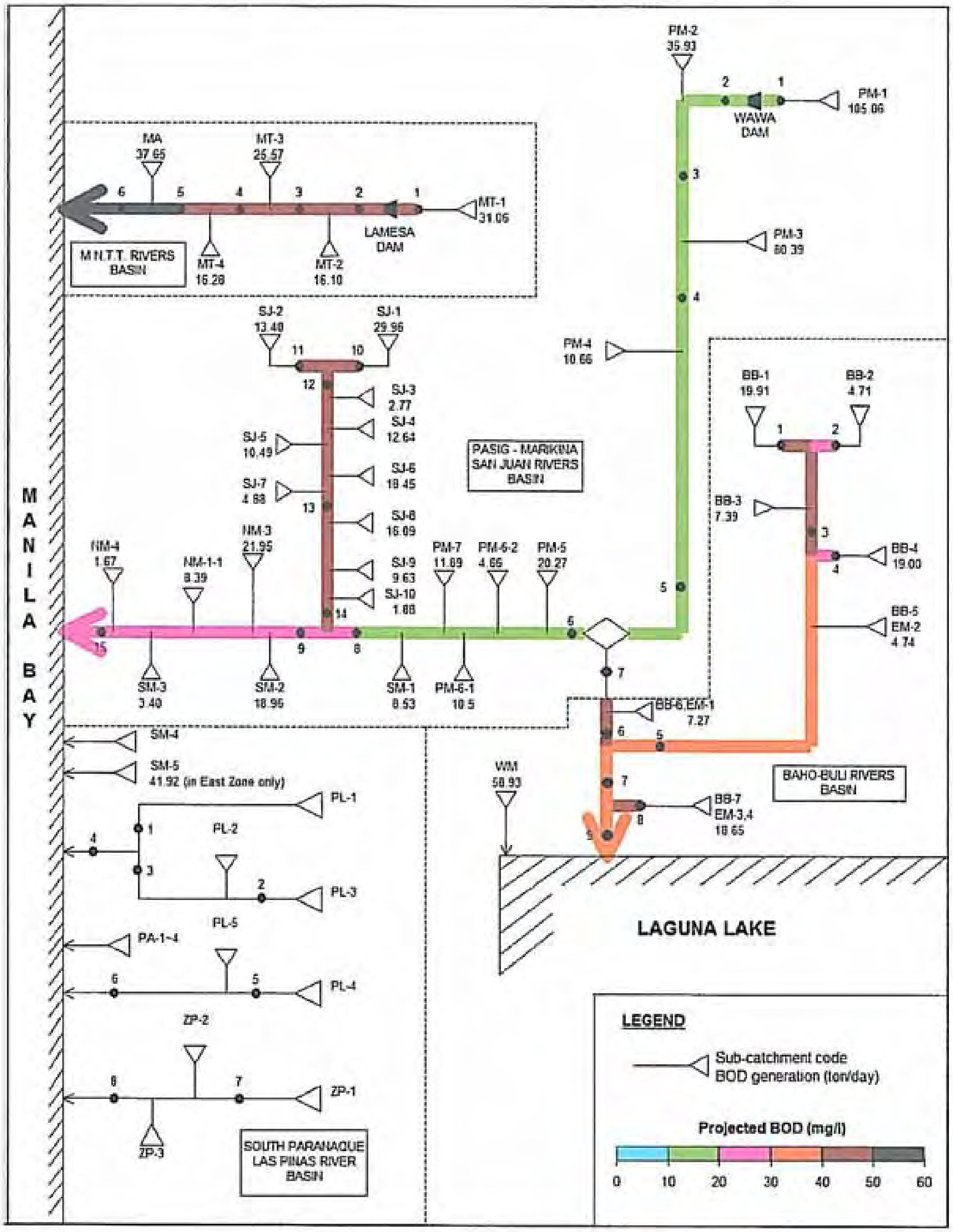


Figure 3.7.2 Projected BOD of Rivers in East Concession Zone (2025)



SECTION 4

Design Criteria for Preliminary Design

SECTION 4 DESIGN CRITERIA FOR PRELIMINARY DESIGN

Design criteria to be applied for drawing-up master plan alternatives will be same as those adopted for the Manila Third Sewerage Project (MTSP) feasibility study. Those criteria are expanded to cover broader variations in local conditions encountered in the various parts of the East Concession area.

4.1 Sewer System

The sewer design criteria is adopted from "MWSS design standards for sanitary sewer system" prepared by Eduardo M. del Fierro. Peak flow factor for combined sewer will be 1.5 as specified by MWSS for this study. Babbitt formula (5/(Population/1000) ^0.2) will be applied for separate sewer flow.

Table 4.1.1 Hydraulic Calculations

Parameters	Formula/Value
Manning formula is used for sewer pipe sizing:	$v = (l/n)\ R^{2/3}\ I^{1/2}$ where, v: velocity of flow (m/s) n: roughness coefficient R: hydraulic radius (m) I: slope n: roughness coefficient of the pipe, as follows: Pipe — Roughness Coefficient Asbestos Cement Pipes — 0.013 Vitrified Clay Pipe — 0.013 PVC/Plastic pipe — 0.010 Concrete pipe/conduit — 0.013 Steel Pipe (coated) — 0.012
Minimum velocity:	Sanitary sewer: 0.60 m/sec
Maximum velocity:	3.0 m/sec
Minimum pipe size:	200mm for sewer main; 100mm for house service connection

Table 4.1.2 Minimum Size of Manhole and Maximum Manhole Spacing

Parameters	Value
Minimum Size of Manhole	900mm
Manhole Maximum Spacing	120m for pipe 400mm and smaller 150m for pipe 450 to 1000mm 250 m for 1100mm and larger

Table 4.1.3 Peak and Minimum Flow Factors

Parameters	Value	Remarks
Peak Factor	=5/(Population/1000) ^0.2	Recommended values = 1.5 to 5.0
Minimum Flow	=(Population/1000) ^0.2/5	

Table 4.1.4 Minimum Depth of Cover and Alignment

Parameters	Value
Minimum Depth of Cover -	Sewer Laterals and Submains (200mm to 500mm): 1.2 m Mains and trunks (600mm to 3,000mm): 2.0m Sub-laterals not subject to traffic loads: 1.0m
Alignment	Sewers 600mm or less shall be laid with a straight alignment between manholes. Sewers 600mm and larger in diameter may be laid in a curved alignment. The maximum curve radius shall be four (4) times the inside diameter of the pipe. A manhole shall be placed immediately before or after a segment of a curve sewer.

4.2 Pumping Station

Submersible pumps shall be used for pumping stations. Preliminary treatment provided for pumping stations is screening only. Grit removal facility will be built at STP. Design criteria for pumping stations are shown below.

Table 4.2.1 Selected Pumping Station Design Criteria

Parameter	Unit	Design Criteria
Pump diameter	mm	$D=146\times(Q/1.5\sim3.0)^{0.5}$ Where D: pump diameter (mm) Q: pump discharge flow (m^3/min/unit)
Pump Head	m	$H=H_a+H_f+H_p$ where H_a : actual pump loss (m) H_f: friction loss (m) H_p: pump and pipe loss at the pump well (m)
Flow velocity in force main	m/s	1.0 ~1.5
Pump power	kW	$P=0.163\times Q\times H\times(1+0.15)/\eta$
Retention time of wet well	min	more than 5 min

Each pumping station will be equipped with:

- Coarse Screen: Bar screen (Opening 100mm)
- Fine Screen: Bar screen (Opening 20mm)
- Pump: Submersible pump, stationary wet installation with guide bars and automatic connection
- Valves: Delivery valve and check valve for each pump
- Piping material: Ductile/cast iron pipes and fitting within pumping station
- Self-standing control panel including power receiving, control and instrumentation, operated in automatic operation mode by water levels measured by level sensors/switched.

4.3 Sewage Treatment

The MTSP feasibility study selected sewage treatment processes suitable for the environmental conditions in the project area. The design criteria for those processes are shown below.

4.3.1 Raw sewage screening

Table 4.3.1 Selected Screens Design Criteria

Parameter	Unit	Design Criteria
Primary Screen		
Type of screen		Automatic mechanical rake
Maximum clear opening	mm	25
Slope to vertical	degree	0 to 45
Maximum approach velocity in feed channel	m/s	0.45 to 0.60*
Maximum flow velocity at screen face	m/s	0.45 to 0.60*
Minimum approach velocity at average flow	m/s	0.45*
Volume of screenings per volume of sewage	$m^3/10^6m^3$	Average 20
Screenings storage period	d	3 to 4**
Screenings handling		Washing and dewatering
Secondary Screen		
Type of screen		Drum or rear scraping mechanical rake
Maximum clear opening	mm	12
Screenings storage period	d	3 to 4**
Screenings handling		Washing and dewatering

Note: *Design will be based on lower maximum velocities to prevent screenings wash-through. **Shorter storage period for screenings will reduce the risk of nuisance from odors, vectors, etc.

4.3.2 Grit removal

Table 4.3.2 Selected Grit Removal Design Criteria

Parameter	Unit	Design Criteria	
Type		Horizontal flow (rectangular)	Vortex-type
Grit removal		submersible pump	vortex pump
Minimum retention at hourly peak flow	minute	1	20 – 30 seconds
Maximum flow through velocity	m/s	0.3	
Chamber dimensions depth : width length : width		 1 : 2 2 : 1	Surface loading: 3000 $m^3/m^{2/d}$
Grit quantity	$m^3/1{,}000\ m^3$ sewage	0.03	
Grit handling		washing and dewatering	

4.3.3 Primary clarifier

Conventional activated sludge, rotating biological and submerged attached growth activated sludge normally require upstream clarification whilst oxidation ditch, extended aeration activated sludge, sequencing batch reactor and submerged membrane bioreactor so not require primary clarifiers.

Table 4.3.3 Selected Primary Clarifier Design Criteria

Parameter	Unit	Design Criteria
Retention time	h	minimum 1.5 (daily average flow)
Surface loading rate: Circular Rectangular	$m^3/m^2/d$	 50 (daily average flow) 50 (daily average flow)
Weir loading rate	$m^3/m/d$	250 (daily average flow)
Upflow rate*	m/h	
Effective depth	m	2.5 - 4.0
Length : width (rectangular)		3 : 1 to 5 : 1

Note: *Upflow rate calculated from surface overflow rate.

4.3.4 Flow balancing

Submerged membrane bioreactors and sequencing batch reactors normally require upstream flow balancing tanks to attenuate diurnal flow variation. Sequencing batch reactors can be built without these tanks with additional reactor capacity.

Table 4.3.4 Balancing Tank Design Criteria

Parameter	Unit	Design Criteria
Retention time	h	minimum 3.0 (peak flow)
Minimum number of pumps		2 (1 stand-by)
Attenuated peak factor		less than 1.3 (daily average)
Other requirement		mixing

4.3.5 Biological sewage treatment system

The biological treatment systems being considered for MTSP are conventional activated sludge, oxidation ditch, extended aeration activated sludge, sequencing batch reactor, rotating biological contactor, submerged attached growth activated sludge, submerged membrane bioreactor.

Table 4.3.5 Design Parameters for Sewage Treatment Process

Parameter	Unit	CAS	OD	EA	SBR Continuous Fill	SBR Intermittent Fill	RBC	Submerged Attached Growth	Submerged Membrane Bioreactor
Reactor Depth (Typical)	m	4 – 6	1 – 6	2 - 6	4 - 5	4 - 5		3 - 5	2 - 5
Reactor width to depth	ratio	1:1 – 2:1	1:1 – 2:1					1:1 – 2:1	
F/M ratio	kgBOD/ kgMLSS/d	0.10 – 0.4	0.05 – 0.10	0.05 – 0.10	0.05- 0.08	0.05 – 0.30			0.1 – 0.4
Hydraulic retention time	h	4 – 8	15 - 30	16 – 24	20 – 30	10 – 30	0.7-1.5		4 - 6
MLSS (Typical)	mg/l	1500 – 3000	3000 – 5000	2000 – 5000	2000 - 5000	2000 - 5000			5000 – 20000
Hydraulic loading	$m^3/m^2/d$						0.08 – 0.16		
Organic loading	kg BOD $/m^3/d$	0.3 – 0.7	0.1 – 0.3	0.1 – 0.3			0.010 – 0.017	< 0.3	0.5 – 1.5
Sludge age (Solids Retention Time: SRT)	d	5 – 15	15 – 30	20 - 40	20 – 30	10 - 20			5 - 30
Aerobic Solids Retention Time (ASRT)	d	3 – 6	8 - 30	13 - 40					
Sludge generation	kg/kg SS in sewage	1.0	0.75	0.75	0.75	0.75	0.92	0.90	0.75

Adopted from Japan Sewerage Works Association (2001) Sewerage Facility Design Guideline; Metcalf & Eddy, Inc. (2003) Wastewater Engineering Treatment and Reuse

4.3.6 Secondary clarifier

Secondary clarifiers are not required for sequencing batch reactors and submerged membrane bioreactor since solid-liquid separation will occur in reactors. The different design criteria are adopted depending on the type of activated sludge system.

Table 4.3.6 Selected Secondary Clarifier Design Criteria

Parameter	Unit	Criteria
Side water depth CAS EA/OD SAG RBC	m	minimum 3 - 4
Minimum hydraulic retention time at peak flow	h	2
Surface overflow rate peak flow CAS EA/OD SAG RBC	$m^3/m^2/d$	 20 - 30 8 - 12 20 – 30 20 – 30
Weir loading at average flow CAS EA/OD SAG	$m^3/d.m$	 150 50 80

4.3.7 Disinfection

Table 4.3.7 Selected Disinfection Design Criteria

Parameter	Unit	Design Criteria
Sodium hypochlorite		
Chlorine dose	mg/l	2 – 4
Contact time at average flow	min	>15
Number of channels		4
Length : width		minimum 6 : 1
Height : width		minimum 2 : 1
UV		
Maximum SS in feed	mg/l	35
UV transmittance	%	40 – 60
UV intensity	million Ws/cm^2	30 for coliforms 60 for other organisms
UV power rating	Wh/m^3	40
Coliform reduction	ratio	500
Contact time	s	up to 30 s (typical 20 s)

4.3.8 Sludge Treatment Process

(1) Sludge generation rates

The recommended total sludge generation rates from different mechanized treatment processes are summarized in Table 4.2.8. The rates are based on the Japanese convention of using feed and removal of TSS to calculate secondary sludge.

Table 4.2.8 Sludge Generation Rates

Treatment Process	Total Sludge Generation (% kg TSS in raw sewage)
SBR	75
OD/EA	75
SMB	75
CAS	100
RBC	85
Submerged attached growth	90

(2) Sludge Disposal

The preliminary designs and cost estimates for the STPs under the MTSP have been based on a dry solids (DS) content of 25%. Since land is not available the use of drying beds is ruled out, hence sludge dewatering using a mechanized process will be required.

(3) Thickening

The basic rationale of the recommended design criteria is that whilst gravity thickening is an acceptable process for primary sludge, secondary sludge exhibits higher moisture contents and is, therefore, best thickened by means of a mechanical process.

Typical design criteria for gravity thickening are a maximum sludge loading rate of 36 $m^3/m^2/d$ and a maximum solids flux of 60 kg solids/m^2/d. For dissolved air flotation a lower solids flux would typically be adopted of say 10 kg solids/m^2/d. The DS content in the thickened sludge would be of the order of 2.5%.

Rotary drum thickeners have been adopted in thickening secondary clarifier sludge. The process is robust, entirely enclosed, and easy to operate and maintain. If two units are provided of 50% daily capacity each on an 8-hour cycle, standby capacity is available if necessary by operating one unit a double shift, rather than providing excess unit capacity. It is suggested that mechanical thickeners be designed on the basis of operating 6 days per week for a double shift of 14 h/d allowing start-up and cleaning.

(4) Mechanized Dewatering

<u>Filter-plate press</u>

Filter-plate presses can consistently produce sludge with 30% or more DS. The use of inorganic chemicals as conditioners can result in a very dry cake up to DS 45% but a considerable proportion of the weight is then comprised of the conditioning chemicals. The process is not continuous, the filling, filtration and cake discharge phases can vary over a wide range (typically over a total cycle time of from 2.5 to 12 hours) and as a result a high level of operator attention and experience is required.

Belt press

Belt presses have been proven to be reliable processes for dewatering sewage sludge. Standard designs provide belt widths of 1 to 3 m and the optimum throughput depends on the required cake dryness and polymer dose. It would be more usual to achieve a cake of say 15 to 23% DS at a polymer dose of 10 kg/t DS from secondary sludge (4% DS), but with a relatively low solids capture of 90%. Feed rates of 150 kg DS/h can be achieved but this is considerably lower than the rates that can be achieved with centrifuges and screw presses (more than 300 kg DS/h).

Centrifuges

Decanter-type centrifuges can exhibit a very high solids capture, typically more than 95%, with 98 to 99% being not unusual when treating a range of sewage sludge. The newer two-gear models can produce significantly drier sludge cake (up to 30% dry solids) from thickened feed sludge at polymer doses of around 8 kg/t DS. Whilst most centrifuge manufacturers will guarantee say 20% DS for secondary sewage sludge, there is a penalty to pay in that the solids capture may fall to around 90 to 95% and the polymer dose typically increases to around 12 kg/t DS.

Screw press

Screw press is robust and capable of dewatering sludge of varying DS feed with minimal maintenance requirements. As with the decanter centrifuge, the process has the advantage of being totally enclosed and with relatively low washing requirements. Operating data in Japan indicate that thickened surplus sludge from an oxidation ditch with a moisture content of 4% DS can produce a cake with 20% DS at a polymer dose of say 10 kg/t. DS with a solids capture of at least 90%.

(5) Odor Control

The locations and processes that are commonly associated with odor nuisance in addition to all stages of sludge treatment and disposal are inlet works, primary clarifiers, and high-rate secondary treatment processes. Whilst not always possible, the layout of the plant should aim to keep potential odor producing processes away from site boundaries and sensitive receivers. The direction of the prevailing wind should also be taken into account. Extended aeration, oxidation ditches and SBR secondary treatment processes are less likely to generate odors than conventional activated sludge systems.

For locations where the risk of release of odors remains, even after the incorporation in the design of precautionary measures, odor treatment will be considered. There are essentially four treatment systems in widespread use, their advantages and disadvantages are summarized in Table 4.3.9. Depending on the anticipated magnitude of the problem and the cost, a biological process (particularly biofiltration) could prove to be the best cost-effective option rather than chemical or bio scrubbing.

Table 4.3.9 Odor Treatment Processes

Process	Advantages	Disadvantages
Chemical scrubbing	Standard technology Easy to monitor and control Can deal with variations on odor feed Quick to re-establish after breakdown	High capital and operating costs Storage of hazardous chemicals Generates concentrated waste
Carbon adsorption	Low cost installation Most efficient for polishing low odor feed levels	High operating cost Affected by humidity Poor efficiency on high sulfide feeds
Bioscrubbing	Robust system Low operating cost Can deal with high odor levels	Cannot achieve high standards Sulfides may inhibit effectiveness on other compounds
Biofiltration (Earth filters)	Easy to operate Simple technology Reliable performance	Large plan area Difficult to re-commission Less effective with high sulfide feeds

The bioscrubbing system increasingly adopted in Japan uses a plastic resin media in a compact tower arrangement with the provision of water flushing as needed to maintain neutral pH levels. The process uses standard technology, it can deal with rapid variations in odor levels, is easy to monitor and control, and does not give rise to concentrated wastes that require treatment.

4.3.9 Evaluation of biological sewage treatment process alternatives

Sequencing batch reactor, oxidation ditch and submerged membrane processes are identified as preferred processes through the technical evaluation for the capacity range between 1,000 and 20,000 m^3/day. For the larger capacity treatment plants, especially for sewerage flow over 50,000 m^3/day, conventional activated sludge system will be considered in the built up area in favor of its small footprint. For small STP that has only limited land, submerged membrane bioreactor will be considered to maximize treatment capacity.

Table 4.3.10 Technical Evaluation of Sewage Treatment Processes

Treatment Process	Process Reliability	Technical Complexity	Land Requirement	Expansion Potential	Overall Weighted Score
SBR	5	4	5	4	37
OD	6	6	1	5	37
SMB	3	5	6	2	33
SAG	2	3	2	3	19
RBC	1	2	3	1	14
CAS	4	1	4	6	28

Note: High number best (6), low number worst (1); overall score based on weight of 3 for process reliability, 2 for technical complexity and land requirement, and 1 for expansion potential.

Table 4.3.11 Cost Comparison of Selected Sewage Treatment Processes

Treatment Process	Construction Cost	Operation Cost		Maintenance Cost
		Power	Labor	
SBR	1.0	1.0	1.2	1
OD	1.0	1.0	1.0	1.1
SMB	1.4	1.0	1.2	1.4
CAS	1.1*	1.0	1.2	1.2

Note: As plant capacity become larger, construction cost becomes closer to that of OD and SBR.

4.3.10 Evaluation of mechanical sludge dewatering process alternatives

The technical evaluation indicates that the preferred sludge dewatering process is screw press and centrifuge. Screw press is most favorable in economic terms. Centrifuge will be considered when high solids recovery is preferred.

Table 4.3.12 Technical Evaluation of Mechanical Dewatering Processes

Process	Cake Solids	Solids Capture	Maintenance Requirement	Technical Complexity	Overall Weighted Score
Filter Press	4	3	1	1	20
Belt Press	1	1	2	2	14
Centrifuge*	3	4	3	3	28
Screw Press	2	2	4	4	28

Note: High number best (4), low number worst (1); overall score based on weight of 3 for cake solids and technical complexity, 2 for maintenance, and 1 for solids capture; *based on two-gear drive decanter centrifuge.

Table 4.3.13 Cost Comparison of Selected Sludge Dewatering Processes

Treatment Process	Construction Cost		Operation Cost		
	Civil/Architectural	M & E	Power	Labor	Chemical
Screw Press	1.0	1.0	1.0	1.0	1
Centrifuge	1.0	1.2	7.0	1.5	1.1
Belt press	1.0	2.2	1.7	1.5	1.4
Filter-plate press	1.0	7.0	1.7	1.5	1.2

4.4 Septage Treatment

The MTSP feasibility study selected screw press dewatering followed by SBR filtrate treatment for septage treatment as a most economical and suitable option for environmental conditions in the East Concession area. The design criteria for these processes are presented in the previous section.

4.4.1 Design Septage Quality

The design septage quality is adopted from "Feasibility Study for Treatment, Handling and Disposal of Septage, Pasig River Environmental Management and Rehabilitation Sector Development Program" prepared by Sinclair Knight Merz (2003).

Table 4.4.1 Design Septage Quality

Parameters	Unit	Design value
pH		7.5
BOD	mg/l	6,000
COD	mg/l	15,000
TS	mg/l	40,000
TVS	mg/l	25,000
TSS	mg/l	20,000
TVSS	mg/l	10,000
NH3-N	mg/l	150
TKN	mg/l	700
TP	mg/l	100

4.4.2 Design Filtrate Quality

Expected filtrate quality from dewatering units is shown in Table 4.4.1.

Table 4.4.1 Design Filtrate Quality

Parameters	Unit	Design value
BOD	mg/l	1,000
TSS	mg/l	800

SECTION 6

Alternative Development

SECTION 6 ALTERNATIVE DEVELOPMENT

6.1 Development of Catchment Areas

The service area was analyzed to determine topography, drainage patterns, and availability of sites for sewage treatment plants. Following the analysis, eleven catchment areas were developed based primarily on the topography and natural drainage patterns.

6.2 Sewage Treatment Plant Sites

There were several potential STP sites identified during the 1999-2000 Master Plan Study. However, due to the fast changing development in the Metropolitan Manila area, most of these sites are unavailable, as many have been developed for commercial, industrial, institutional and residential use. Of 43 sites identified in the 1999-2000 Master Plan Study, only 10 STP sites are still available. Figure 6.2.1 and Appendix E present the current status of the potential sites identified. A field survey was conducted to identify alternative/new sites, especially in Mandaluyong, San Juan, Pasig and Quezon City. These new sites, together with previously identified sites that are available, are listed in Table 6.2.1. The current market prices for each site were obtained from the local government units.

Table 6.2.1 Potential Sewage Treatment Plant Sites

Catchment Area	Location	Owner	Available Area	Assessed Value	Market Value
			(ha)	Ps/m²	Ps/m²
QC North	UP Campus, Quezon City	UP Diliman	approx. 10.0	--	7,000
QC East	Beside Marikina River and near Tumana Bridge, Loyola Heights Subd., Concepcion Uno, Marikina	for inquiry	approx 10.0	12,000	--
QC South	14th St. corner Sta. Cecilia St. New Manila (Near National Childrens Hospital), Quezon City	Private Property	approx. 7 ha	for inquiry	for inquiry
QC Central	PCSO Compound, corner E. Rodriguez & Araneta, Quezon City	Government	1.0	na	na
Mandaluyong – San Juan	Near Pasig River, beside Gregorio Araneta Inc., Punta Sta. Ana, Manila	Marcelo Steel Corporation	total is 9.0, for sale is 6.0	7,350	20,000
Pasig North	E. Rodriguez Ave. In front of Eagle Factory, Brgy. Ugong, Pasig	Meat Packing Corporation	12.3	35,000	--
Makati	Magallanes STP, Magallanes Villlage,Brgy. Magallanes, Makati	MWSS	1.0	na	na
Taguig West	Land at Villamor Golf Course	Government	> 1.0	na	na
Pasig South	Land near Tapayan Pond Taguig	for inquiry	> 15 ha	2,000 - 3,000	--
Pateros	Land near Labasan Pond Taguig	for inquiry	> 15 ha	2,000 - 3,000	--
Taguig	Land near Taguig Pond Taguig	for inquiry	approx. 5 ha	2,000 - 3,000	--

6.3 Sewerage Alternatives Development

A total of five sewerage alternatives were developed, three for separate sewerage systems and two for combined sewerage systems. These alternatives are listed below:

Alternative 1 – 1997 Concession Agreement Target Service Levels and Implementation Schedule (Separate Sewerage Systems in Eleven Catchment Areas)

Alternative 2 – 1997 Concession Agreement Target Service Levels with Extended Implementation Schedule (Separate Sewerage Systems in Eleven Catchment Areas)

Alternative 3 – 1997 Concession Agreement Target Service Levels with Extended Implementation Schedule (Separate Sewerage Systems in Seven Catchment Areas)

Alternative 4 – 1997 Concession Agreement Service Area with Extended Implementation Schedule (Combined Sewerage Systems in Eleven Catchment Areas)

Alternative 5 – 1997 Concession Agreement Service Area with Extended Implementation Schedule (Combined Sewerage Systems in Seven Catchment Areas)

6.3.1 Reasons for Selection of Alternatives

The five alternatives were selected to allow comparisons of different systems to assess the effect of variations on cost, tariff impact/affordability, technical constraints and benefits. The comparisons that can be made include:

- extended implementation schedule and deferred capital investments, to reduce the NPV and tariff impact.
- comparison of implementation of separate sewerage systems versus combined sewerage systems, to reduce the NPV, tariff impact and technical constraints.
- reduced number of STPs by joining adjacent catchment areas in cases where STP sites are located relatively close together, sewage can be transferred from one catchment area to another relatively easily, limited space is available for construction of an STP, or the cost of land is relatively high; to reduce the NPV, tariff impact and technical constraints.

6.3.2 Description of Variations Between Alternatives

The first alternative is based on the system requirements and implementation schedule to meet the 1997 Concession Agreement service targets, utilizing eleven catchment areas with separate sewer systems and eleven STPs. The second alternative is the same system as that for the first alternative, but with an extended implementation schedule that allows completion of construction to occur in 2025, whereas the implementation schedule has most of the construction completed by 2015 and all of the construction completed by 2020 with the exception of the final house connections. The catchment areas for Alternatives 1 and 2 are summarized in Table 6.3.1.

Table 6.3.1 Summary of Catchment Areas for Alternatives 1 and 2

Catchment Area	Area (Ha)	2025 Population Served
QC East	1,124	179,867
QC North	2,047	304,564
Mandaluyong- San Juan	1,456	250,912
Pasig North	1,809	207,313
Pasig South	1,627	373,242
QC South	1,597	238,417
QC Central	1,233	183,456
Makati	1,556	261,651
West Taguig	372	87,359
Pateros	1,567	410,659
Taguig	2,047	740,657
Total	16,434	3,238,096

In the third alternative, the number of catchment areas is reduced from eleven to seven with separate sewer systems and seven STPs. In this alternative two adjacent catchment areas were joined together, with the sewage from one catchment area transferred to an adjacent catchment area. QC East was joined with QC North, QC South was joined with QC Central, and Makati was joined with Taguig West because the STP sites for these adjacent catchment areas are located relatively closely together, or the sewage could be easily transferred from one catchment area to the other. Pasig South was combined with Pasig North, mainly because of the relatively high cost of the system that would serve Pasig North, due mainly to the high cost of land and low population density in Pasig North. The implementation schedule for the third alternative allows for completion of construction to occur in 2025. The catchment areas for Alternative 3 are summarized in Table 6.3.2.

Table 6.3.2 Summary of Catchment Areas for Alternatives 3

Catchment Area	Area	Population Served
QC East & QC North	3,171	484,431
Mandaluyong- San Juan	1,456	250,912
Pasig North & Pasig South	3,436	580,555
QC South & QC Central	2,830	421,872
Makati & West Taguig	1,928	349,010
Pateros	1,567	410,659
Taguig	2,047	740,657
Total	16,434	3,238,096

The fourth alternative is based on the system requirements for combined sewerage systems covering the same service area as the first three alternatives, utilizing eleven catchments areas and eleven STPs. The implementation schedule for the fourth alternative allows for completion of construction to occur in 2025. The catchment areas for Alternative 4 are summarized in Table 6.3.3.

Table 6.3.3 Summary of Catchment Areas for Alternatives 4

Catchment Area	Area (Ha)	2025 Population Served
QC East	1,124	180,670
QC North	2,047	306,457
Mandaluyong- San Juan	1,432	238,446
Pasig North	1,422	152,607
Pasig South	1,627	373,242
QC South	1,846	276,181
QC Central	1,233	184,596
Makati	1,634	266,593
West Taguig	690	194,609
Pateros	1,420	389,236
Taguig	1,800	648,036
Total	**16,275**	**3,210,672**

The fifth alternative is similar to the third alternative in that the number of catchment areas and STPs are reduced from eleven to seven. However, the fifth alternative utilizes combined sewers, rather than separate sewers that are utilized in the third alternative. The implementation schedule for the fifth alternative also allows for completion of construction to occur in 2025. The seven catchment areas for Alternative 5 are shown in Figure 6.3.4.

Table 6.3.4 Summary of Catchment Areas for Alternatives 5

Catchment Area	Area	Population Served
QC East & QC North	3,171	487,127
Mandaluyong- San Juan	1,432	238,446
Pasig North & Pasig South	3,048	525,848
QC South & QC Central	3,079	460,778
Makati & West Taguig	2,324	461,202
Pateros	1,420	389,236
Taguig	1,800	648,036
Total	**16,275**	**3,210,672**

6.3.3 Comparisons Between Specific Alternatives

To evaluate the effects of differences between the alternatives on cost, tariff impact/affordability, technical constraints and benefits; comparisons can be made between specific alternatives. The comparisons between specific alternatives are listed below:

- Alternatives 1 and 2 allow comparison of same separate sewerage systems (11 separate sewer systems, 11 STPs) with an extended implementation schedule.
- Alternatives 2 and 4 allow comparison of separate and combined sewerage systems (11 separate or combined sewer systems, 11 STPs).
- Alternatives 3 and 5 allow comparison of separate and combined sewerage systems (7 separate or combined sewer systems, 7 STPs).
- Alternatives 2 and 3 allow comparison of reduced number of STPs for separate sewerage systems (11 separate sewer systems, 11 STPs; versus 7 separate sewer systems, 7 STPs).
- Alternatives 4 and 5 allow comparison of reduced number of STPs for combined sewerage systems (11 combined sewer systems, 11 STPs; versus 7 combined sewer systems, 7 STPs).

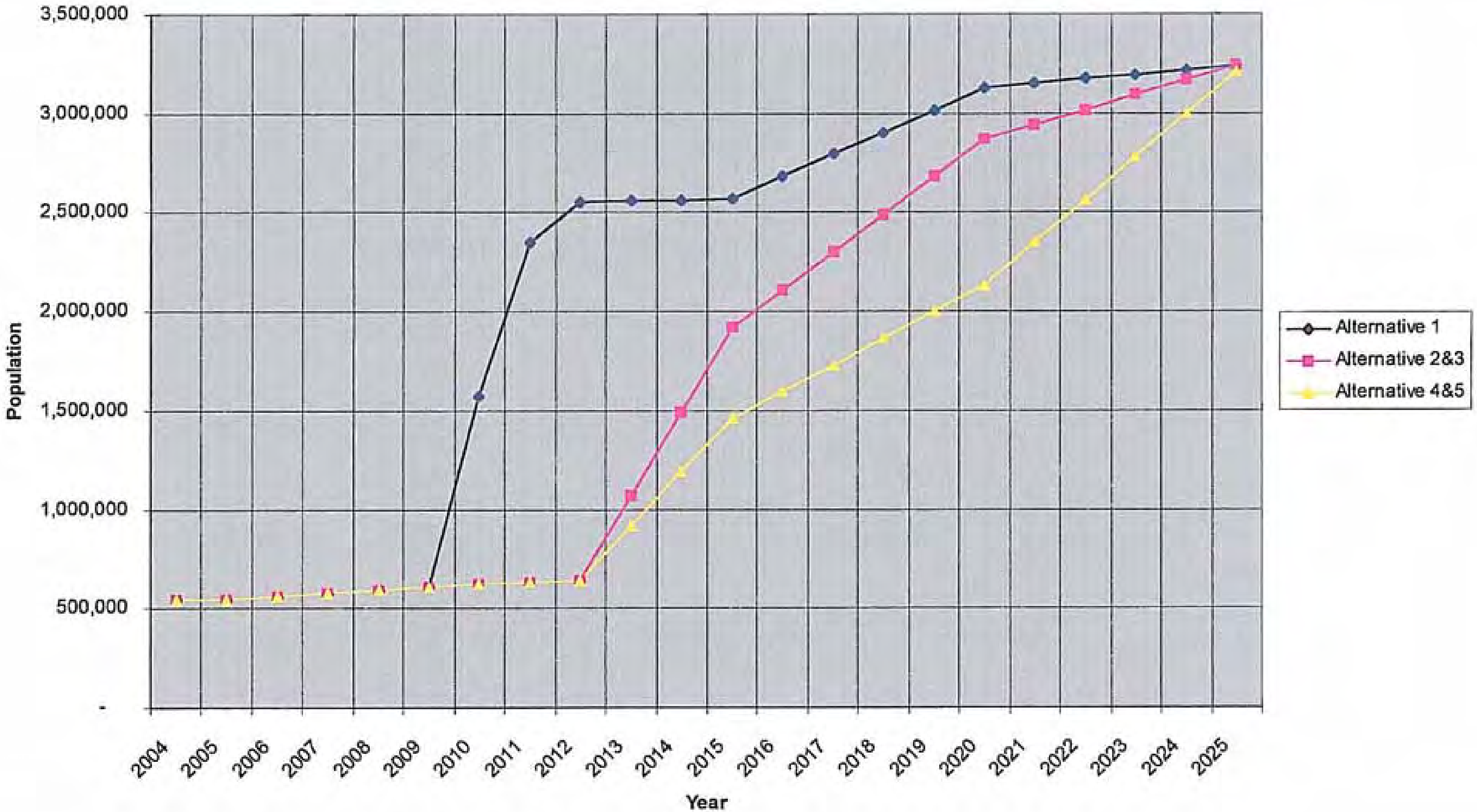
6.3.4 Boundaries of Catchment Areas

The eleven catchment areas for the separate sewer systems in Alternatives 1 and 2 are shown in Figure 6.3.1. The seven catchment areas for the separate sewer system in Alternative 3 are shown in Figure 6.3.2.

The eleven catchment areas for the combined sewer systems in Alternative 4 are shown in Figure 6.3.3. The seven catchment areas for the combined sewer system in Alternative 5 are shown in Figure 6.3.4.

The increase in population served for each of the alternatives from 2008 to 2025 is shown in Figure 6.3.5. The rate of increase in population served depends mainly on the implementation schedules for the different alternatives.

Figure 6.3.5 Target Population for Sewerage Services



6.4 Alternative 1 - 1997 Concession Agreement Target Service Levels and Implementation Schedule (Separate Sewerage Systems in Eleven Catchment Areas)

The 1997 Concession Agreement target ultimately requires 100% sewerage coverage for Makati, Mandaluyong, San Juan, Pasig and Quezon City. For Pasig City, only 68% of the areas are required to be sewered. Cainta and Taytay will be partially sewered, at 14% and 15%, respectively. Decentralized separate systems under the MSSP and MTSP shall be maintained. For study purposes, it is assumed that combined sewerage systems under the MTSP will be replaced with separate sewerage systems under Alternatives 1, 2 and 3.

The catchments areas, service populations, and estimated sewage flows for Alternative 1 are summarized in Table 6.4.1. Drawings showing the catchment areas and the trunk sewer systems are presented in Figures B.1.1 to B.1.12 in Appendix B.

The trunk sewer systems for each of the eleven sewerage systems consist of 250 mm to 1500 mm gravity sewer pipes. To limit excavation depths to 4 to 5 m, several lift and pump stations will be provided for each catchment area. Inverted siphons shall be provided across creek crossings to minimize the number of pumping stations. Pipe jacking will be required, particularly for trunk sewers running across and along major thoroughfares. The details of the sewerage system, including trunk sewers, pump stations, force mains and sewage treatment plants are summarized in Table 6.4.2.

Conveying sewage to the trunk sewers, 200 mm lateral sewers shall be laid in most of the streets within the catchment area. Estimates of the length of the lateral sewers are based on GIS data of street lengths collected from the MMEIRS. Quezon City has the lowest estimated sewer density at 112 m per hectare, while San Juan and Makati, has the highest sewer density at around 150 m per hectare.

Eleven sewage treatment plants would be required, with capacities ranging from 32,600 m^3/day (West Taguig Catchment) to 163,600 m^3/day (Taguig Catchment). Given the available area in the proposed STP sites, treatment systems that have small footprints like conventional activated sludge systems are proposed. Extended aeration systems will not be viable. For the Makati catchment area, the additional STP capacity requirement is around 100,000 m^3/day, while the available area in the Magallanes STP is quite limited at around 10,000 m^2. For this site, there may be a need to employ SBRs or attached-growth treatment systems, which require a relatively small footprint.

The estimated capital cost for Alternative 1 is Ps 88,552 million. A breakdown of the capital and operation & maintenance costs is presented in Table 6.4.3. A comparison of the capital costs relative to the population served is presented in Table 6.4.4. The capital costs for the different catchment areas range from Ps 17.66 million/1,000 people in Taguig to Ps 51.70 million/1,000 people in Pasig North. The relatively high cost in Pasig North results from the high cost of land and the low population density. House connections shall be made from the property line and connect to 200 mm lateral sewers. As shown in the cost estimates, at unit costs of Ps 33,000 to Ps 58,000 per connection, the total cost of house connections is significant.

To meet the 2011 target, most of the investments for sewerage systems will be constructed from the Years 2007 to 2011. Phasing will be done for Quezon North, Pasig South and Taguig. By 2020, all sewers and STP facilities for 2025 capacities will be in place. The proposed implementation schedule for Alternative 1 is shown in Figure 6.4.1.

6.5 Alternative 2 - 1997 Concession Agreement Target Service Levels with Extended Implementation Schedule (Separate Sewerage System in Eleven Catchment Areas)

The level of service and the system requirements for Alternative 2 are exactly the same as those for Alternative 1. The catchment areas for this alternative are the same as for Alternative 1, and are summarized in Table 6.4.1 and shown in Figures B.1.1 to B.1.12 in Appendix B.

The difference between Alternative 2 and Alternative 1 is the implementation schedule. In this alternative the implementation schedule is extended. This alternative allows evaluation of the effect of extending the implementation on the system cost, expressed as net present value. This alternative would also limit disruption of traffic to a smaller area where construction works are being executed, compared to Alternative 1. However it would extend the length of time during which traffic disruption would occur. The implementation schedule for Alternative 2 is shown in Figure 6.5.1. The implementation schedule shows the sequencing of construction between 2008 and 2025. In Alternative 1, most of the sewerage investments would be made prior to 2011. As can be seen from the schedule for Alternative 2, most of the sewerage investments would be made after 2011.

6.6 Alternative 3 - 1997 Concession Agreement Target Service Levels with Extended Implementation Schedule (Separate Sewerage System in Seven Catchment Areas)

The level of service for Alternative 3 is exactly the same as that for Alternative 1 and Alternative 2. However, in this alternative the number of catchment areas is reduced to seven from eleven by joining eight adjacent catchment areas, to form four larger catchment areas. The catchment areas that were joined and the means of transferring sewage from one drainage basin to the other are listed below:

Catchment Area	Transfer of Sewage
QC East & QC North	Sewage from QC North is pumped QC East sewer system, then to the QC East STP
Pasig North & Pasig South	Sewage from Pasig North is pumped to Pasig South sewer system, then to the Pasig South STP
QC South & QC Central	Sewage from QC South is pumped to QC Central STP
Makati & West Taguig	Makati gravity sewerage system is re-routed to Taguig West STP site

The catchments areas, service populations, and estimated sewage flows for Alternative 3 are summarized in Table 6.6.1. Drawings showing the catchment areas and the trunk sewer systems are presented in Figures B.2.1 to B.2.8 in Appendix B.

The details of the sewerage system, including trunk sewers, pump stations, force mains and sewage treatment plants are summarized in Table 6.6.2. Seven sewage treatment plants would be required, with capacities ranging from 78,800 m^3/day (Mandaluyong Catchment) to 191,000 m^3/day (QC East & QC North Catchment). Given the available area in the proposed STP sites, treatment systems that have small footprints like conventional activated sludge systems are proposed. Extended aeration systems will not be viable. Alternative 3 eliminates the need for an additional STP capacity of 100,000 m^3/day for the Makati Catchment area at the Magallanes STP, which has an available area of approximately 10,000 m^2. The sewage from the Makati Catchment area will be re-routed to the STP at West Taguig.

The estimated capital cost for Alternative 3 is Ps 83,545 million, a reduction of approximately Ps 5,000 million compared to Alternative 1 and Alternative 2. A breakdown of the capital and operation & maintenance costs is presented in Table 6.6.3. A comparison of the capital costs relative to the population served is presented in Table 6.6.4. The capital costs for the different catchment areas range from Ps 17.66 million/1,000 people in Taguig to Ps 30.73 million/1,000 people for Mandaluyong - San Juan. The capital cost for Pasig North is reduced from Ps 51.70 million/1,000 people for Alternative 1 and Alternative 2 to Ps 27.63 million/1,000 people. The relatively high cost in Pasig North in Alternative 1 and Alternative 2 results from the high cost of land and the low population density.

6.7 Alternative 4 - 1997 Concession Agreement Service Area with Extended Implementation Schedule (Combined Sewer System in Eleven Catchment Areas)

This alternative covers the 1997 Concession Agreement Service Area, similarly to the first three alternatives. However, Alternative 4 utilizes combined sewer systems with STPs, rather than separate sewer systems. This alternative was develop given the acceptance of combined sewer systems as a means of achieving the sewerage targets by MWSS, the high cost of separate sewer systems, the reluctance of customers to connect to the sewer system. It is noted that an important aspect of the strategy involving combined sewer systems is continued intensive septage collection and treatment. The catchments areas, service populations, and estimated sewage flows for Alternative 4 are summarized in Table 6.7.1. Drawings showing the catchment areas and the interceptor sewer systems are presented in Figures B.3.1 to B.3.12 in Appendix B.

In addition to street drainage improvements, the combined sewer systems will be comprised of 375 mm to 1500mm interceptor pipes, with a minimum cover of 2.5m. Several lift and pumps stations will be provided for each catchment area to limit excavation depths to 4 to 5m, but inverted siphons will be provided across small creeks to minimize the number of such pumping stations. Interceptor boxes will be located at main drainage points. At some points, small creeks will be intercepted, and a weir and intake structure would have to be constructed. Small drainage lines crossing the interceptors will be collected by a parallel drainage pipe which would drain to the nearest interceptor boxes. Pipe jacking will be required, particularly for interceptors running across and along major thoroughfares. With combined systems, use of individual septic tanks will not be discontinued, and an intensified septage collection and treatment program as called for under the MTSP would have to be pursued. The details of the sewerage system, including interceptor sewers, pump stations, force mains and sewage treatment plants are summarized in Table 6.7.2. Eleven sewage treatment plants would be required, with capacities ranging from 61,700 m^3/day (West Taguig Catchment) to 155,800 m^3/day (Taguig Catchment). Given the available area in the proposed STP sites, treatment systems that have small footprints like conventional activated sludge systems are proposed. Extended aeration systems will not be viable. For the Makati Catchment area, the additional STP capacity requirement is around 110,000 m^3/day, while the available area in the Magallanes STP is quite limited at around 10,000 m^2. For this site, there may be a need to employ SBRs or attached-growth treatment systems, which require a relatively small footprint.

The estimated capital cost for Alternative 4 is Ps 37,188 million. Drainage rehabilitation costs are excluded in the capital cost estimate. It is assumed that these will be mainly funded by the local government units (LGUs). A breakdown of the capital and operation & maintenance costs is presented in Table 6.4.3. A comparison of the capital costs relative to the population served is presented in Table 6.4.4. The capital costs for the different catchment areas range from Ps 5.95 million/1,000 people in Taguig to Ps 33.57 million/1,000 people in Pasig North. The relatively high cost in Pasig North results from the high cost of land and the low population density. The capital cost for Alternative 4 is significantly lower than that for Alternative 1, Alternative 2 and Alternative 3. The treatment plant costs and pump station costs are similar for all four alternatives, since the treatment capacities are approximately the same. The cost reduction is mainly due to the elimination of trunk sewers and house connections. The elimination of the trunk sewers and the house connections will also reduce the level of traffic disruption, and the time duration for constructing the combined sewer system within a catchment area. The implementation schedule for this Alternative 4 is presented in Figure 6.7.1. Since less time is required construct the combined sewer system, the implementation schedule can be extended and capital investments deferred. As with the other alternatives, the completion of construction for the 11 catchment areas is scheduled for 2025.

6.8 Alternative 5 - 1997 Concession Agreement Service Area with Extended Implementation Schedule (Combined Sewer System in Seven Catchment Areas)

This alternative covers the 1997 Concession Agreement Service Area, similarly to the first four alternatives. This alternative utilizes combined sewer systems in seven catchment areas. Similarly to Alternative 4, an important aspect of the strategy involving combined sewer systems is continued intensive septage collection and treatment. This will involve continued utilization of the septage management facilities that will be developed under MTSP and expansion of the septage treatment capacity by 2020. The catchments areas, service populations, and estimated sewage flows for Alternative 5 are summarized in Table 6.8.1. Drawings showing the catchment areas and the interceptor sewer systems are presented in Figures B.4.1 to B.4.8 in Appendix B.

The details of the sewerage system, including interceptor sewers, pump stations, force mains and sewage treatment plants are summarized in Table 6.8.2. Seven sewage treatment plants would be required, with capacities ranging from 82,900 m^3/day (Mandaluyong Catchment) to 206,000 m^3/day (QC East & QC North Catchment). Given the available area in the proposed STP sites, treatment systems that have small footprints like conventional activated sludge systems are proposed. Extended aeration systems will not be viable. Alternative 5 eliminates the need for an additional STP capacity of 110,000 m^3/day for the Makati Catchment area at the Magallanes STP, which has an available area of approximately 10,000 m^2. The sewage from the Makati Catchment area will be re-routed to the STP at West Taguig. The estimated capital cost for Alternative 5 is Ps 33,649 million, a reduction of approximately Ps 3,500 million compared to Alternative 4. Drainage rehabilitation costs are excluded in the capital cost estimate, as with Alternative 4. A breakdown of the capital and operation & maintenance costs is presented in Table 6.8.3. A comparison of the capital costs relative to the population served is presented in Table 6.8.4. The capital costs for the different catchment areas range from Ps 5.95 million/1,000 people in Taguig to Ps 14.02 million/1,000 people for Mandaluyong – San Juan. The capital cost for Pasig North is reduced from Ps 33.57 million/1,000 people for Alternative 4 to Ps 10.96 million/1,000 people. The relatively high cost in Pasig North in Alternative 4 results from the high cost of land and the low population density.

Table 6.4.1 Catchment Areas, Service Population and Estimated Sewage Flow for Alternative 1 and Alternative 2

Catchment Area	Separate System Area (ha)	Projected 2025 Population	Estimated Ave. Sewage Flow in 2025 (m^3/d)			Infiltration (m^3/d)	Total STP Average Flow (m^3/d)	MSSP (m^3/d)	MTSP (m^3/d)	CST (m^3/d)	Adjusted STP Average Flow (m^3/d)
			Residential	Commercial	Total						
QC East	1,124	179,867	39,993	19,145	59,139	8,428	67,566				67,566
QC North	2,047	304,564	74,801	40,278	115,078	15,352	130,430	7,027			123,403
Mandaluyong-San Juan	1,456	250,912	44,795	23,092	67,887	10,920	78,807				78,807
Pasig North	1,809	207,313	44,091	36,208	80,299	13,571	93,870				93,870
Pasig South	1,627	373,242	63,551	15,274	78,825	12,200	91,025				91,025
QC South	1,597	238,417	55,288	29,770	85,058	11,978	97,036				97,036
QC Central	1,233	183,456	45,057	24,261	69,318	9,247	78,565				78,565
Makati	1,556	261,651	78,497	52,331	130,829	11,670	142,499	40,000			102,499
West Taguig	372	87,359	19,674	10,135	29,809	2,792	32,600				32,600
Pateros	1,567	410,659	77,494	31,842	109,336	11,753	121,089				121,089
Taguig	2,047	740,657	117,593	30,671	148,264	15,352	163,616				163,616
Total	16,434	3,238,096	660,833	313,009	973,842	123,262	1,097,103	47,027			1,050,077

Note: Separate sewage system to STP (All MSSP/MTSP/CST flow to new STP (Except Makati, and UP))

Table 6.4.2 Summary of Details of Sewerage System for Alternative 1 and Alternative 2

Description		Quezon City East	Quezon City North	Mandaluyong - San Juan	Pasig North	Pasig South	Quezon City South	Quezon City Central	Makati	West Taguig	Pateros	Taguig
Catchment Area	Ha	1,124	2,047	1,456	1,648	1,627	1,597	1,233	1,556	372	1,567	2,047
Population Served (2025)		179,867	304,564	250,912	186,614	373,242	238,417	183,456	261,651	87,359	410,659	740,657
Trunk Sewer												
RCP Pipes												
900mmØ and below	LM	19,212	19,230	27,170	30,431	10,790	28,330	9,810	14,436	6,332	14,780	9,675
1,050mmØ and above	LM	1,450	710	3,670	0	5,900	3,100	3,130	6,160	0	5,763	4,740
Force Main												
PE Pipes (SDR 11)	LM	4,100	10,560	500	400	0	700	2,750	20	1,480	1,300	950
Steel Pipes	LM	1,320	10,760	680	1,370	180	1,500	350	500	250	190	8,315
Inverted Siphons	UNIT	2	9	3	0	0	4	0	0	0	0	0
Lateral Sewers	LM	135,073	170,115	197,869	214,124	216,782	194,370	64,798	128,581	52,452	207,758	249,470
Pump Stations	UNIT	12	23	5	9	4	10	6	5	5	5	9
Q, Discharge	m^3/min	107	465	109	198	170	161	139	227	78	212	284
STP Capacity	m^3/d	67,566	123,403	78,807	93,870	91,025	97,036	78,565	102,499	32,600	121,089	163,616

Table 6.4.3 Cost Estimate for Alternative 1 and Alternative 2 (in Ps Million)

Item	Foreign	Local	Total
Capital Cost			
Land Purchase	--	7,740	7,740
STP Civil Works	2,551	5,952	8,503
STP M & E Works	6,133	3,160	9,293
PS Civil Works	465	1,085	1,550
PS M & E Works	1,385	714	2,099
Trunk Sewer	2,605	4,839	7,444
Laterals	2,740	10,959	13,698
House Connections	7,034	28,137	35,171
Trucks	58	15	73
Engineering Studies			
STP	747	498	1,246
PS / Sewer	694	1,041	1,735
Total Capital Cost	**24,414**	**64,139**	**88,552**
O & M Costs			
Operation STP	235	941	1,177
Operation PS	--	96	96
Maintenance: STP	68	35	103
Maintenance: PS	12	6	18
Maintenance: Sewer	10	24	34
Maintenance: Lateral	19	44	63
Total O & M Costs	**344**	**1,147**	**1,491**

Table 6.4.4 Comparison of Capital Costs Relative to Population Served for Alternative 1 and Alternative 2

Catchment Area	Land Cost (Ps Million)	Construction Cost Ps Million	Total Cost (Ps Million)	2025 Population	Land Cost/ Population (Ps Million/1,000)	Construction Cost/ Population (Ps Million/1,000)	Total Cost/ Population (Ps Million/1,000)
Quezon East	420	5,006	5,426	179,867	2.34	27.83	30.17
Quezon North	0	8,431	8,431	304,564	0.00	27.68	27.68
Mandaluyong - San Juan	1,200	6,509	7,709	250,912	4.78	25.94	30.73
Pasig North	2,800	7,917	10,717	207,313	13.51	38.19	51.70
Pasig South	300	8,685	8,985	373,242	0.80	23.27	24.07
Quezon South	1,200	7,008	8,208	238,417	5.03	29.39	34.43
Quezon Central	720	5,067	5,787	183,456	3.92	27.62	31.55
Makati	0	6,244	6,244	261,651	0.00	23.86	23.86
Taguig West	500	2,750	3,250	87,359	5.72	31.48	37.21
Pateros	300	10,415	10,715	410,659	0.73	25.36	26.09
Taguig	300	12,779	13,079	740,657	0.41	17.25	17.66
Total	**7,740**	80,812	88,552	3,238,097	–	–	–
				Maximum	13.51	38.19	51.70
				Average	3.39	27.08	30.47
				Minimum	0.00	17.25	17.66

Figure 6.4.1 Implementation Schedule – Alternative 1

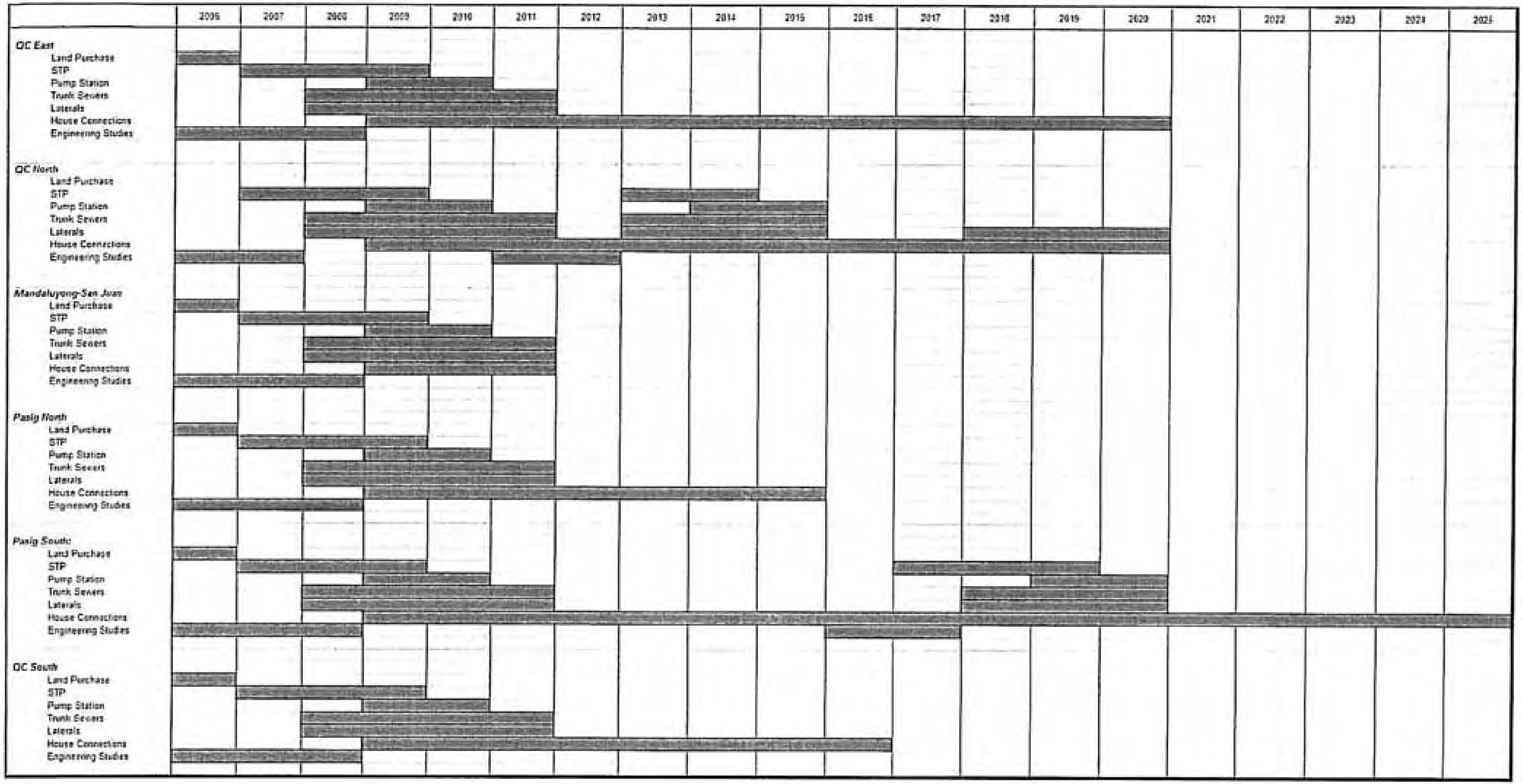


Figure 6.4.1 Implementation Schedule – Alternative 1 (Continued)

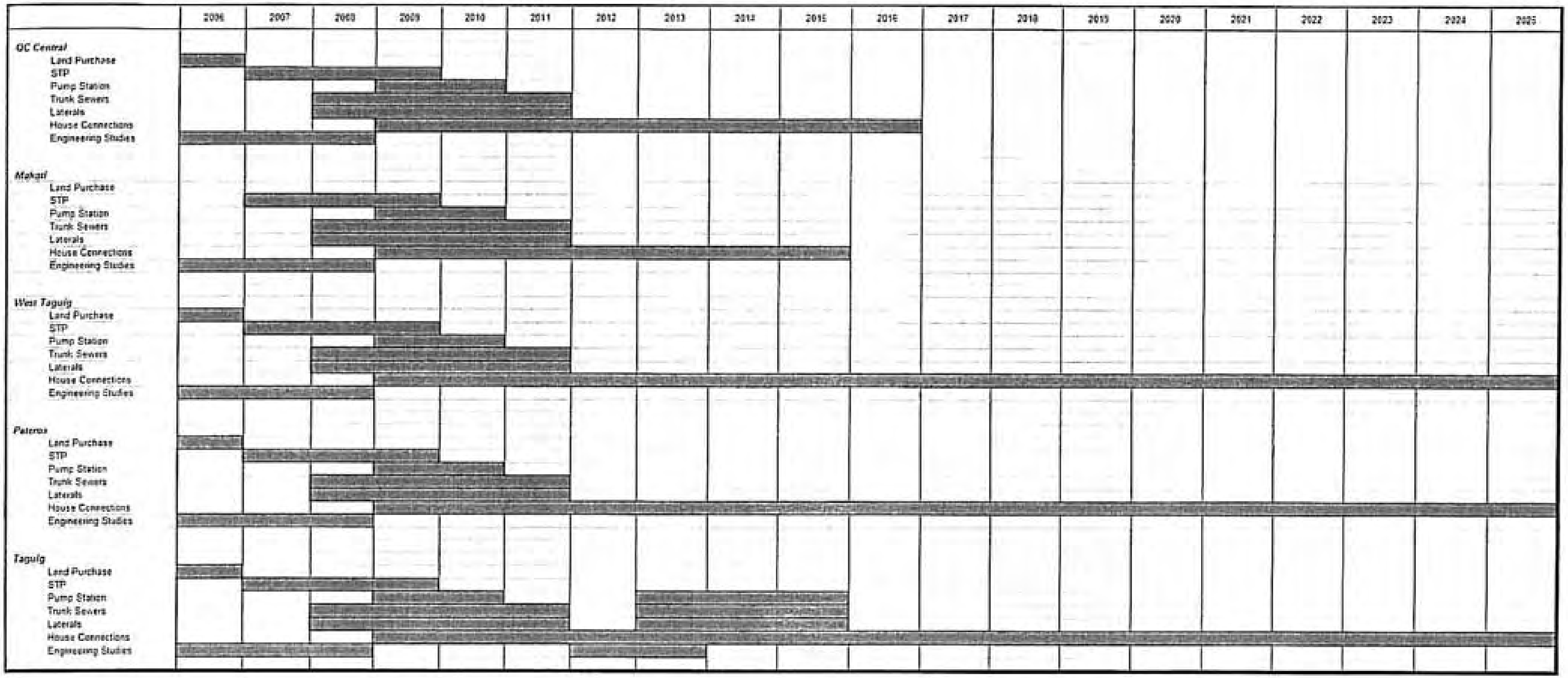


Figure 6.4.2 Implementation Schedule – Alternative 2

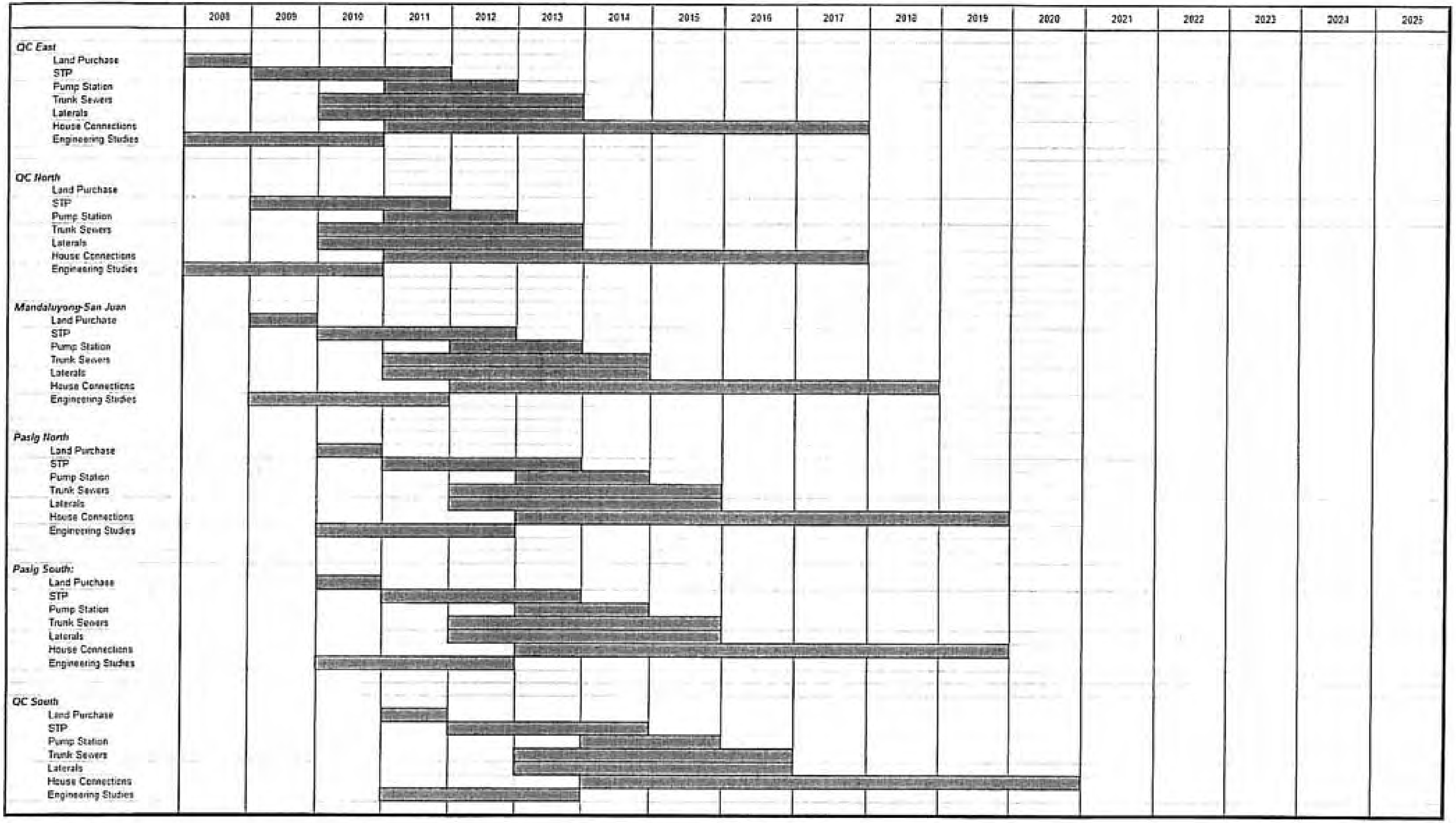


Figure 6.4.2 Implementation Schedule – Alternative 2 (Continued)

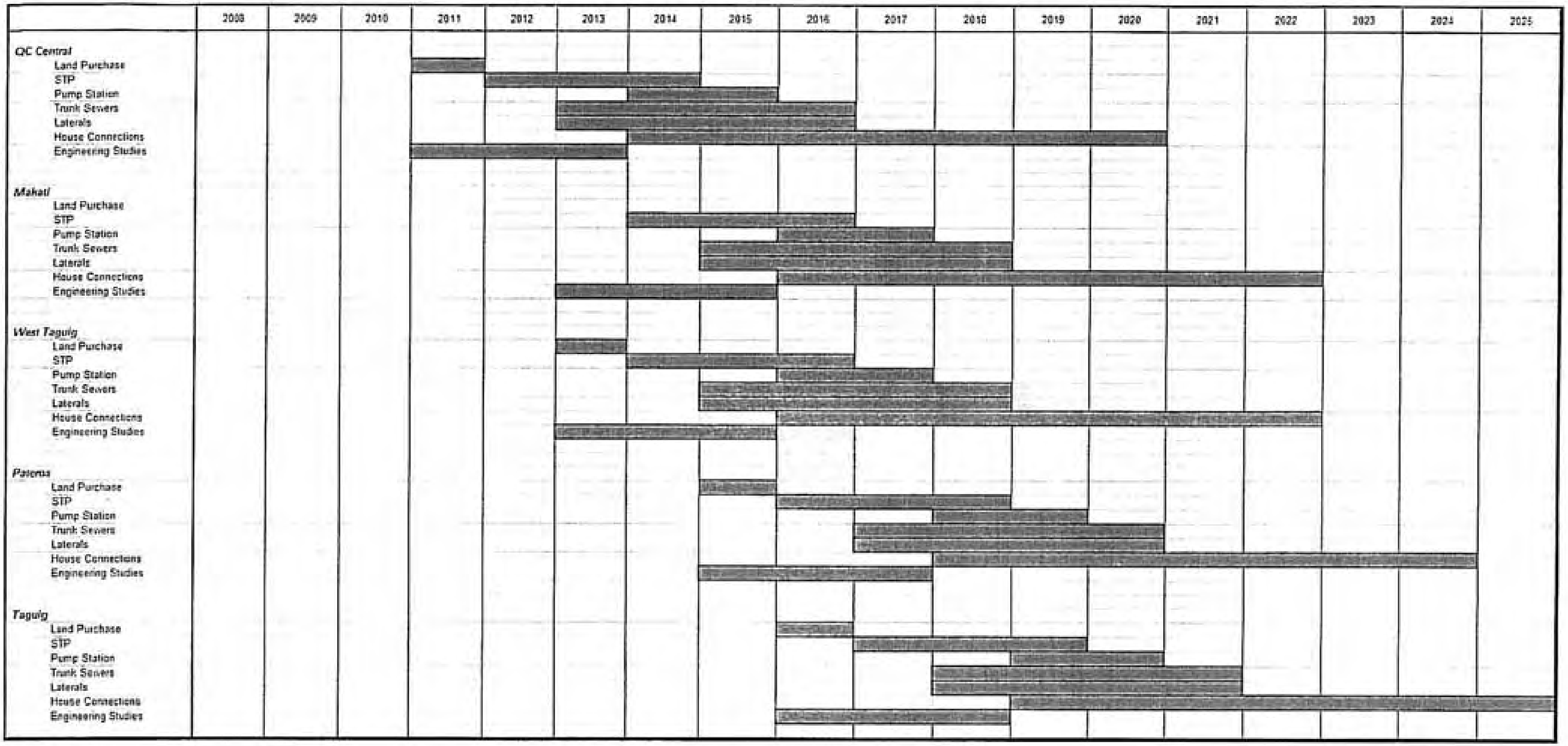


Table 6.6.1 Catchment Areas, Service Population and Estimated Sewage Flow for Alternative 3

Catchment Area	Separate System Area (ha)	Projected 2025 Population	Estimated Ave. Sewage Flow in 2025 (m^3/d)			Infiltration (m^3/d)	Total STP Average Flow (m^3/d)	MSSP (m^3/d)	MTSP (m^3/d)	CST (m^3/d)	Adjusted STP Average Flow (m^3/d)
			Residential	Commercial	Total						
QC East & QC North	3,171	484,431	114,794	59,423	174,217	23,780	197,997	7,027			190,970
Mandaluyong-San Juan	1,456	250,912	44,795	23,092	67,887	10,920	78,807				78,807
Pasig North & Pasig South	3,436	580,555	107,641	51,482	159,124	25,771	184,894				184,895
QC South & QC Central	2,830	421,872	100,345	54,032	154,376	21,225	175,601				175,601
Makati & West Taguig	1,928	349,010	98,171	62,466	160,637	14,462	175,099	40,000			135,099
Pateros	1,567	410,659	77,494	31,842	109,336	11,753	121,089				121,089
Taguig	2,047	740,657	117,593	30,671	148,264	15,352	163,616				163,616
Total	**16,434**	**3,238,096**	**660,833**	**313,009**	**973,842**	**123,262**	**1,097,103**	**47,027**			**1,050,077**

Note: Separate Sewage Flow to STP (All MSSP/MTSP/CST flow to new STP (Except Makati, and UP))

Table 6.6.2 Summary of Details of Sewerage System for Alternative 3

Description		QC East & QC North	Mandaluyong - San Juan	Pasig North & Pasig South	QC South & QC Central	Makati & West Taguig	Pateros	Taguig
Catchment Area	Ha	3,171	1,456	3,275	2,830	1,928	1,567	2,047
Population Served (2025)		484,431	250,912	559,855	421,872	349,010	410,659	740,657
Trunk Sewer								
RCP Pipes								
900mmØ and below	LM	37,022	27,170	36,871	38,140	20,768	14,780	9,675
1,050mmØ and above	LM	3,580	3,670	11,950	6,230	6,520	5,763	4,740
Force Main								
PE Pipes (SDR 11)	LM	14,660	500	400	3,450	1,500	1,300	950
Steel Pipes	LM	14,880	680	3,050	3,550	750	190	8,315
Inverted Siphons	UNIT	11	3	0	4	0	0	0
Lateral Sewers	LM	305,188	197,869	430,906	259,168	181,033	207,758	249,470
Pump Stations	UNIT	36	5	15	18	9	5	9
Q, Discharge	m^3/min	936	109	665	636	474	212	284
STP Capacity	m^3/d	190,970	78,807	184,895	175,601	135,099	121,089	163,616

Table 6.6.3 Cost Estimate for Alternative 3
(in Ps Million)

Item	Foreign	Local	Total
Capital Cost			
Land Purchase	--	5,560	5,560
STP Civil Works	2,272	5,301	7,573
STP M & E Works	5,456	2,810	8,266
PS Civil Works	357	832	1,188
PS M & E Works	1,176	606	1,783
Trunk Sewer	2,905	5,395	8,300
Laterals	2,629	10,516	13,145
House Connections	6,973	27,893	34,866
Trucks	37	9	46
Engineering Studies			
STP	665	443	1,109
PS / Sewer	684	1,025	1,709
Total Capital Cost	23,154	60,392	83,545
O & M Costs			
Operation STP	242	968	1,210
Operation PS	--	173	173
Maintenance: STP	60	31	91
Maintenance: PS	13	7	20
Maintenance: Sewer	12	27	38
Maintenance: Lateral	19	44	63
Total O & M Costs	344	1,250	1,596

Table 6.6.4 Comparison of Capital Costs Relative to Population Served for Alternative 3

Catchment Area	Land Cost (Ps Million)	Construction Cost (Ps Million)	Total Cost (Ps Million)	2025 Population	Land Cost/ Population (Ps Million/1,000)	Construction Cost/ Population (Ps Million/1,000)	Total Cost/ Population (Ps Million/1,000)
Quezon East + Quezon North	840	13,240	14,080	484,431	1.73	27.33	29.06
Mandaluyong - San Juan	1,200	6,509	7,709	250,912	4.78	25.94	30.73
Pasig North + Pasig South	480	15,563	16,043	580,555	0.83	26.81	27.63
Quezon South + Quezon Central	1,440	10,786	12,226	421,873	3.41	25.57	28.98
Makati + Taguig West	1,000	8,604	9,604	349,010	2.87	24.65	27.52
Pateros	300	10,415	10,715	410,659	0.73	25.36	26.09
Taguig	300	12,779	13,079	740,657	0.41	17.25	17.66
Total	5,560	77,896	83,456	3,238,097	–	–	–
				Maximum	4.78	27.33	30.73
				Average	2.11	24.70	26.81
				Minimum	0.41	17.25	17.66

Figure 6.6.1 Implementation Schedule – Alternative 3

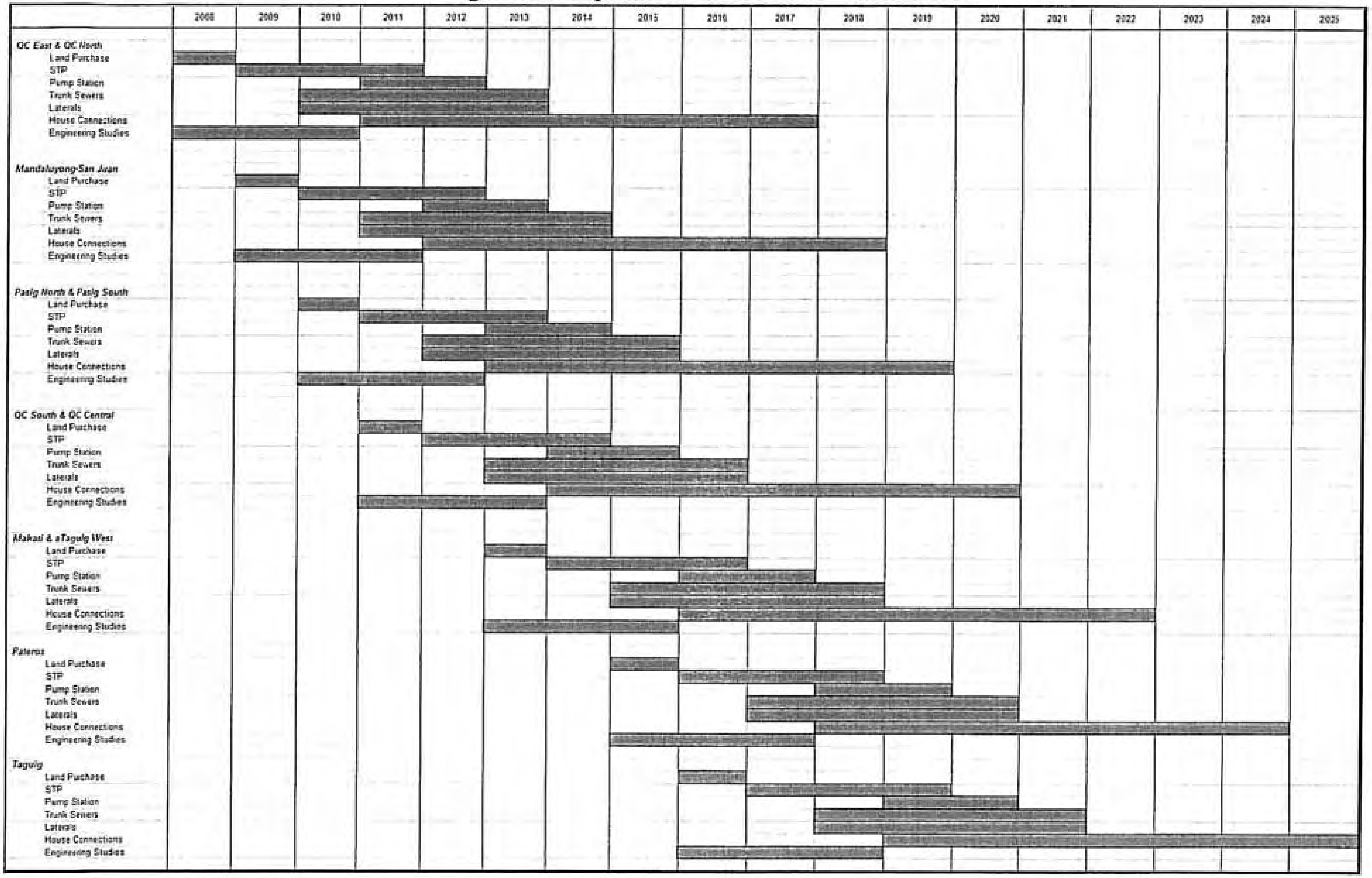


Table 6.7.1 Catchment Areas, Service Population and Estimated Sewage Flow for Alternative 4

Catchment Area	Combined System Area (ha)	Projected 2025 Population	Estimated Ave. Sewage Flow in 2025 (m^3/d)			Infiltration (m^3/d)	Total STP Average Flow (m^3/d)	MSSP (m^3/d)	MTSP (m^3/d)	CST (m^3/d)	Adjusted STP Average Flow (m^3/d)
			Residential	Commercial	Total						
QC East	1,124	180,670	40,190	19,252	59,442	13,485	72,926				72,926
QC North	2,047	306,457	75,266	40,528	115,794	24,563	140,356	7,027			133,329
Mandaluyong-San Juan	1,432	238,446	43,158	22,596	65,754	17,189	82,943				82,943
Pasig North	1,422	152,607	30,762	29,043	59,804	17,061	76,865				76,865
Pasig South	1,627	373,242	63,551	15,274	78,825	19,520	98,345				98,345
QC South	1,846	276,181	64,126	34,529	98,656	22,152	120,808				120,808
QC Central	1,233	184,596	45,337	24,412	69,749	14,795	84,544				84,544
Makati	1,634	266,593	79,980	53,320	133,299	16,340	149,639	40,000			109,639
West Taguig	690	194,609	37,688	15,683	53,371	8,280	61,651				61,651
Pateros	1,420	389,236	70,288	26,682	96,970	17,041	114,011				114,011
Taguig	1,800	648,036	105,013	29,222	134,234	21,600	155,834				155,834
Total	16,275	3,210,672	655,357	310,541	965,898	192,026	1,157,924	47,027			1,110,897

Note: Combined Sewage Flow to (All MSSP/MTSP/CST flow to new STP (Except Makati, and UP))

Table 6.7.2 Summary of Details of Sewerage System for Alternative 4

Description		Quezon City East	Quezon City North	Mandaluyong - San Juan	Pasig North	Pasig South	Quezon City South	Quezon City Central	Makati	West Taguig	Pateros	Taguig
Catchment Area	Ha	1,124	2,047	1,432	1,422	1,627	1,846	1,233	1,634	690	1,420	1,800
Population Served (2025)		180,670	306,457	238,446	152,607	373,242	276,181	184,596	266,593	194,609	389,236	648,036
Interceptor												
RCP Pipes												
900mmØ and below	LM	3,400	510	5,050	11,210	17,430	6,960	6,760	4,170	265	13,070	6,955
1,050mmØ and above	LM	1,280	0	1,250	0	4,200	0	0	7,225	75	6,890	6,830
Force Main												
PE Pipes (SDR 11)	LM	730	1,700	0	550	370	1,097	3,290	0	0	0	700
Steel Pipes	LM	1,700	5,600	1,100	2,200	25	1,650	3,170	0	0	910	410
Inverted Siphons	UNIT	0	0	0	0	1	0	0	1	0	1	0
Interceptor Box	UNIT	10	7	15	27	34	10	18	20	2	26	18
Diversion Weir	UNIT	2	2	3	3	8	3	1	4	2	11	6
Pump Stations	UNIT	3	6	3	6	7	6	17	3	1	3	5
Q, Discharge	m^3/min	93	242	159	132	155	280	366	256	62	160	206
STP Capacity	m^3/d	72,926	133,329	82,943	76,865	98,345	120,808	84,544	109,639	61,651	114,011	155,834

Table 6.7.3 Cost Estimate for Alternative 4
(in Ps Million)

Item	Foreign	Local	Total
Capital Cost			
Land Purchase	--	7,740	7,740
STP Civil Works	2,691	6,280	8,971
STP M & E Works	6,689	3,446	10,135
PS Civil Works	233	543	776
PS M & E Works	734	378	1,112
Sewer	2,261	4,199	6,460
Trucks	58	15	73
Engineering Studies			
STP	802	535	1,337
PS / Sewer	234	351	584
Total Capital Cost	**13,702**	**23,486**	**37,188**
O & M Costs			
Operation STP	249	996	1,245
Operation PS	--	145	145
Maintenance: STP	72	37	109
Maintenance: PS	9	4	13
Maintenance: Sewer	9	21	30
Total O & M Cost	**338**	**1,204**	**1,542**

Table 6.7.4 Comparison of Capital Costs Relative to Population Served for Alternative 4

Catchment Area	Land Cost (Ps Million)	Construction Cost (Ps Million)	Total Cost (Ps Million)	2025 Population	Land Cost/ Population (Ps Million/1,000)	Construction Cost/ Population (Ps Million/1,000)	Total Cost/ Population (Ps Million/1,000)
Quezon East	420	1,864	2,284	180,670	2.32	10.32	12.64
Quezon North	0	2,803	2,803	306,457	0.00	9.15	9.15
Mandaluyong - San Juan	1,200	2,143	3,343	238,446	5.03	8.99	14.02
Pasig North	2,800	2,323	5,123	152,607	18.35	15.22	33.57
Pasig South	300	3,196	3,496	373,242	0.80	8.56	9.37
Quezon South	1,200	2,744	3,944	276,181	4.34	9.93	14.28
Quezon Central	720	2,623	3,343	184,596	3.90	14.21	18.11
Makati	0	3,139	3,139	266,593	0.00	11.77	11.77
Taguig West	500	1,706	2,206	194,609	2.57	8.77	11.34
Pateros	300	3,349	3,649	389,236	0.77	8.61	9.38
Taguig	300	3,558	3,858	648,036	0.46	5.49	5.95
Total	**7,740**	**29,448**	**37,188**	**3,210,673**	--	--	--
				Maximum	18.35	15.22	33.57
				Average	3.51	10.09	13.60
				Minimum	0.00	5.49	5.95

Figure 6.7.1 Implementation Schedule – Alternative 4

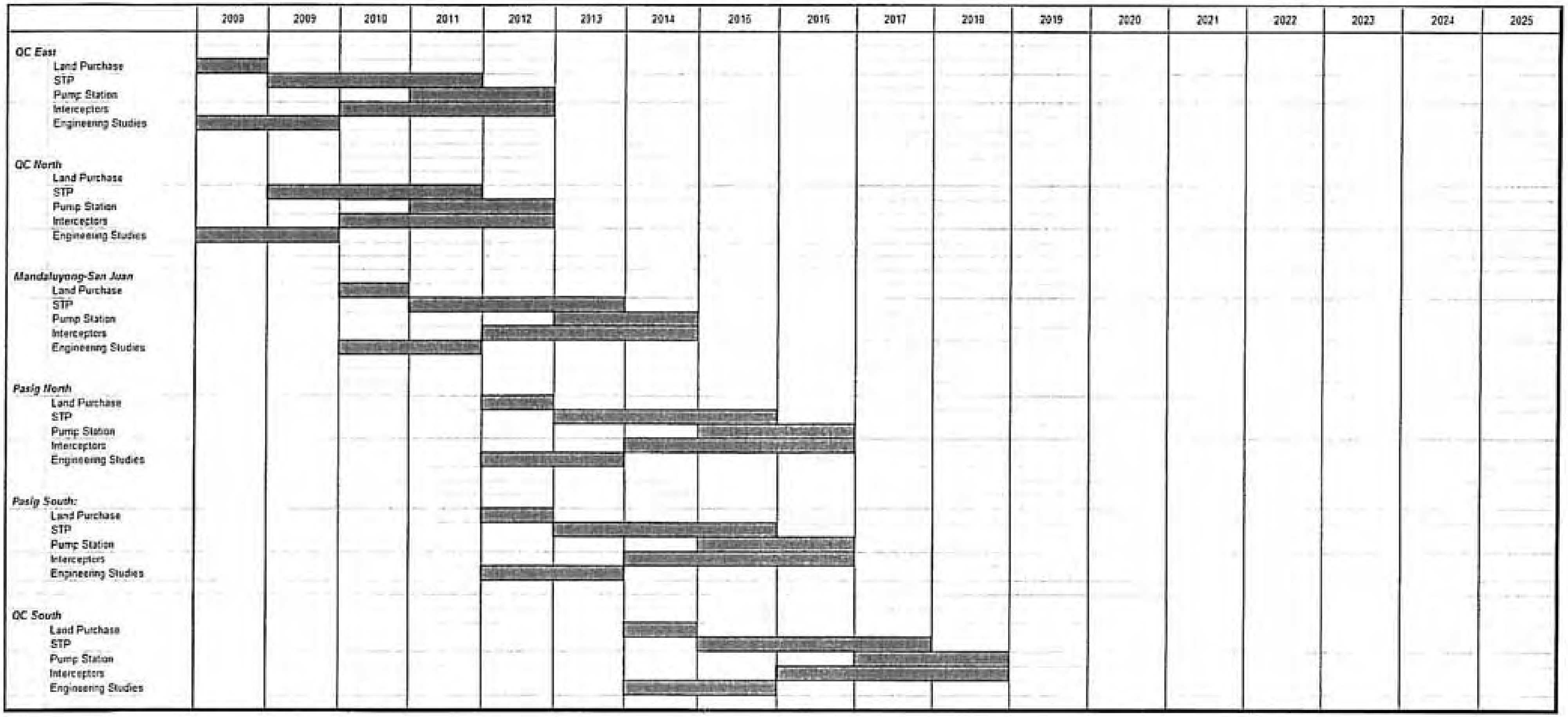


Figure 6.7.1 Implementation Schedule – Alternative 4 (Continued)

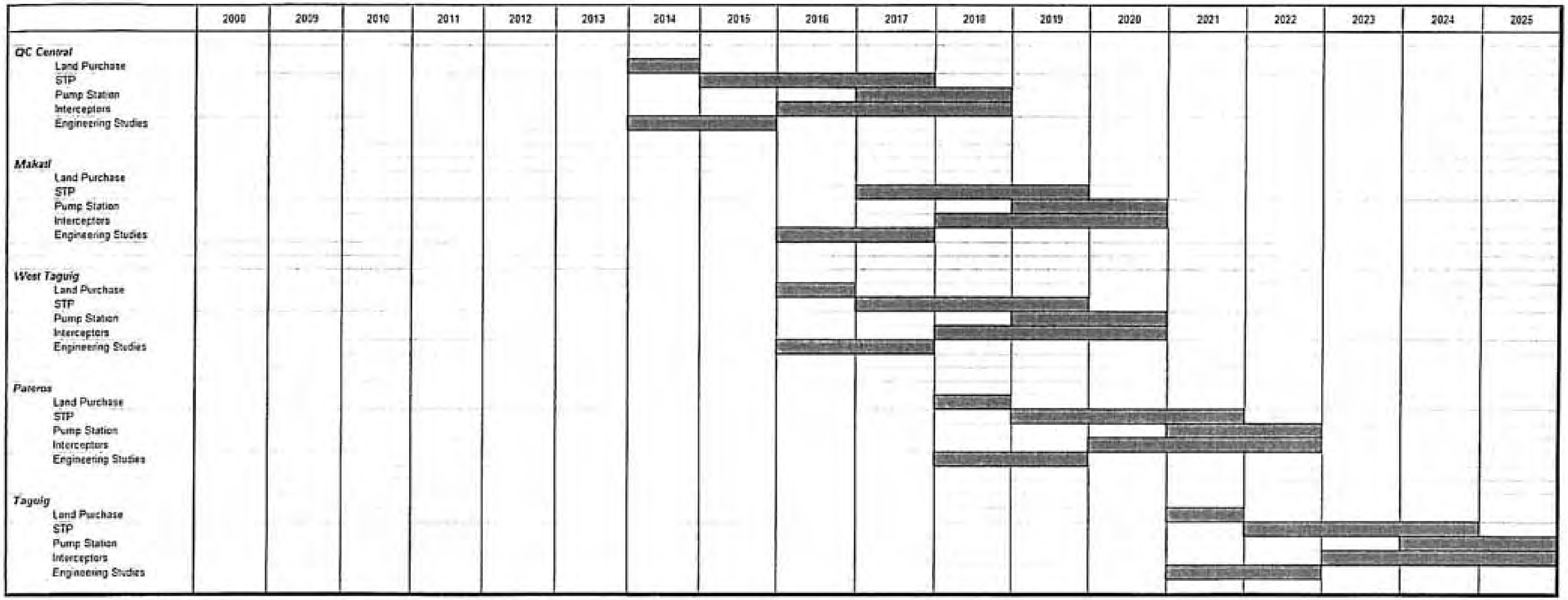


Table 6.8.1 Catchment Areas, Service Population and Estimated Sewage Flow for Alternative 5

Catchment Area	Combined System Area (ha)	Projected 2025 Population	Estimated Ave. Sewage Flow in 2025 (m^3/d)			Infiltration (m^3/d)	Total STP Average Flow (m^3/d)	MSSP (m^3/d)	MTSP (m^3/d)	CST (m^3/d)	Adjusted STP Average Flow (m^3/d)
			Residential	Commercial	Total						
QC East & QC North	3,171	487,127	115,456	59,779	175,236	38,047	213,283	7,027			206,256
Mandaluyong-San Juan	1,432	238,446	43,158	22,596	65,754	17,189	82,943				82,943
Pasig North & Pasig South	3,048	525,848	94,312	44,317	138,629	36,581	175,210				175,210
QC South & QC Central	3,079	460,778	109,463	58,942	168,405	36,948	205,353				205,353
Makati & West Taguig	2,324	461,202	117,667	69,003	186,670	24,620	211,290	40,000			171,290
Pateros	1,420	389,236	70,288	26,682	96,970	17,041	114,011				114,011
Taguig	1,800	648,036	105,013	29,222	134,234	21,600	155,834				155,834
Total	**16,275**	**3,210,672**	**655,357**	**310,541**	**965,898**	**192,026**	**1,157,924**	**47,027**			**1,110,897**

Note: Combined Sewage Flow to (All MSSP/MTSP/CST flow to new STP (Except Makati, and UP))

Table 6.8.2 Summary of Details of Sewerage System for Alternative 5

Description		QC East & QC North	Mandaluyong - San Juan	Pasig North & Pasig South	QC South & QC Central	Makati & West Taguig	Pateros	Taguig
Catchment Area	Ha	3,171	1,432	3,048	3,079	2,324	1,420	1,800
Population Served (2025)		487,127	238,446	525,848	460,778	461,202	389,236	648,036
Interceptor								
RCP Pipes								
900mmØ and below	LM	5,510	5,050	30,730	13,720	4,170	13,070	6,955
1,050mmØ and above	LM	1,280	1,250	5,260	0	7,565	6,890	6,830
Force Main								
PE Pipes (SDR 11)	LM	2,080	0	920	4,387	0	0	700
Steel Pipes	LM	15,700	1,100	2,875	5,420	0	910	410
Inverted Siphons	UNIT	0	0	0	0	1	1	0
Interceptor Box	UNIT	17	15	61	28	22	26	18
Diversion Weir	UNIT	4	3	11	4	6	11	6
Pump Stations	UNIT	10	3	12	23	3	3	5
Q, Discharge	m^3/min	647	159	567	694	318	160	206
STP Capacity	m^3/d	213,283	82,943	175,210	205,353	171,290	114,011	155,834

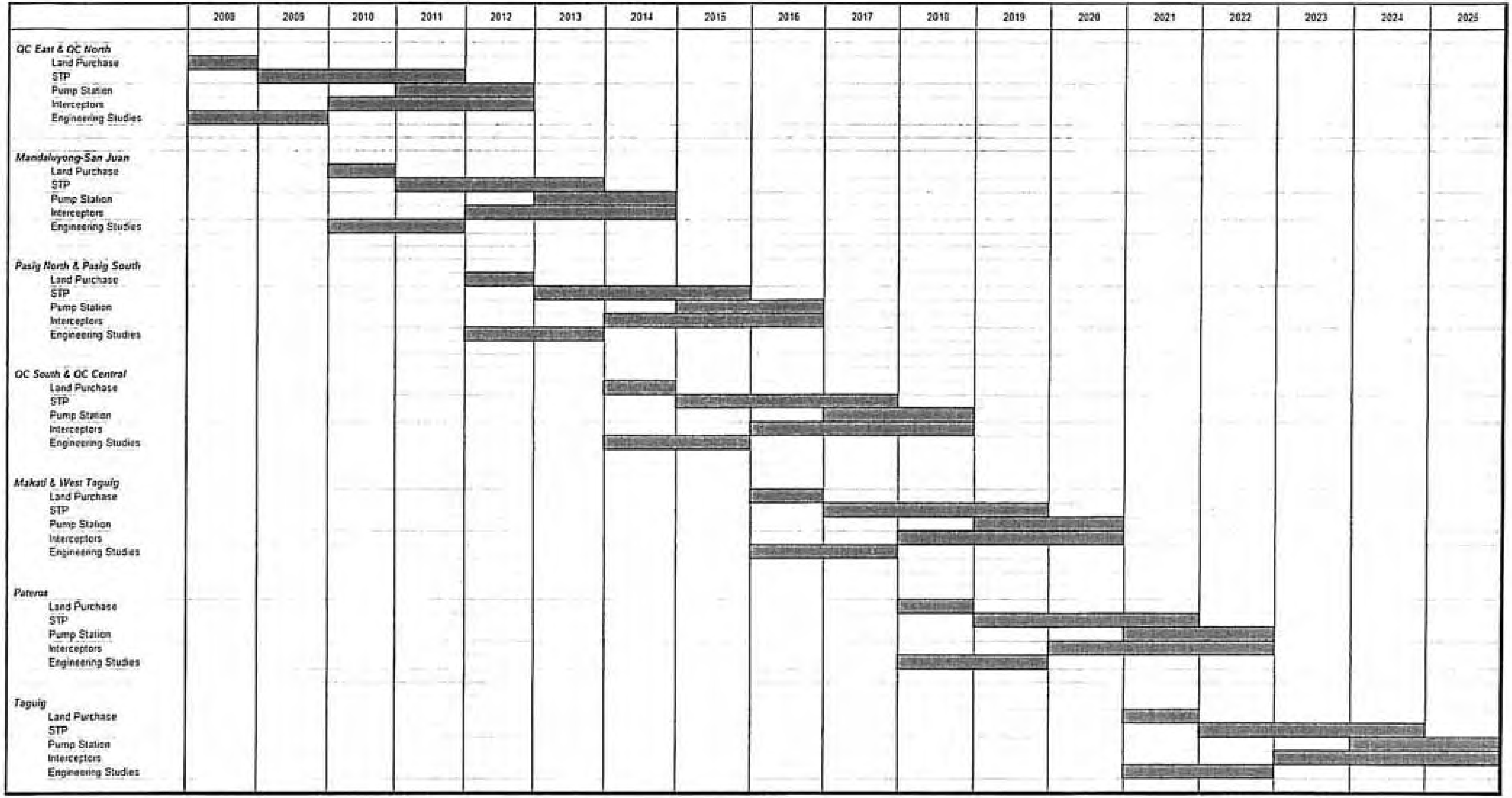
Table 6.8.3 Cost Estimate for Alternative 5
(in Ps Million)

Item	Foreign	Local	Total
Capital Cost			
Land Purchase	--	5,560	5,560
STP Civil Works	2,345	5,473	7,818
STP M & E Works	5,638	2,904	8,542
PS Civil Works	309	721	1,030
PS M & E Works	1,019	525	1,545
Sewer	2,546	4,728	7,274
Trucks	37	9	46
Engineering Studies			
STP	687	458	1,145
PS / Sewer	276	414	689
Total Capital Cost	**12,857**	**20,792**	**33,649**
O & M Costs			
Operation STP	252	1,009	1,261
Operation PS	--	274	274
Maintenance: STP	63	32	95
Maintenance: PS	11	6	17
Maintenance: Sewer	10	24	34
Total O & M Costs	**336**	**1,344**	**1,681**

Table 6.8.4 Comparison of Capital Costs Relative to Population Served for Alternative 5

Catchment Area	Land Cost (Ps Million)	Construction Cost (Ps Million)	Total Cost (Ps Million)	2025 Population	Land Cost/ Population (Ps Million/1,000)	Construction Cost/ Population (Ps Million/1,000)	Total Cost/ Population (Ps Million/1,000)
Quezon East + Quezon North	840	5,016	5,856	487,127	1.72	10.30	12.02
Mandaluyong - San Juan	1,200	2,143	3,343	238,446	5.03	8.99	14.02
Pasig North + Pasig South	480	5,282	5,762	525,849	0.91	10.04	10.96
Quezon South + Quezon Central	1,440	4,836	6,276	460,777	3.13	10.50	13.62
Makati + Taguig West	1,000	3,905	4,905	461,202	2.17	8.47	10.63
Pateros	300	3,349	3,649	389,236	0.77	8.61	9.38
Taguig	300	3,558	3,858	648,036	0.46	5.49	5.95
Total	5,560	28,089	33,649	3,210,673	--	--	--
				Maximum	5.03	10.50	14.02
				Average	2.03	8.91	10.94
				Minimum	0.46	5.49	5.95

Figure 6.8.1 Implementation Schedule – Alternative 5



6.9 Sanitation Alternatives

6.9.1 Sanitation Requirements for Separate Sewer System Alternatives

If separate sewer systems are implemented in the 11 catchment areas by 2025, approximately 1,800 m^3/day of septage needs to be collected from the East Concession Area, around 10% of which will come from the NCR cities/towns, and 90%, from served areas in Rizal Province. With the proposed 600 m^3/day Antipolo SPTP, and the 586 m^3/day North and 814 m^3/day South SPTPs, coming onstream from 2005-2008, it would not be necessary to provide for new septage collection and treatment facilities within the Master Plan period.

6.9.2 Sanitation Requirements for Combined Sewer System Alternatives

If combined sewer systems are implemented in the 11 catchment areas by 2025, approximately 3,089 m^3/day of septage will be collected by 2025. Approximately 1,260 m^3/day will be collected from NCR cities/towns, and 1,829 m^3/day from towns in Rizal. There will be a need to provide for new septage treatment capacity by 2020. As shown in Table 6.9.1, the capacity of new capacity should be approximately 695 m^3/day by 2020, and increase to 1,089 m^3/day, by 2025.

Table 6.9.1 Septage System Capacity Requirements

Pipeline	System Capacity (m^3/day)				
	2005	2010	2015	2020	2025
Antipolo SPTP	-	600	600	600	600
MTSP	-	1,050	1,400	1,400	1,400
Total	-	1,650	2,000	2,000	2,000
Requirement	1,145	1,427	2,029	2,695	3,089
Excess/(Backlog)	(1,145)	223	(29)	(695)	(1,089)

Two alternatives for providing additional SPTP capacity by Year 2020 are evaluated in this study, as follows:

- Expand Antipolo SPTP (1,089 m^3/d additional SPTP capacity). The strategy entails a mechanized process, and calls for the construction/installation of similar process equipment as proposed for the Antipolo SPTP, i.e., provision of screening/degritting facilities, screw press dewatering equipment and filtrate treatment facilities, e.g., SBR. Lime stabilization may be required, particularly if the selected or preferred disposal scheme poses risks of direct human contact and crop contamination.

- Construct new SPTP for Rizal area, ideally in the Bingonan/Cardona area (1,089 m^3/d additional SPTP capacity). If urbanization in this area will remain limited, the option of employing natural system processes for treating septage can be explored. For this option, drying beds for dewatering sludge and combination of UASB system and stabilization ponds for treating filtrate are considered.

The estimated investment and operational costs of the two alternatives are shown in Table 6.9.2 and 6.9.3. Included are incremental operational costs for the Antipolo SPTP, to cover the increased loads to the plant.

Table 6.9.2 Estimated SPTP Investment Costs

	Investment Costs (Ps million)					
	2005	2010	2015	2020	2025	Total
Alternative 1						
1. Increasing Operating Hours in Antipolo SPTP	-	-	na	na	na	
2. Antipolo SPTP Expansion	-	-	na	556.00	315.20	871.20
3. Additional Vacuum Trucks	-	-		206.00	83.16	289.16
Total:			-	762.00	398.36	1,160.36
Alternative 2						
1. Increasing Operating Hours in Antipolo SPTP	-	-	na	na	na	
2. Construct new SPTP in Binagonan/Cardona	-	-		87.32	8.09	95.41
3. Additional Vacuum Trucks	-	-		206.00	83.16	289.16
Total			-	293.32	91.25	384.57

Table 6.9.3 Estimated SPTP Operational Costs

	Incremental Operational Costs (Ps million/year)				
	2005	2010	2015	2020	2025
Alternative 1					
1. Increase Operating Hours in Antipolo SPTP	-	-	0.55	-	-
2. Antipolo SPTP Expansion (incl. vacuum truck operation)	-	-	-	40.91	60.16
Total	-	-	0.55	40.91	60.16
Alternative 2					
1. Increase Operating Hours in Antipolo SPTP	-	-	0.55	-	-
2. Construct new SPTP in Binangonan/ Cardona (incl. vacuum truck operation)	-	-	-	17.19	26.18
Total	-	-	0.55	17.19	26.18

Clearly, the non-mechanized option is less expensive. However, its viability will depend largely on the availability of land suitable for the proposed treatment process. Even if by 2020, there is available land, MWSS should also assess the rate of urbanization at that time, and assess if the economic lifetime of a non-mechanized SPTP will not be reduced significantly due to urbanization pressures.

SECTION 7

Benefit Assessment

SECTION 9

Alternative Evaluation

SECTION 9 ALTERNATIVE EVALUATION

9.1 Catchment Area Prioritization

Four major criteria were used to determine the priorities for implementation of the sewerage facilities in the eleven independent catchment areas. The criteria include water quality improvement in rivers, concession agreement sewerage target areas, community development and health improvements & MTSP components.

9.1.1 Water Quality Improvement in Rivers

Water quality improvement in rivers relates to a catchment's contribution to the reduction of BOD in inland waters in Metro Manila, in particular, identified "hotspots" like the Pasig River and the San Juan River. An approach to cleaning up polluted rivers is to implement pollution control project in upstream segments first, and working downstream. In this manner, the upstream segments are no longer polluted and benefits realized from the project are realized immediately for those segments. Also, this reduces the pollutant load on downstream segments of the river. Therefore, the implementation program should consider development of sewerage systems in upstream segments of the river system. In general, Quezon City is an upstream source of pollution in the Marikina River and the San Juan River.

9.1.2 Concession Agreement Sewerage Target Areas

Both the 1997 Concession Agreement and the 2003 Rate Rebasing included sewerage service targets spread out over various municipalities throughout Metro Manila. Although this leads to a decentralized sewerage system, it would be unfair to the other communities if all of the sewerage projects were implemented in a single municipality in the initial phases, with some communities not being served at all until 2025. It would also likely be politically and socially unacceptable to take that approach. Therefore, the implementation program should consider the constraints imposed by the Concession Agreement service target areas, as well as social and political concerns. Sewerage development was proposed for Quezon City, Mandaluyong-San Juan and Pasig in the 2003 Rate Rebasing. These will probably also be target areas in the 2008 Rate Rebasing.

9.1.3 Community Development

Priority for development of projects should consider that some municipalities are fully developed, while other areas are in the process of urbanization. The increase in sewage flows over time during the project period (2025) is shown in Table 9.1.1. Approximately 80% to 90% of the sewage flows in Quezon City, Mandaluyong - San Juan, Pasig City, and Makati will be realized by 2010; increasing to 95% to 100% in these municipalities by 2020. On the other hand, only 60% to 70% of the sewage flows in West Taguig, Pateros and Taguig will be realized by 2010. The implementation program should consider the rate of development of the different municipalities within the Concession Agreement service area.

9.1.4 Health Improvements & MTSP Components

Development of sewerage systems leads to a reduction in the morbidity and mortality rates from diseases that are caused by poor sanitation conditions. The effectiveness of the proposed sewerage systems for the different catchment areas is equal in all areas, but priority should be given to areas where there is a higher proportion of low-income families, who are at most risk to water-borne diseases. As discussed in Section 7, a higher level of health benefits are realized from separate sewer systems, compared to combined sewer systems. Septage collection, transport and treatment being implemented under MTSP will provide health benefits by reducing septic tank overflows. The septage collection, transport and treatment will be implemented in all of the catchment areas; reducing the health risk in areas where there is a higher proportion of low income families, as well as in other areas.

The Pateros and Taguig catchments will serve a relatively large number of people with a high proportion of low-income families. Without septage collection, transport and treatment implanted under MTSP, these catchments would be a higher priority, because of the higher level of health benefits. Drainage improvements and STPs in these catchments that are also being implemented under MTSP will also reduce the health risk in these areas. Since these communities will be served under MTSP, they are considered a lower priority for implementation of sewerage systems.

Table 9.1.1 Increase in Sewage Flows During Project Period in Different Catchment Areas

Catchment Area	Projected 2025 Population	STP Average Flow 2010 (m3/d)	STP Average Flow 2015 (m3/d)	STP Average Flow (2020) (m3/d)	STP Average Flow (2025) (m3/d)
QC East	180,670	63,134 87%	63,448 87%	74,125 100%	72,926 100%
QC North	306,457	118,147 89%	117,684 88%	135,901 100%	133,329 100%
Mandaluyong-San Juan	238,446	73,557 89%	79,901 96%	86,118 100%	82,943 100%
Pasig North	152,607	65,302 85%	67,149 87%	77,560 100%	76,865 100%
Pasig South	373,242	71,858 73%	74,868 76%	93,357 95%	98,345 100%
QC South	276,181	110,448 91%	110,026 91%	123,979 100%	120,808 100%
QC Central	184,596	75,399 89%	75,121 89%	86,094 100%	84,544 100%
Makati	266,593	93,701 85%	94,405 86%	109,009 100%	109,639 100%
West Taguig	194,609	44,512 72%	47,737 77%	58,105 94%	61,651 100%
Pateros	389,236	82,237 72%	89,629 79%	108,856 95%	114,011 100%
Taguig	648,036	93,316 60%	106,739 68%	140,972 90%	155,834 100%
Total	3,210,672	891,611	926,706	1,094,076	1,110,897

Notes: (1) Population and sewage flow based on combined sewer alternatives.
(2) Percent values in table are percentage of the 2025 flow in catchment area.

9.1.5 Identification of Priority Catchment Areas

The priority ranking of the eleven catchment areas is listed from highest to lowest in Table 9.1.2. The prioritization was developed by considering the evaluation criteria for each of the catchment areas. In general, the most important criterion in the prioritization was potential for river water quality improvements; because the largest benefit that will be realized by development of sewerage systems is attributable to improved surface water quality, rather than health improvement. A summary of the basis for selection of each catchment area as a high or low priority is presented in Table 9.1.2.

9.2 Technical Evaluation/Implementation Issues

9.2.1 Issues

Alternative 1 would meet the 1997 Concession Agreement sewerage targets. Alternative 2 and Alternative 3 would meet the ultimate service target, but over an extended implementation schedule to defer capital investment and improve the affordability of separate sewerage systems. Alternative 4 and Alternative 5 are based on implementation of combined sewer systems, and were developed because MWSS has decided to accept combined systems as a means of achieving the sewerage targets. However, as discussed below, several issues would have to be resolved/evaluated if there is a decision to develop further these strategies.

(1) Availability of STP and Pumping Station Sites and "NIMBY"

For the Master Plan, it is assumed that MWSS/MWCI will be able to acquire the STP and pumping station sites, either through a direct sale, or, for government properties, through a land "donation." If specific projects push through, the land availability must be evaluated, at the latest, at the start of the feasibility study stage.

Fears of malodor, noise, waste accidents, and a negative impact on land values would make it hard to secure community acceptance for the construction and operation of STPs. There might also be political resistance, particularly if an STP would accept sewage coming from cities/municipalities outside the city/municipality where the STP is located.

(2) Low-lying Pocket Areas

Especially for the separate sewerage system alternatives, there may be a need to avoid low-lying "pocket" areas that will require pumping stations for the conveyance of sewage to the gravity sewer network. The cost of installing and operating dozens of small pumping stations should be weighed against the benefits of providing sewerage service to these areas.

Table 9.1.2 Priority Ranking of Eleven Catchment Areas

Catchment Area	Summary of Basis for Selection as Priority Catchment
Quezon City East	Marikina River upstream of Quezon City East is relatively unpolluted, so cleaning polluted upstream stretch of river. Also Quezon City is a rate rebasing target area.
Quezon City North	San Juan River is polluted by discharges from Quezon City North. San Juan River is pollution" hot spot". Will clean up upstream stretch of river.
Mandaluyong - San Juan	Discharges from Mandaluyong - San Juan flow to San Juan and Pasig Rivers which are both pollution "hot spots". The CA requires completion of work in different municipalities. Mandaluyong - San Juan is a rate rebasing target area.
Pasig North	Pasig North is located downstream of Quezon City East along Marikina River, which should be less polluted after implementation of system for QC East. This would cleanup another segment of the river. Also, Pasig is a rate rebasing target area.
Pasig South	Catchment area mainly drains to Laguna de Bay. This will reduce pollution load to the lake. Taguig and Pateros are addressed to some extent as part of MTSP to reduce discharges to Laguna de Bay. Remainder of Pasig South catchment area drains to Marikina River. This would complete the cleanup of the Marikina River.
Quezon City South	Discharges from Quezon City South flow to San Juan River which is pollution hot spot. Cleans up stretch of San Juan River between Quezon City North and Mandaluyong - San Juan.
Quezon City Central	Discharges from Quezon City South flow to San Juan River which is pollution hot spot. Completes clean up of stretch of San Juan River between Quezon City North and Mandaluyong - San Juan.
Makati	Prior projects will have completed cleanup of Marikina and San Juan Rivers. This addresses a pollution hot spot in Pasig River. Also, part of drainage from Makati flows to upstream segment of polluted Manila/Pasay creek that flows through the Western Concession Area and ultimately to Manila Bay.
West Taguig	Discharges from West Taguig flow to hot spot in Paranaque/Las Pinas River that flows though the Western Concession Area and ultimately to Manila Bay. Also West Taguig is a rate rebasing target area.
Pateros	Expanding system to cover entire catchment area and upgrading MTSP treatment systems, to reduce pollution load to Laguna de Bay. Also, area not yet completely developed. Program phasing to allow time for development to occur.
Taguig	Expanding system to cover entire catchment area and upgrading MTSP treatment systems, to reduce pollution load to Laguna de Bay. Also, area not yet completely developed. Program phasing to allow time for development to occur.

(3) Pipe Jacking

The heavy traffic load within Metro Manila will require the use of pipe jacking in many areas.

(4) Sewage Treatment

Investments for all the STPs are based on secondary biological treatment for BOD removal, but with no nutrient removal. All the plants will be provided with sludge dewatering facilities. If nitrogen and phosphorus removal will be required in the long-term, it would not be difficult to retrofit the plant facilities and revise the operation regime for nutrient removal. On the other hand, capacity expansion will be difficult because of the limited land area. Capacity expansion will be limited though since population saturation levels would have been reached already by the design year 2025, presuming land use controls are in-place and enforced. In fact, as reflected in the population projections, some cities/municipalities are expected to have negative growth rates in the future.

9.2.3 Integration of Proposed MTSP Facilities

(1) Separate Sewerage System Alternatives

In developing the separate sewerage system alternatives (Alternatives 1, 2 and 3), the integration of MTSP components into the expanded system was considered.

<u>Taguig Sewerage System</u>

Separate sewerage systems will be developed in the Pasig South, Pateros and Taguig catchment areas to convey wastewater to the sites of the primary treatment plants and polishing ponds that will be developed under MTSP. The primary treatment plants will be upgraded to provide secondary treatment for the sewage.

<u>Riverbanks Sewage Treatment Plants</u>

Separate sewerage systems will be installed in the Pasig, Mandaluyong, and Makati catchment areas. These riverbank STPs could operate as stand-alone plants, treating separate sewage from the same catchment area it is designed for under a combined system scheme. It is recommended however that the trunk sewers running to the regional STPs serving the bigger basins be designed to accept flows from these Riverbank basins, since in the long-term, when the Riverbanks STPs need to be replaced, the regional plants may have excess capacities, or it may be more economical to expand the regional plants rather than to replace facilities at these Riverbanks STPs.

<u>Septage Treatment Plant</u>

Under the separate sewerage system alternatives, there will be no need to expand the septage treatment capacity during the Master Plan Period. The capacity that will be provided by the North and South SPTPs (that will be constructed under MTSP) and the Antipolo SPTP (that will be constructed under the PRRP) will be adequate until beyond 2025. The septage treatment plant will continue to be operated after separate sewerage systems are developed, receiving septage mainly from areas in Rizal Province.

Sanitation for Low-Income Communities

When the separate sewerage system is developed in the Taguig catchment area, the Taguig STP will be taken out of service. All of the MTSP components are located within the target sewerage service area covered by this Master Plan, except for the Manggahan Low-Income STP, which is in the Taytay-Cainta catchment area draining to Laguna de Bay. The Manggahan Low-Income STP will help in reducing pollution loads to the Laguna de Bay. The Manggahan STP will continue to treat combined sewage flows, until such time as a separate sewer system is developed. At that time, the Manggahan STP may be taken out of service and replaced by a new STP.

Quezon City - Marikina Sewerage System

A separate sewerage system will be developed in the catchment area that is served by the Quezon-Marikina STP. The separate sewers will drain to the site of the STP, which will be converted to a pump station to convey the sewage to a new STP that will receive sewage from the entire Pasig North catchment area.

Upgrade of Existing Sanitation Systems

The Community Septic Tanks (CSTs) that are upgraded to STPs (East Avenue and Road 5) will continue in service for a period of time, until the development of the separate sewer systems are completed in the Quezon City Central and Quezon City North catchment areas. At that time the STPs will be converted to pump stations to convey sewage to the new STPs that will serve these catchment areas.

(2) Combined Sewerage System Alternatives

In developing the combined sewerage system alternatives (Alternatives 1, 2 and 3), the integration of MTSP components into the expanded system was considered.

Taguig Sewerage System

Combined sewerage systems will be developed in the Pasig South, Pateros and Taguig catchment areas to convey wastewater to the sites of the primary treatment plants and polishing ponds that will be developed under MTSP. The primary treatment plants will be upgraded to provide secondary treatment for the sewage.

The treatment ponds at Labasan, Hagonoy, and Tapayan with primary treatment will have capacity to treat sewage up to at least 2025. The treatment pond at Taguig with primary treatment may be overloaded by 2025. Under the combined sewerage system alternatives, the Taguig, Labasan and Tapayan primary treatment plants will be upgraded to secondary STPs to replace the pond systems between 2020 and 2025. The Hagonoy primary treatment plant will be converted to a pump station, with the sewage pumped to the Taguig STP. Due to the potential overloading of the Taguig primary treatment plant and pond system, the primary treatment plant at Taguig should be upgraded to an STP before the systems at Labasan and Tapayan.

Riverbanks Sewage Treatment Plants

For the Riverbank STPs, if and when full development of the Pasig, Mandaluyong, and Makati basins are pushed through, these STPs can operate as stand-alone plants, treating combined sewage from the same catchment area it is designed for under a combined system scheme. It is recommended however that the interceptors running to the regional STPs serving the larger basins be designed to accept flows from these Riverbank basins, since in the long-term, when the Riverbanks STPs need to be replaced, it may be more economical to expand the regional plants rather than to replace facilities at the Riverbanks STPs.

Septage Treatment Plant

Under the combined sewerage alternatives, there will be a need to expand the septage treatment capacity by 2020. The North and South SPTPs will continue to operate throughout the Master Plan Period. The capacity expansion of 1,089 m^3/d will occur either at the Antipolo SPTP or at a new SPTP for Rizal area, ideally in the Binangonan/Cardona area.

Sanitation for Low-Income Communities

When the combined sewerage system is developed in the Taguig catchment area, the Taguig STP will be converted to a pump station. The Manggahan Low-Income STP, while located outside the service area covered by this Master plan, will help in reducing pollution loads to the Laguna de Bay. The Manggahan STP will continue to treat combined sewage flows, until such time as the combined sewer system is developed for the entire catchment area. At that time, the Manggahan STP may be expanded or may be taken out of service and replaced by a new STP.

Quezon City – Marikina Sewerage System

When the combined sewerage system is developed in the Pasig North catchment area, the Quezon-Marikina STP will be converted to a pump station to convey sewage from the drainage basin to a new STP that will receive sewage from the entire Pasig North catchment area.

Upgrade of Existing Sanitation Systems

The Community Septic Tanks (CSTs) that are upgraded to STPs (East Avenue and Road 5) will continue in service for a period of time, until the development of the combined sewer systems are completed in the Quezon City Central and Quezon City North catchment areas. At that time the STPs may remain in service or may be converted to pump stations to convey sewage to the new STPs that will serve these catchment areas.

9.3 Evaluation of Sewerage Alternatives

Five alternatives for implementation of sewerage systems between 2008 and 2025 were developed. Three of the alternatives are based on the use of separate sewer systems with varying implementation schedules and number of catchment area. The other two alternatives are based on the use of combined sewer systems with varying number of catchment areas. These five alternatives are evaluated in the following subsections. The alternatives were evaluated by comparing the costs for each alternative, implementability of the alternatives (consideration of technical constraints), and benefits that will be achieved though development of the alternative sewerage systems.

9.3.1 Evaluation of Costs of Alternatives

A comparison of the costs for implementation of the five alternatives is presented in Table 9.3.1. Alternative 5, which is comprised of combined sewerage system in seven separate catchment areas has the lowest NPV and would require the smallest tariff increase to implement.

The incremental tariff increase for Alternative 5 is estimated to be 4.06 Ps/m^3. With this increment the all-inclusive tariff would be increased from 18.85 Ps/m3 to 24.17 Ps/m3, including cost recovery for MTSP components and the Master Plan facilities. This represents a 28% in the tariff.

With the tariff increase to 24.17 Ps/m3, the average monthly water bill would be Ps 725.25/month, which is an increase of approximately Ps 160/month. At this rate, the average monthly water bill would represent approximately 2.5% of the average monthly income for the NCR and 3.82% of the median monthly income for the NCR. These percentages are less than the maximum of 5% of the average monthly income that is used to determine affordability.

Table 9.3.1 Cost Comparison of Alternatives

Alternative Identification	Cost	
	NPV (Ps million)	Required Tariff Increment (Ps/m^3)
(1) Separate Sewer System With 11 Catchment Areas and Concession Agreement Implementation Schedule	51,265	15.64
(2) Separate Sewer System With 11 Catchment Areas and Extended Implementation Schedule	31,825	9.77
(3) Separate Sewer System With 7 Catchment Areas and Extended Implementation Schedule	29,774	9.16
(4) Combined Interceptor System With 11 Catchment Areas and Extended Implementation Schedule	14,078	4.32
(5) Combined Interceptor System With 7 Catchment Areas and Extended Implementation Schedule	13,216	4.06

9.3.2 Implementability Evaluation of Alternatives

The major technical constraints in the development of sewerage systems are lack of available land for construction of STPs, traffic congestion during construction of the sewerage networks, and inadequacy of storm drainage systems in some areas. A comparison of the implementability of the five alternatives is presented in Table 9.3.2.

(1) STP Sites

Alternative 1, 2 and 4 would require acquisition of 81 ha of land for 11 STPs at a total cost of Ps 7,740 million. As discussed in Section 6, the STP site for the Makati catchment is at the Magallanes STP. The additional STP capacity requirement is approximately 100,000 m^3/day to 110,000 m3/d depending on whether a separate of combined sewer system is developed, while the available area in the Magallanes STP is quite limited at around 10,000 m^2. For this site, there may be a need to employ SBRs or attached-growth treatment systems, which require a relatively small footprint.

Alternative 3 and 5 would require acquisition of 76 ha of land for 7 STPs at a total cost of Ps 5,560 million. In these two alternatives, the sewage from the Makati catchment is transferred to the West Taguig STP. This avoids the potential constraint of limited land availability at the Magallanes STP.

Under Alternatives 1, 2 and 4 (with 11 catchment areas), the cost for purchasing land for the Pasig North STP is Ps 2,800 million and the cost for purchasing land for the Pasig South STP is Ps 300 million for a total cost of Ps 3,100 million for purchase of only these two sites.

Under Alternatives 3 and 5 (with 7 catchment area), the sewage from Pasig North catchment is transferred to the Pasig South STP. This eliminates the need for purchasing high cost land in Pasig North. The cost for purchasing land at the site for the Pasig South STP for treatment of the sewage from both Pasig North and Pasig South is Ps 480 million.

Alternatives 3 and 5 (with 7 catchment areas) avoid the potential constraint of limited land availability and reduce the overall cost of land purchase for the STP sites by Ps 2,180 million from Ps 7,740 million to Ps 5,560 million.

(2) Traffic Disruption

A significant constraint in the development of separate sewer systems is the extensive nature of the required system. Under Alternative 1, 1,700 km of 200mm lateral pipes alone would have to be put in-place for a period of approximately four years, from Year 2008 to 2012. Considering the magnitude of the works, this schedule will be very difficult to attain, and the delay in the laying of lateral sewers and service connections may be inevitable. Under Alternative 2 and 3 the same amount of work would be completed over an extended period of time up to 2025.

Implementation of separate sewer systems in Alternatives 1, 2, or 3 would cause significant traffic disruption and congestion across large areas of Metro Manila. Such congestion, in an already heavily congested urban environment would result in business financial losses, as well as increase air pollution and fuel consumption due to idling vehicles in traffic jams.

Table 9.3.2 Implementability Comparison of Alternatives

Alternative Identification	Implementability	
	STP Site	Traffic Disruption
(1) Separate Sewer System With 11 Catchment Areas and Concession Agreement Implementation Schedule	Total land cost Ps 7,740 million, 81 Ha required for 11 STPs, with expensive land in Pasig North, and relatively small site in Makati.	Highest traffic disruption with multiple projects implemented in different areas concurrently.
(2) Separate Sewer System With 11 Catchment Areas and Extended Implementation Schedule	Same as (1)	High traffic disruption, extended schedule limits the impacted area, but disruption occurs over a longer period of time.
(3) Separate Sewer System With 7 Catchment Areas and Extended Implementation Schedule	Total land cost Ps 5,560 million, 76 Ha required for 7 STPs, avoid expensive land in Pasig North and relatively small site in Makati.	Same as (2)
(4) Combined Interceptor System With 11 Catchment Areas and Extended Implementation Schedule	Same as (1)	Significantly less traffic disruption than that for separate sewer systems.
(5) Combined Interceptor System With 7 Catchment Areas and Extended Implementation Schedule	Same as (3)	Same as (4)

Implementation of combined sewer systems would minimize the traffic disruption and congestion, and consequent adverse impacts because of the reduced amount of work in laying lateral pipes and making housing connections. The extended implementation schedule for installation of combined sewer systems would reduce the severity of the impact. It is noted however, that the lesser impact would occur over an extended period of time.

(3) Storm Drainage Systems

A requisite to an effective combined sewerage system is the provision of an adequate storm drainage network to collect sewage flows from the households, in the absence of laterals that are provided in separate sewerage systems. In some pockets of the CA coverage area, the storm drainage systems will have to be improved, either by providing drains where there are none, or the rehabilitation of existing drains, especially for drains that pose a health risk, i.e., those that are not covered and there is risk of human contact with the sewage.

In general, inadequate drainage systems are found in low-income communities, especially, areas inhabited by informal settlers. In these areas, small open rectangular channels are common, as in the case of low-income communities covered under the MTSP.

At present, the responsibility for the development and maintenance of local storm drainage systems lies with the respective local government units (LGUs). Main drainage systems are maintained by DPWH/MMDA. There is no reason for changes in this institutional arrangement. Nevertheless, MWCI may, as is proposed under the MTSP, fund drainage improvement works, with the primary objective of minimizing health risks. Experience to be gained from implementing MTSP components involving combined systems complemented with drainage rehabilitation will serve as a basis for implementing combined systems after 2008.

Some areas, mainly in Taguig, are identified as future residential/commercial zones as per the respective LGU land use plan, but still lack the proper road and drainage systems. Clearly, sewerage coverage for these areas could only be implemented after provision of such infrastructure.

9.3.3 Benefits Evaluation of the Alternatives

Implementation of sewerage systems provides water quality improvement and health benefits. Benefits associated with improvement of the environmental and aesthetic quality of the rivers are resulting tourism and property value increases. Health benefits are reduced morbidity and mortality rates. A comparison of the benefits realized by implementation of the five alternatives is presented in Table 9.3.3.

(1) Water Quality Improvement Benefits

The separate sewer system alternatives provide the highest level of water quality improvement in the main rivers, creeks and drains. The combined sewer system alternatives provide approximately the same level of water quality in the main rivers, but minimal improvement in creeks and drains.

(2) Health Improvement Benefits

The separate sewer system alternatives provide the highest level of public health improvement. The combined sewer system alternatives provide a lower level of public health improvement. However, as shown in Economic Assessment of Sewerage Alternatives in Section 8, the economic value of health improvements under separate or combined systems alternatives are relatively small compared to the economic environmental benefits that result from improved water quality.

(3) Economic Benefits

The Economic Internal Rate of Return (EIRR) for each of the alternatives is listed in Table 9.3.3. The EIRR values for the separate sewer system alternatives are negative, indicating that the economic value of the benefits resulting from development of the separate sewerage system are less than the economic cost of development of the separate sewerage system. The EIRR values for the combined sewer systems are 14.6% for Alternative 4 and 18.9% for Alternative 5. These values indicate that the investment in the combined sewerage system is worthwhile, because the economic value of the benefits that will be realized exceed the economic cost of the investment.

In the Philippines as in many other countries, financial resources for investments in such projects are limited. Many projects go unfounded, because other projects produce a higher level of benefits for the capital invested. EIRR is a tool used for prioritizing investments in projects such as the one addressed in this Master Plan. The National Economic and Development Authority (NEDA) of the Government of the Philippines prioritizes investments partially based on EIRR, and typically does not support projects that do not have an EIRR value greater than the social discount rate of 15%.

9.4 Summary of Alternative Evaluation

A summary of the sewerage alternative evaluation is presented in Table 9.4.1. This table presents a comparison of relevant factors that should be considered in recommending a particular sewerage alternative.

Table 9.3.3 Benefit Comparison of Alternatives

Alternative Identification	Benefits		
	Water Quality	Health	Economic (EIRR)
(1) Separate Sewer System With 11 Catchment Areas and Concession Agreement Implementation Schedule	Highest water quality improvement in main rivers, tributaries, creeks and drains.	Highest level of public health improvement.	- 0.83 %
(2) Separate Sewer System With 11 Catchment Areas and Extended Implementation Schedule	Same ultimate level, not achieved as fast.	Same level of public health improvement as 1, but not achieved as fast with extended schedule.	- 2.05 %
(3) Separate Sewer System With 7 Catchment Areas and Extended Implementation Schedule	Same as (2)	Same as (2)	- 1.78 %
(4) Combined Interceptor System With 11 Catchment Areas and Extended Implementation Schedule	Improvement in main rivers, lesser improvement in tributaries, creeks and drains.	Septic tank desludging will reduce overflows to drains, combined with drainage improvements will improve public health.	9.97 %
(5) Combined Interceptor System With 7 Catchment Areas and Extended Implementation Schedule	Same as (4)	Same as (4)	11.79 %

Table 9.4.1 Summary of Alternative Evaluation

Service Targets	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Projected 2025 Sewerage Service Population	3,238,096	3,238,096	3,238,096	3,210,672	3,210,672
Projected 2025 Volume of Sewage Collection and Treated (m^3/day)	1,050,077	1,050,077	1,050,077	1,110,897	1,110,897
Number of Catchment Areas	11	11	7	11	7
Number of STPs	11	11	7	11	7
Land Requirement for STPs (ha)	81	81	76	81	76
Total Pipeline Length (km)	2,107	2,107	2,116	131	145
Number of Pump Stations	93	93	97	60	59
Total Capital Costs (Ps million)	80,812	80,812	77,896	29,448	28,089
Total Land Cost (Ps million)	7,740	7,740	5,560	7,740	5,560
EIRR (%)	- 0.83 %	- 2.05 %	- 1.78 %	9.97 %	11.79 %
ENPV (Ps million)	(21,531)	(9,807)	(8,420)	(1,265)	(726)
Tariff Impact (Ps/m^3)	15.64	9.77	9.16	4.32	4.06

9.5 Evaluation of Septage Treatment Alternatives for Sanitation

The septage treatment capacity will require expansion by 2020, if combined sewer systems are installed in the 11 catchment areas. If separate sewer systems are installed, no septage treatment capacity expansion will be required within the Master Plan period. As discussed in Section 6.9, two alternatives are presented to meet the required septage collection and treatment system expansion.

The first alternative calls for the expansion of the Antipolo SPTP and the provision of mechanical process equipment similar to what is proposed now for the Antipolo SPTP. The second alternative involves a "natural system" SPTP employing sludge drying beds for dewatering septage, and UASBs and stabilization ponds for filtrate treatment. The advantages and disadvantages of the two alternatives are presented in Table 9.5.1.

Table 9.4.1 Septage Alternatives Comparison

Alternative	Advantages	Disadvantages
Expansion of Antipolo SPTP (Mechanized Option)	Land acquisition is not necessary, and there will be no need for additional managerial and maintenance staff.	High investment and operational costs. Increased concentration of vehicular traffic to the area resulting to increased noise and air pollution levels.
New SPTP in the Binangonan/Cardona Area (Natural System Option)	Minimal operational costs. Investment costs, are relatively, much lower than mechanized option.	Large land requirements (around 10 hectares will be required). Odor will be uncontrollable, and consequently, there will be a need to locate the plant in low-population density areas, and to provide for wide buffer zones. Dewatered sludge (collected from the sludge drying beds) is not completely stabilized, limiting disposal options. Construction of access roads may be required.

Clearly, the non-mechanized alternative is less expensive, and on this basis, may be preferred. However, its viability will depend largely on the availability of land suitable for the proposed treatment process. Even if by 2020, there is available land, MWSS should also assess the rate of urbanization at that time, and assess if the economic lifetime of a non-mechanized SPTP will not be reduced significantly due to urbanization (land use) pressures.

SECTION 10

Conclusions and Recommendations

SECTION 10 CONCLUSIONS AND RECOMMENDATIONS

10.1 Introduction

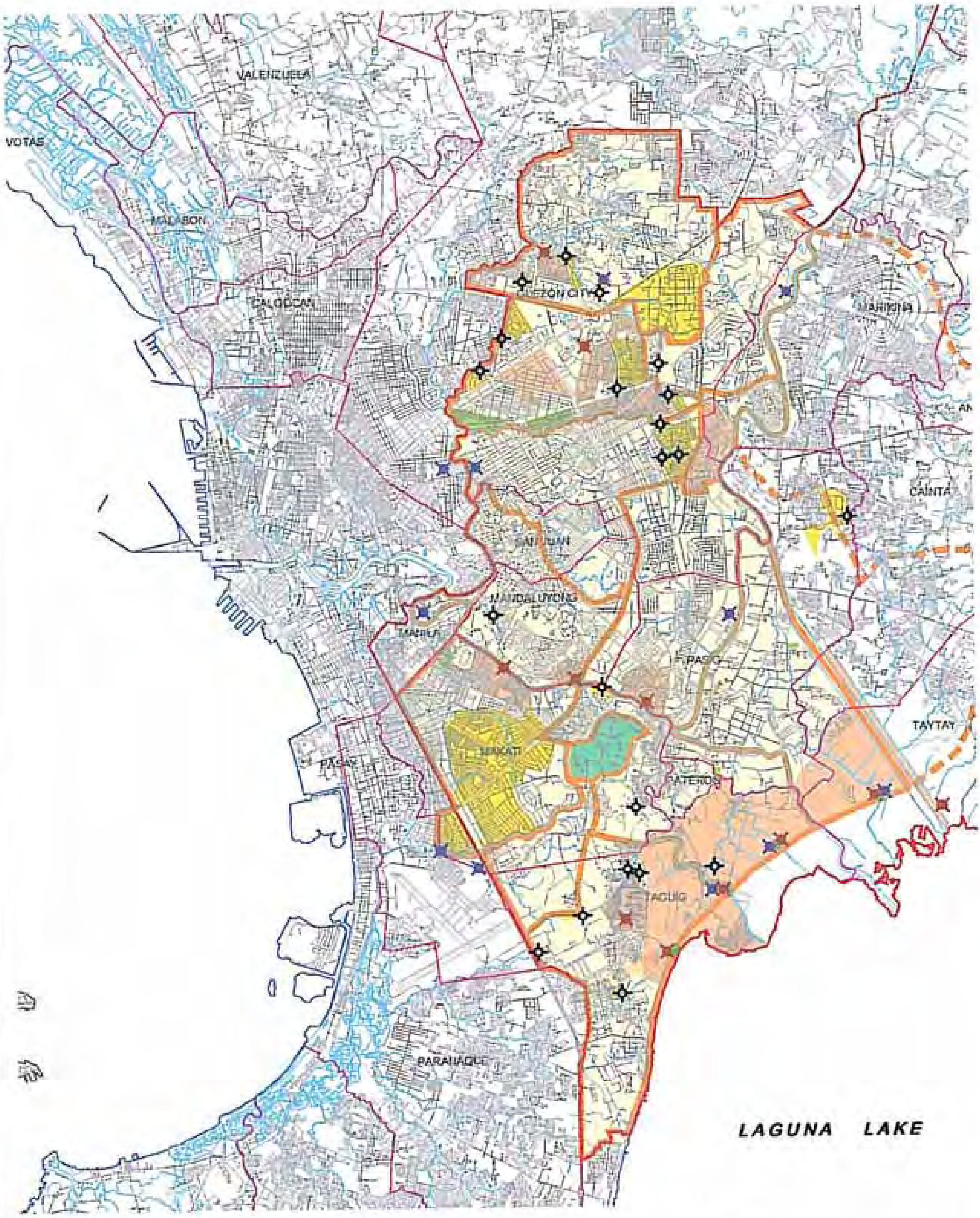
Water supply and sewerage is provided by MWCI under a Concession Agreement with MWSS. The 1997 Concession Agreement (CA) had targets for sewerage service connections using a separate sewer system, and sanitation using septage collection, transport and treatment. The CA has provisions for negotiation of revised service targets and rate rebasing, which is a mechanism that allows the Concessionaire to recover historical capital, operating and investment expenditures and to review future capital, operating and investment plans. The rate rebasing mechanism allows the concessionaire to charge a rate to recover costs and earn a reasonable rate of return. In the 2003 Rate Rebasing, the sewerage service targets were reduced and utilization of combined sewer systems (without direct connections) as a means of achieving the sewerage targets was agreed by MWSS.

A fundamental issue that will determine the level of investment and development of the sewerage system in the East Concession Area up to 2025 is the sewerage service targets that are agreed between MWCI and MWSS. This Master Plan addresses development of sewerage systems in the East Concession Area, specifically in the areas shown in Figure 10.1.1. The completeness of development of sewerage in this area in the period up to 2025, and the rate of development of the system will depend on the affordability of the tariff increment required, technical limitations such as adequate land availability and traffic disruption, and financial considerations such as the future price of land.

In this Master Plan for the period up to 2025, five alternatives were evaluated for development of sewerage systems in the East Concession Area of Metro Manila. The 1997 Concession Agreement and 2003 Rate Rebasing sewerage and sanitation targets are presented in Table 10.1.1 All five alternatives, if fully implemented, would achieve the ultimate sewerage service targets in the 1997 Concession Agreement by 2025; although only Alternative 1 would achieve the targets as scheduled in the 1997 Concession Agreement. All of the alternatives would exceed by far sewerage service 2003 Rate Rebasing sewerage service targets agreed between MWCI and MWSS. This Master Plan presents alternatives that may be implemented in stages, through development of sewerage systems that serve independent catchment areas. This Master Plan can serve as part of the basis for establishing revised 2008 Rate Rebasing sewerage service targets.

Table 10.1.1 Comparison of Service Targets

Service Targets	1997 Concession Agreement Targets	2003 Rate Rebasing Targets
Projected 2025 Sewerage Service Population	3,219,481	603,009
Projected 2025 Sanitation (Septage Collection & Treatment) Service Population	2,098,604	7,642,597
Projected 2025 Volume of Sewage Collection (m^3/day)	955,447	184,876
Projected 2025 Volume of Septage Collection (m^3/day)	862	3,095



LEGEND :

- CST CATCHMENT
- MSSP CATCHMENT
- MTSP CATCHMENT
- GLOBAL CITY (FORT BONIFACIO)
- NEW SEWERAGE COVERAGE AREA
- SEWERAGE CATCHMENT BOUNDARY
- PROPOSED STP SITE
- STP MTSP
- STP MSSP

0 1000 2000 3500 7000

GRAPHICAL SCALE

FIGURE 10.1.1

MASTER PLAN STUDY AREA

MANILA THIRD SEWERAGE PROJECT

METROPOLITAN WATERWORKS & SEWERAGE SYSTEM

NJS Consultants

CEST, Inc.

Mott MacDonald

10.2 Summary of Alternative Evaluation

The five alternatives were evaluated by identification of technical issues and constraints; and by comparing the relative costs, implementability and benefits that would be realized by implementation. In addition, integration of the proposed MTSP components into the expanded sewerage system was considered. The economic and financial viability of the alternatives were analyzed. A summary of the comparison of alternatives and the results of the analysis of financial and economic viability of the alternatives is presented in Table 10.2.1. A comparison of alternatives based on relative ease of implementation is presented in Table 9.3.2 in Section 9.

The water quality in the major rivers will be the same regardless of whether separate sewer systems or combined sewer systems are developed. Separate sewers will significantly improve the water quality in creeks and drains, while combined sewers will provide little improvement in the creeks and drains.

Water quality projections in Figure 7.1.1 in Section 7 show that if either the combined or separate sewerage systems are implemented in the area covered by all 11 catchment areas, BODs in Marikina River and Pasig River will be in the 10-20 mg/L range, more than the Class C target of 10 mg/L, but still less than the projected 20-30 mg/L BOD in parts of Pasig River if no interventions are made (see Section 3.7.2 in Section 3). The San Juan River will remain more polluted than the two aforementioned rivers, as the projected BOD is in the range 20-30 mg/L.

It is noted however that the water quality model assumes no sewerage interventions in the west concession area, part of which drains to the San Juan River basin. It is also better than the projected 40-50 mg/L BOD in a no intervention scenario.

10.3 Conclusions

The following conclusions are based on the comparative evaluation of the five sewerage system alternatives:

- Combined sewer systems can be implemented for a significantly lower capital cost than separate sewer systems, due to elimination of laterals and house connections.
- Combined sewer systems are relatively easier to implement than separate sewer systems, due to elimination of laterals and house connections.
- Combined sewer systems can be constructed in a shorter time period than separate sewer systems, due to elimination of laterals and house connections.
- Combined sewer systems would, during construction, reduce traffic congestion, business financial losses, air pollution and unnecessary fuel consumption due to idling in traffic; compared to separate sewer systems.
- The required tariff increment for combined sewer systems is less than half that for separate sewer systems.
- Improvements in water quality in the major rivers would be the same with either combined or separate sewer systems.

Table 10.2.1 Comparison of Alternatives

Service Targets	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Projected 2025 Sewerage Service Population	3,238,096	3,238,096	3,238,096	3,210,672	3,210,672
Projected 2025 Sanitation (Septage Collection & Treatment) Service Population	4,436,402	4,436,402	4,436,402	7,642,597	7,642,597
Projected 2025 Volume of Sewage Collection, in m^3/day	1,050,077	1,050,077	1,050,077	1,110,897	1,110,897
Projected 2025 Volume of Septage Collection, in m^3/day	1,800	1,800	1,800	3,095	3095
Additional Investment Requirements					
Investment Requirements (Ps million)	88,552	88,552	83,456	37,188	33,649
Required New STPs	11	11	7	11	7
EIRR (Ps million)	- 0.83 %	- 2.05 %	- 1.78 %	9.97 %	11.79 %
EIRR	(21,531)	(9,807)	(8,420)	(1,265)	(726)
Tariff Impact (Ps/m^3)	15.64	9.77	9.16	4.32	4.06

- The calculated Economic Internal Rate of Return (EIRR) values for combined sewer alternatives range from 10 - 12%, while those for separate sewer systems are negative; indicating that separate sewer systems are not economically viable.

- Implementation of separate sewer systems is not feasible; due to the high tariff impact which is considered to be unaffordable and the unacceptable disruption of traffic and potential for construction delays, given the large quantities of sewers (approximately 2,100 km of sewers) that would be required.

- Sewer systems in catchment areas can be implemented for a significantly lower capital cost than sewer systems in eleven catchment areas, due to elimination of four STPs.

- Sewer systems in seven catchment areas would be relatively easier to implement and would reduce land availability constraint, compared to sewer systems in eleven catchment areas.

- The required tariff increment for sewer systems in seven catchment areas is less than that for sewer systems in eleven catchment areas.

- The sewer systems in seven catchment areas or eleven catchment areas can be implemented independently in sequential phases.

- Alternative 5 with combined sewers in seven catchment areas has the lowest NPV, the lowest tariff impact, the highest EIRR, and is the relatively easiest alternative to implement.

- The EIRR for Alternative 5 is 11.79%, which is slightly less than the 15% social discount rate adopted by NEDA.

- The incremental tariff increase for Alternative 5 for implementation in 2008, considering costs expressed in 2004 prices, is estimated to be 4.06 Ps/m^3. With this increment the all-inclusive tariff would be increased from 18.85 Ps/m^3 to 24.17 Ps/m^3, including cost recovery for MTSP components and the Master Plan facilities. This represents a 28% in the tariff.

- With the tariff increase to 24.17 Ps/m^3, the average monthly water bill would be Ps 725.25/month, which is an increase of approximately Ps 160/month.

- With the increased tariff, the average monthly water bill would represent approximately 2.5% of the average monthly income for the NCR and 3.82% of the median monthly income for the NCR. These percentages are less than the maximum of 5% of the average monthly income that is used to determine affordability.

- Following careful consideration of the alternatives, as well as the technical and financial constraints, Alternative 5 is the most feasible alternative.

10.4 Recommendations

- MWSS and MWCI should consider the data and evaluations presented in this Master Plan, when establishing sewerage service targets during the 2008 Rate Rebasing, as well as planning for future projects beyond MTSP.

- If MWSS and MWCI establish service targets that require development of combined sewers in the service area covered by this Master Plan, then implementation of Alternative 5 with combined sewers in seven catchment areas in accordance with the schedule in Section 6 is recommended. The seven catchment areas are presented in Figure 10.4.1.

- However, if MWSS and MWCI decide that the incremental tariff increase of 4.06 Ps/m^3 is politically or socially unacceptable, then the implementation program could be extended beyond 2025 to reduce the tariff impact or catchments can be prioritized for implementation.

10.5 Considerations for the 2025 – 2050 Master Plan

This Master Plan addresses development of sewerage and sanitation facilities for the period up to 2025. The following development period will be 2025 – 2050. This subsection provides considerations for development of the plan for the following development period. Future development requirements should be considered and be taken into consideration during the design and implementation; so the facilities can be adapted, expanded and upgraded as needed in the future.

If development of sewerage systems is not completed in all of the seven catchment areas by 2025, either because the implementation was delayed to defer capital expenditures and improve affordability, or due to technical constraints; the Master Plan for the following development period should address the completion of systems in those catchment areas.

If development of sewerage systems is completed in all of the seven catchment area by 2025, the next step would be to expand the system to catchment areas in the East Concession Area, that are not addressed in this Master Plan. For catchment areas that are addressed in this plan that are adjacent to those that are not addressed, consideration should be given to potential transfer of sewage from adjacent catchment areas to a common STP that would serve both catchment areas.

Surface drainage facilities will be improved under this Master Plan to reduce exposure to sewage. It is anticipated that issues relating to drainage operations and maintenance, rehabilitation and upgrade will be addressed during the Master Plan period, with lessons learned from implementing the MTSP combined system components. Further improvement to drainage facilities should be developed during the following development period. The combined sewerage systems that will be implemented under this Master Plan will serve to improve water quality in the major rivers. However, little improvement will be achieved in the creeks and major drains. In the next development period, alternatives should be developed for improvement of water quality in the drainage facilities upstream of the major rivers.

LEGEND :

- CST CATCHMENT
- MSSP CATCHMENT
- MTSP CATCHMENT
- GLOBAL CITY (FORT BONIFACIO)
- NEW SEWERAGE COVERAGE AREA
- SEWERAGE CATCHMENT BOUNDARY
- PROPOSED STP SITE
- STP MTSP
- STP MSSP

0 1000 2000 3500 7000

GRAPHICAL SCALE

FIGURE 10.4.1

RECOMMENDED CATCHMENT AREAS

MANILA THIRD SEWERAGE PROJECT

METROPOLITAN WATERWORKS & SEWERAGE SYSTEM

NJS Consultants

CEST, Inc. Mott MacDonald

The treatment plants that will be installed under this Master Plan will be designed to meet Class C discharge standards for BOD and TSS. In the future these treatment plants may need to be upgraded to provide nutrient removal, to further improve surface water quality.

In the following planning period, it may be technically feasible and economically viable to increase centralization of sewage treatment to reduce the long-term cost of repair, maintenance and operation of the STPs. Some of the treatment plants could be converted into pump stations to transfer sewage to fewer expanded or new STPs. If the new STPs are located in outlying eastern portions of the East Concession Area, it may be possible to purchase relatively inexpensive land.

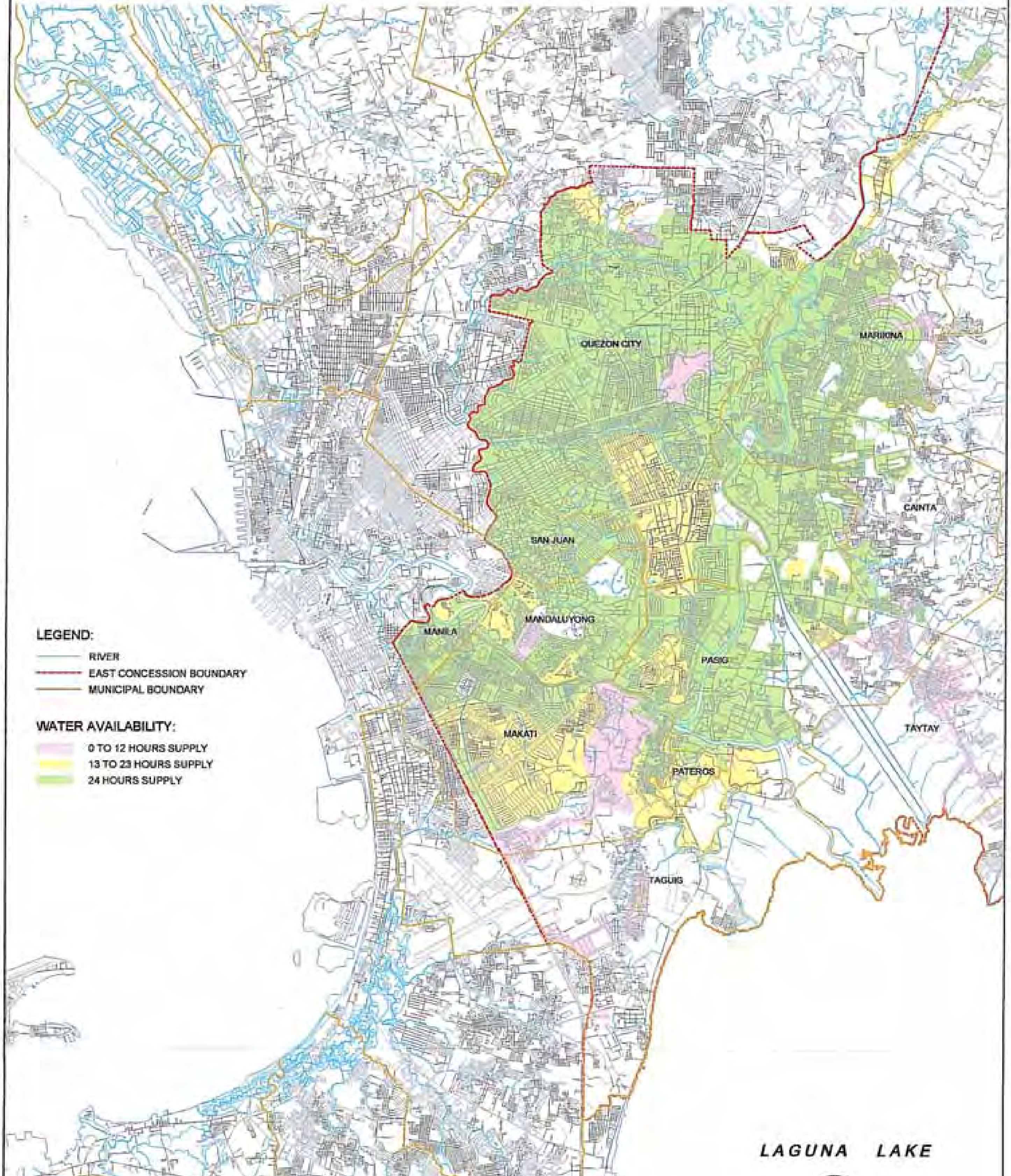


FIGURE 2.2.1

MWCI EXISTING WATER SUPPLY SYSTEMS/
WATER COVERAGE MAP YEAR 2003

MANILA THIRD SEWERAGE PROJECT

CEST, Inc. Mott MacDonald

FIG. 2.2.1

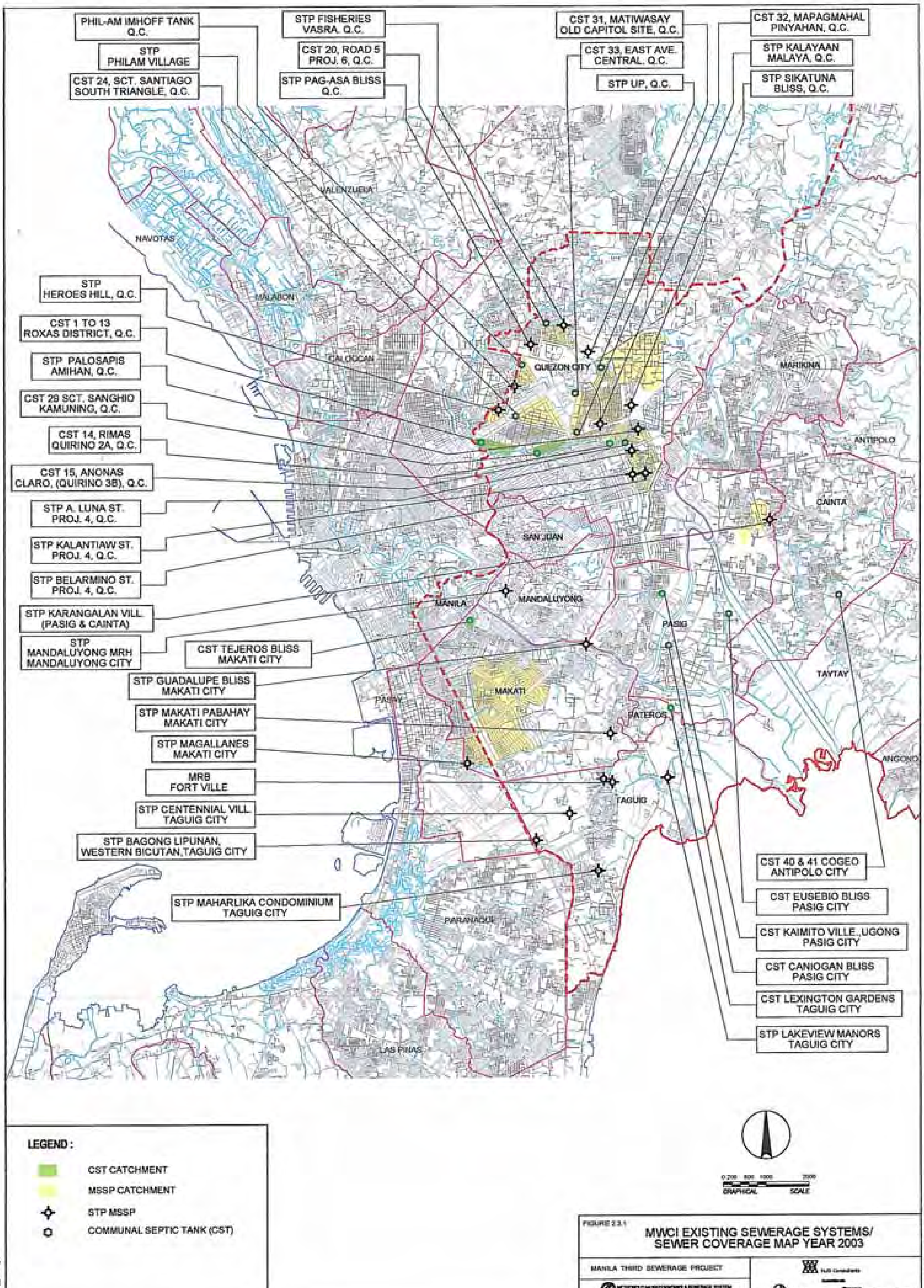
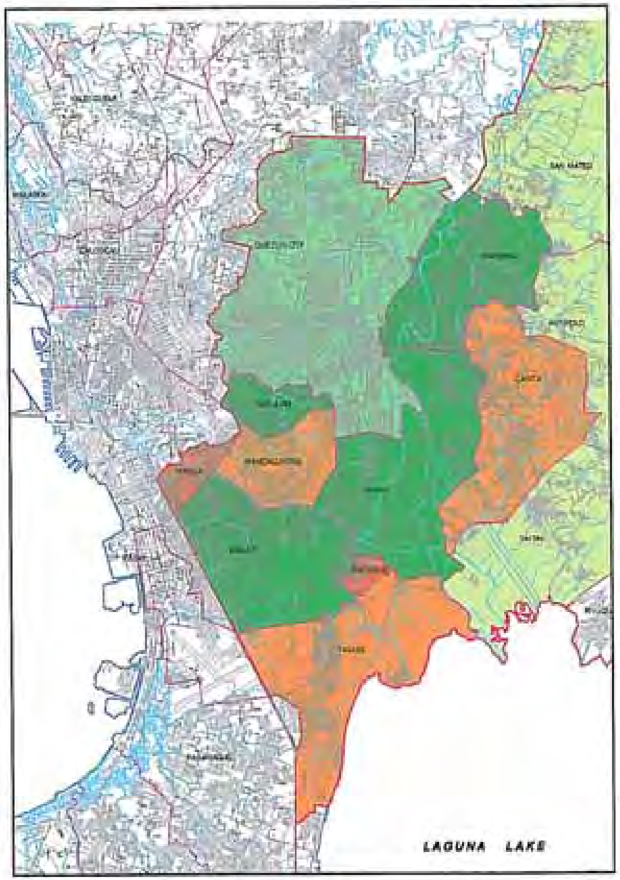
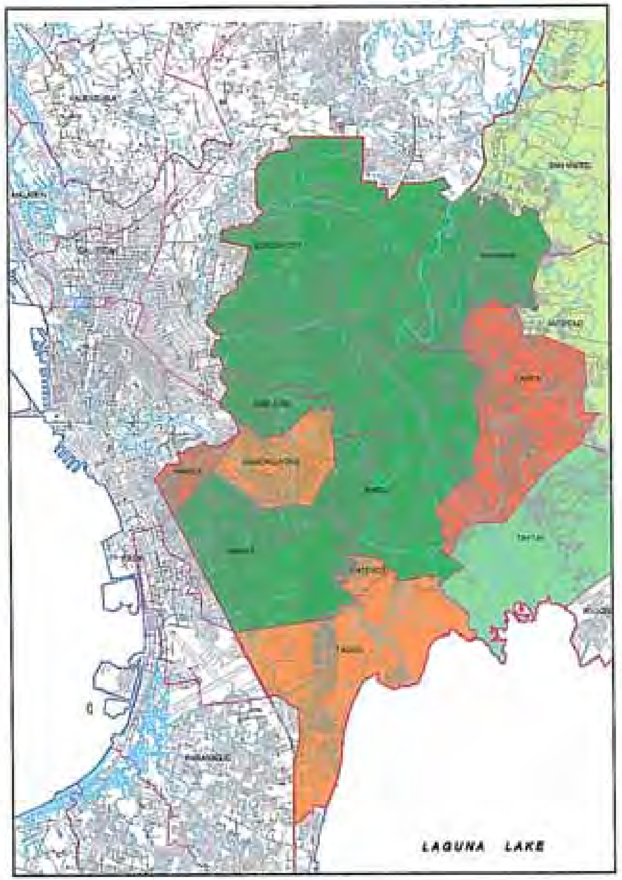


FIGURE 2.3.1
MWCI EXISTING SEWERAGE SYSTEMS/ SEWER COVERAGE MAP YEAR 2003

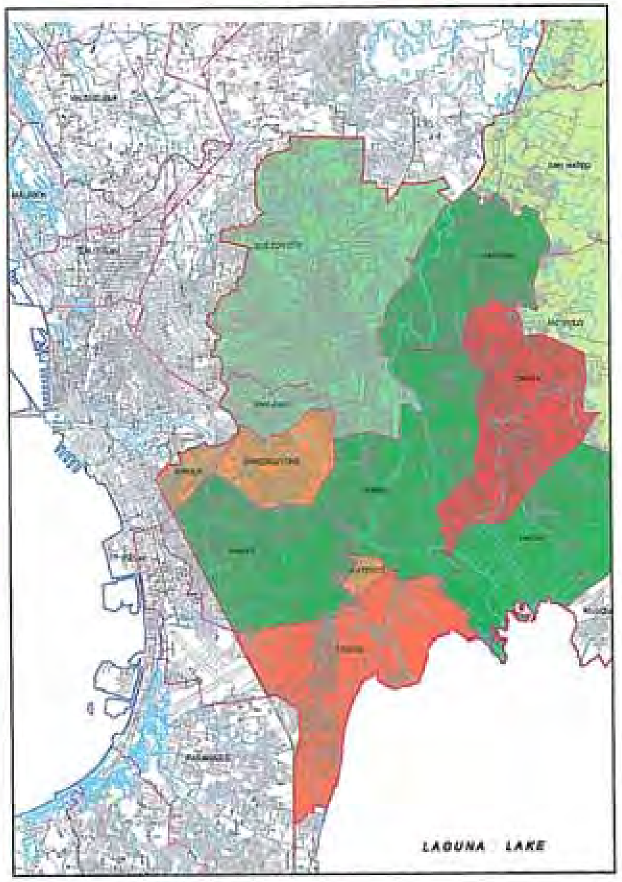
FIG. 2.3.1



2005 POPULATION DENSITY MAP



2015 POPULATION DENSITY MAP



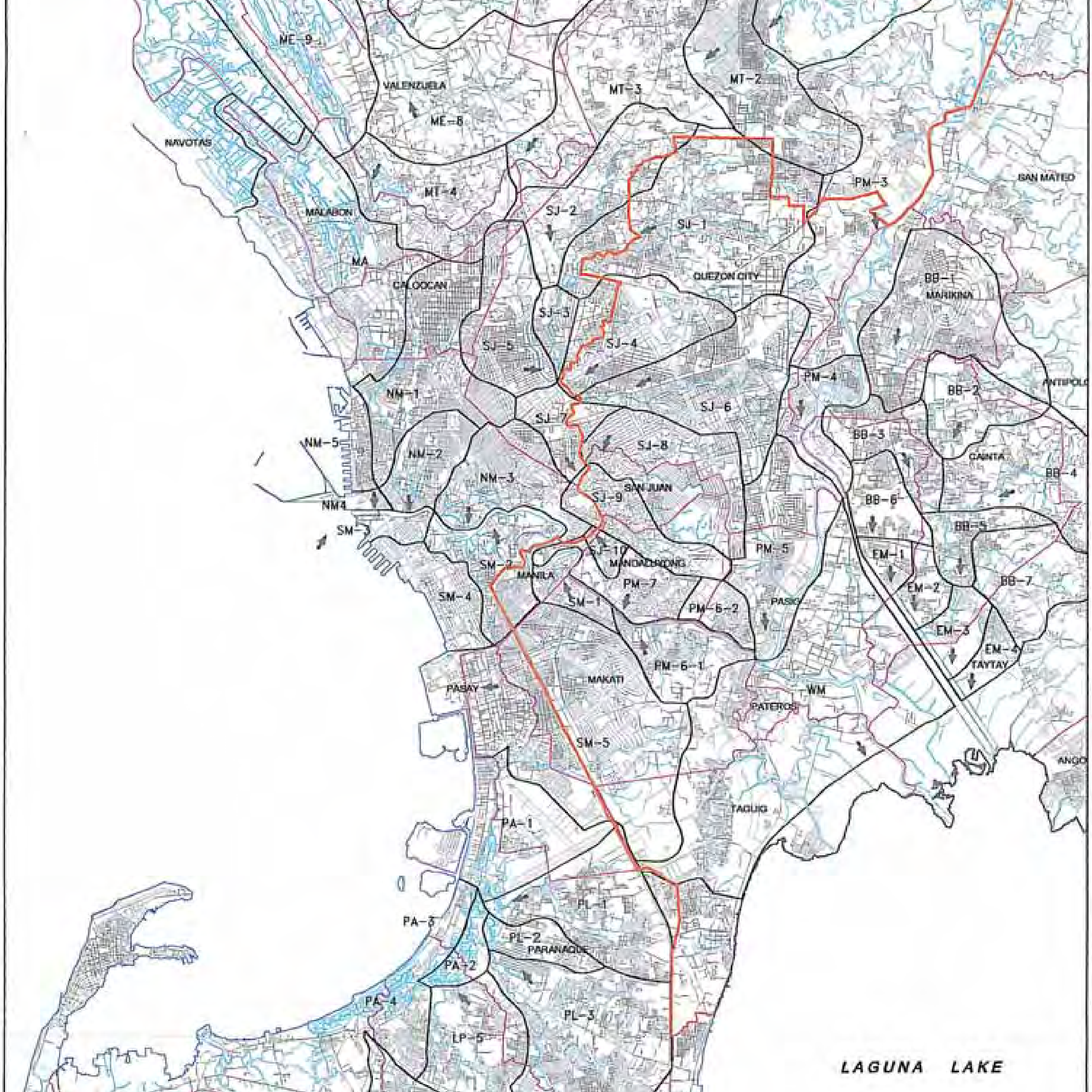
2025 POPULATION DENSITY MAP

LEGEND :

- 0 - 100 ca / ha
- 100 - 150 ca / ha
- 150 - 200 ca / ha
- 200 - 300 ca / ha
- 300 - 400 ca / ha
- ABOVE 400 ca / ha

0 1000 2000 3000 4000 5000 10000
GRAPHICAL SCALE

FIGURE 3.2.2 POPULATION DENSITY MAP	
MANILA THIRD SEWERAGE PROJECT	NJS Consultants
METROPOLITAN WATERWORKS & SEWERAGE SYSTEM	CEST, Inc. Mott MacDonald



LEGEND:

SUB-CATCHMENT BOUNDARY

EAST CONCESSION ZONE

CITY BOUNDARY

GRAPHICAL SCALE

FIGURE 3.4.2	DRAINAGE SUB- CATCHMENTS
MANILA THIRD SEWERAGE PROJECT	NJS Consultants
METROPOLITAN WATERWORKS & SEWERAGE SYSTEM	CEST, Inc. Mott MacDonald

FIG. 3.4.2

Table 3.6.4 Pollution Load Generation in Sub-catchments (Year 2005)

Pasig-Marikina sub-catchments-BOD generation — PM

Sub-catchments: PM-1, PM-2, PM-3, PM-4, PM-5, PM-6-1, PM-6-2, PM-7, Sub-catchment Total (each: Area km², Population, Commercial PE)

Municipality	Population Density per km²	Domestic BOD Load g/c/day
Taytay	388	41.7
Antipolo	2,180	41.7
Rodriguez	4,636	41.7
San Mateo	2,636	41.7
Quezon City	15,075	45.4
Marikina	19,546	44.5
Pasig	17,325	46.2
Taguig	12,875	44.1
Mandaluyong	24,817	44.8
Makati	15,665	47.3
Manila City	39,734	45.5
Total		
BOD domestic/commercial (kg/d)		
BOD domestic+commercial (kg/d)		
BOD industrial (kg/d)		
Total BOD generation (kg/d)		
BOD discharge per area (kg/km2/d)		

San Juan sub-catchments-BOD generation — SJ

Sub-catchments: SJ-1 to SJ-10, Sub-catchment Total (each: Area km², Population, Commercial PE)

Municipality	Population Density per km²	Domestic BOD Load g/c/day
Quezon City	15,075	45.4
Pasig	17,325	46.2
San Juan	18,902	47.8
Mandaluyong	24,817	44.8
Manila City	39,734	45.5
Total		
BOD domestic/commercial (kg/d)		
BOD domestic+commercial (kg/d)		
BOD industrial (kg/d)		
Total BOD generation (kg/d)		
BOD discharge per area (kg/km2/d)		

South Manila sub-catchments-BOD generation — SM

Municipality	Population Density per km²	Domestic BOD Load g/c/day
Quezon City	15,075	45.4
Makati	15,665	47.3
Manila City	39,734	45.5
Total		
BOD domestic/commercial (kg/d)		
BOD domestic+commercial (kg/d)		
BOD industrial (kg/d)		
Total BOD generation (kg/d)		
BOD discharge per area (kg/km2/d)		

Makati sub-catchments-BOD generation — SM-5

Municipality	Population Density per km²	Domestic BOD Load g/c/day
Taguig	12,875	44.1
Makati	15,665	47.3
Pasay	[illegible]	45.1
Total		
BOD domestic/commercial (kg/d)		
BOD domestic+commercial (kg/d)		
BOD industrial (kg/d)		
Total BOD generation (kg/d)		
BOD discharge per area (kg/km2/d)		

Malabon-Tullahan sub-catchments-BOD generation — MT

Sub-catchments: MT-1, MT-2, MT-3, MT-4, MA, Sub-catchment Total (each: Area km², Population, Commercial PE)

Municipality	Population Density per km²	Domestic BOD Load g/c/day
Quezon City	15,075	45.4
Valenzuela	[illegible]	44.8
Malabon	[illegible]	42.5
Caloocan	[illegible]	43.9
Navotas	[illegible]	42.8
Manila City	39,734	45.5
Total		
BOD domestic/commercial (kg/d)		
BOD domestic+commercial (kg/d)		
BOD industrial (kg/d)		
Total BOD generation (kg/d)		
BOD discharge per area (kg/km2/d)		

West Manila sub-catchment-BOD generation — WM

Municipality	Population Density per km²	Domestic BOD Load g/c/day
Pasig	17,325	46.2
Cainta	8,432	41.7
Taytay	[illegible]	41.7
Makati	15,665	47.3
Pateros	[illegible]	44.1
Taguig	12,875	44.1
Total		
BOD domestic/commercial (kg/d)		
BOD domestic+commercial (kg/d)		
BOD industrial (kg/d)		
Total BOD generation (kg/d)		
BOD discharge per area (kg/km2/d)		

Baho-Buli sub-catchments-BOD generation — BB

Sub-catchments: BB-1 to BB-7, BM-1 to BM-4, Sub-catchment Total (each: Area km², Population, Commercial PE)

Municipality	Population Density per km²	Domestic BOD Load g/c/day
Antipolo	2,180	41.7
Marikina	19,546	44.5
Cainta	8,432	41.7
Pasig	17,325	46.2
Taytay	[illegible]	41.7
Total		
BOD domestic/commercial (kg/d)		
BOD domestic+commercial (kg/d)		
BOD industrial (kg/d)		
Total BOD generation (kg/d)		
BOD discharge per area (kg/km2/d)		

Table 3.6.5 Pollution Load Generation in Sub-catchments (Year 2025)

Pasig-Marikina sub-catchments-BOD generation PM

Municipality	Population Density per km²	Domestic BOD Load g/c/day	PM-1 (Area km², Population, Commercial PE)	PM-2	PM-3	PM-4	PM-5	PM-6-1	PM-6-2	PM-7	Sub-catchment Total
Taytay	726	50.0	[illegible]								[illegible]
Antipolo	7,106	50.0	[illegible]		[illegible]						[illegible]
Rodriguez	[illegible]	50.0	[illegible]	[illegible]							[illegible]
San Mateo	5,728	50.0			[illegible]						[illegible]
Quezon City	15,639	50.0			[illegible]	[illegible]	[illegible]				[illegible]
Marikina	[illegible]	50.0			[illegible]	[illegible]					[illegible]
Pasig	17,868	50.0				[illegible]	[illegible]		[illegible]		[illegible]
Taguig	23,261	50.0						[illegible]			[illegible]
Mandaluyong	20,948	50.0							[illegible]	[illegible]	[illegible]
Makati	15,547	50.0						[illegible]		[illegible]	[illegible]
Manila City	28,979	50.0								[illegible]	[illegible]
Total			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD domestic/commercial (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD domestic+commercial (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD industrial (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total BOD generation (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD discharge per area (kg/km2/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

San Juan sub-catchments-BOD generation SJ

Municipality	Population Density per km²	Domestic BOD Load g/c/day	SJ-1	SJ-2	SJ-3	SJ-4	SJ-5	SJ-6	SJ-7	SJ-8	SJ-9	SJ-10	Sub-catchment Total
Quezon City	15,639	50.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
Pasig	17,868	50.0								[illegible]			[illegible]
San Juan	[illegible]	50.0								[illegible]	[illegible]		[illegible]
Mandaluyong	20,948	50.0								[illegible]	[illegible]	[illegible]	[illegible]
Manila City	28,979	50.0									[illegible]	[illegible]	[illegible]
Total			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD domestic/commercial (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD domestic+commercial (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD industrial (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total BOD generation (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD discharge per area (kg/km2/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

South Manila sub-catchments-BOD generation SM

Municipality	Population Density per km²	Domestic BOD Load g/c/day	SM-1	SM-2	SM-3	NM-3	NM-1-1	NM-4	Sub-catchment Total
Quezon City	15,639	50.0				[illegible]			[illegible]
Makati	15,547	50.0	[illegible]						[illegible]
Manila City	28,979	50.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD domestic/commercial (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD domestic+commercial (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD industrial (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total BOD generation (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD discharge per area (kg/km2/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Makati sub-catchment-BOD generation SM-5

Municipality	Population Density per km²	Domestic BOD Load g/c/day	SM-5
Taguig	23,261	50.0	[illegible]
Makati	15,547	50.0	[illegible]
Pasay	[illegible]	50.0	[illegible]
Total			[illegible]
BOD domestic/commercial (kg/d)			[illegible]
BOD domestic+commercial (kg/d)			[illegible]
BOD industrial (kg/d)			[illegible]
Total BOD generation (kg/d)			[illegible]
BOD discharge per area (kg/km2/d)			[illegible]

Malabon-Tullahan sub-catchments-BOD generation MT

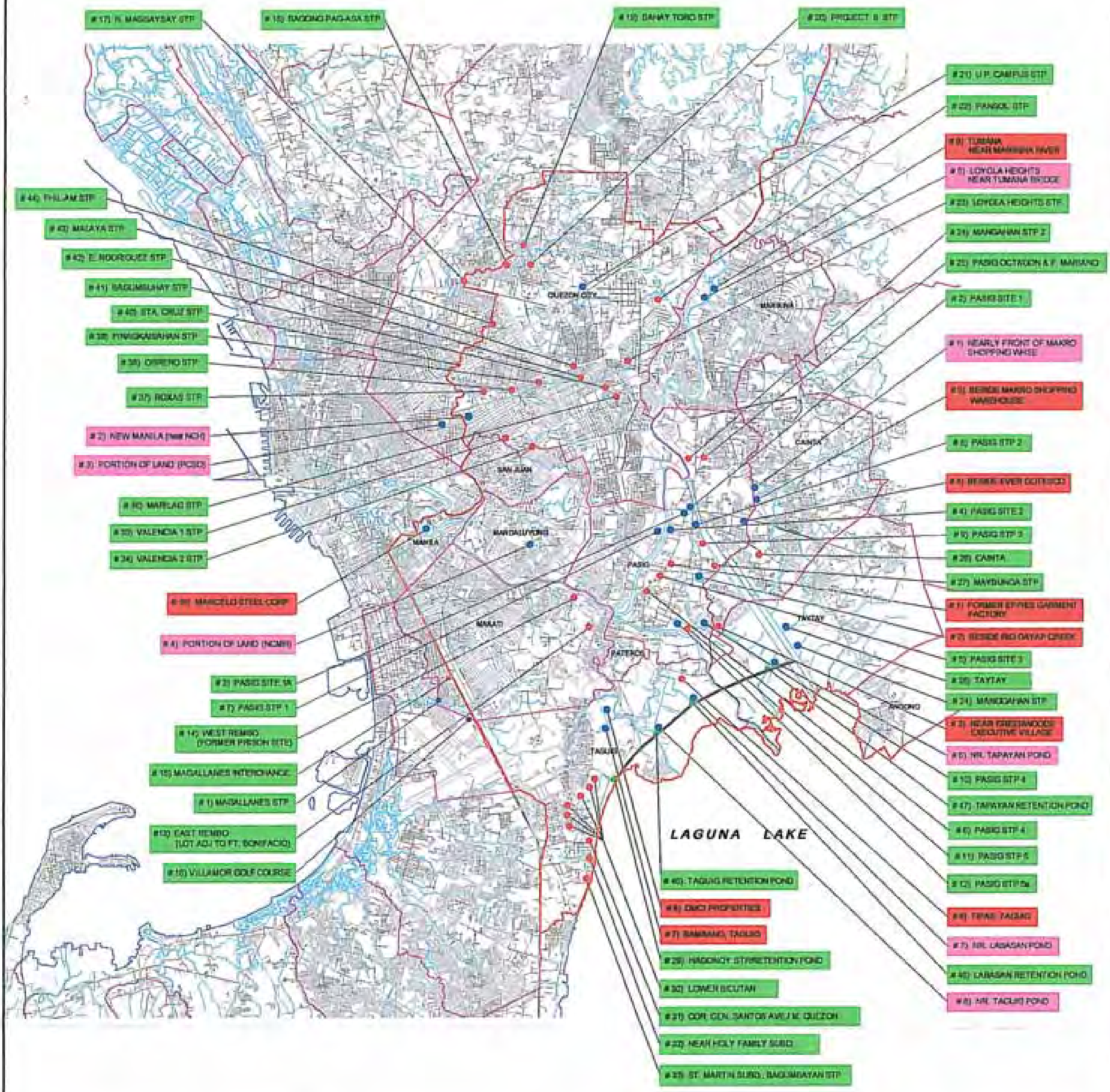
Municipality	Population Density per km²	Domestic BOD Load g/c/day	MT-1	MT-2	MT-3	MT-4	MA	Sub-catchment Total
Quezon City	15,639	50.0	[illegible]	[illegible]	[illegible]			[illegible]
Valenzuela	[illegible]	50.0			[illegible]	[illegible]		[illegible]
Malabon	[illegible]	50.0				[illegible]	[illegible]	[illegible]
Caloocan	[illegible]	50.0			[illegible]	[illegible]	[illegible]	[illegible]
Navotas	[illegible]	50.0					[illegible]	[illegible]
Manila City	28,979	50.0					[illegible]	[illegible]
Total			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD domestic/commercial (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD domestic+commercial (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD industrial (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total BOD generation (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD discharge per area (kg/km2/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

West Manila sub-catchment-BOD generation WM

Municipality	Population Density per km²	Domestic BOD Load g/c/day	WM
Pasig	17,868	50.0	[illegible]
Cainta	[illegible]	50.0	[illegible]
Taytay	[illegible]	50.0	[illegible]
Makati	15,547	50.0	[illegible]
Pateros	[illegible]	50.0	[illegible]
Taguig	23,261	50.0	[illegible]
Total			[illegible]
BOD domestic/commercial (kg/d)			[illegible]
BOD domestic+commercial (kg/d)			[illegible]
BOD industrial (kg/d)			[illegible]
Total BOD generation (kg/d)			[illegible]
BOD discharge per area (kg/km2/d)			[illegible]

Baho-Buli sub-catchments-BOD generation BB

Municipality	Population Density per km²	Domestic BOD Load g/c/day	BB-1	BB-2	BB-3	BB-4	BB-5	BB-6	BB-7	BM-1	BM-2	BM-3	BM-4	Sub-catchment Total
Antipolo	7,106	50.0	[illegible]	[illegible]		[illegible]			[illegible]					[illegible]
Marikina	[illegible]	50.0	[illegible]		[illegible]									[illegible]
Cainta	[illegible]	50.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
Pasig	17,868	50.0			[illegible]			[illegible]		[illegible]				[illegible]
Taytay	[illegible]	50.0							[illegible]			[illegible]	[illegible]	[illegible]
Total			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD domestic/commercial (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD domestic+commercial (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD industrial (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total BOD generation (kg/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BOD discharge per area (kg/km2/d)			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



LEGEND:

# ABC	: MASTER PLAN PROPOSED STP SITES
# ABC	: PRRC PROPOSED STP SITES
# ABC	: ADDITIONAL PROPOSED STP SITES
	: EXISTING POND
	: AVAILABLE SITE
	: SITE NOT AVAILABLE

0 500 1000 2000 4000
GRAPHICAL SCALE

FIGURE 6.2.1

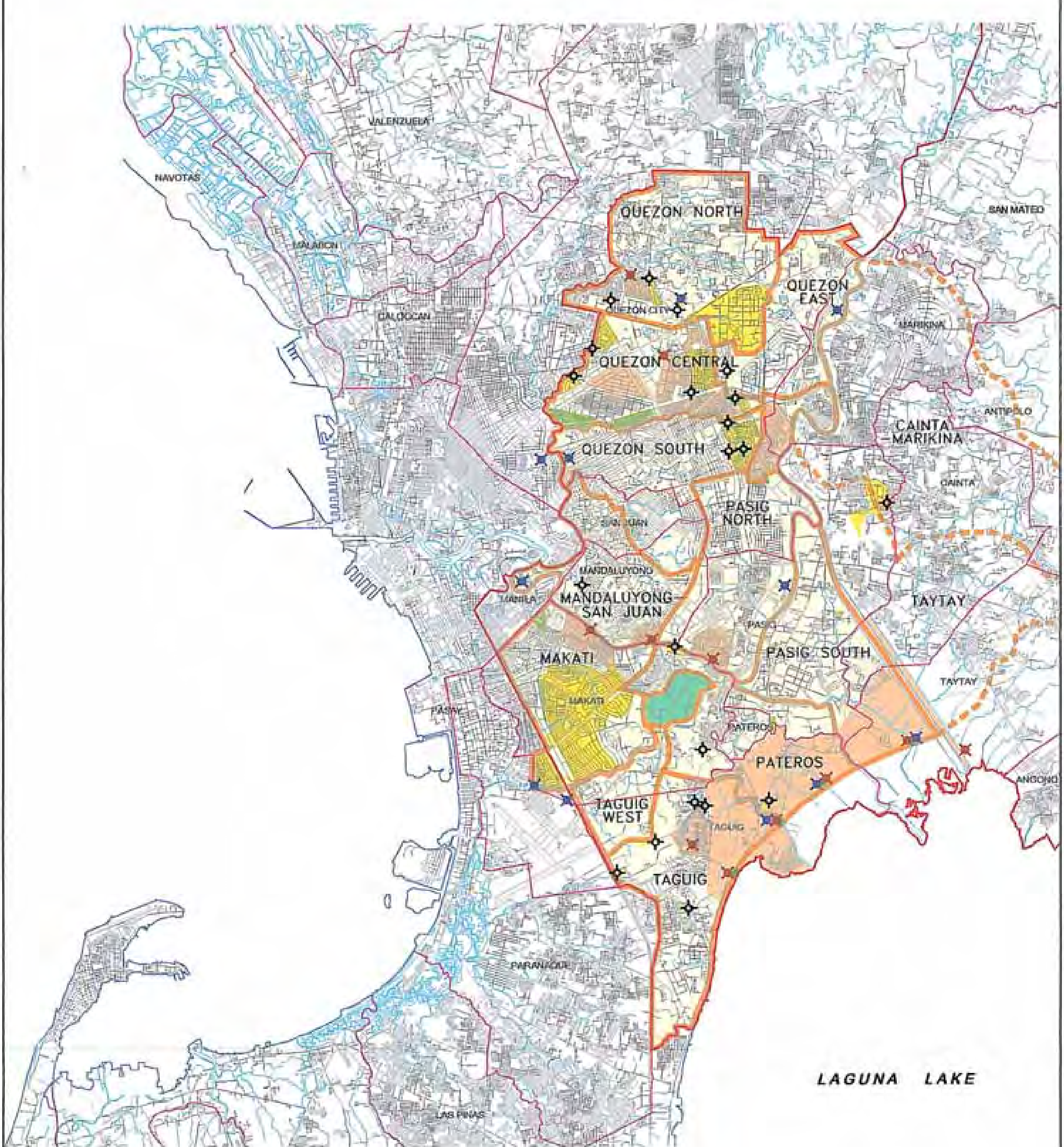
PROPOSED STP SITES

MANILA THIRD SEWERAGE PROJECT

METROPOLITAN WATERWORKS & SEWERAGE SYSTEM

NJS Consultants
CEST, Inc.
Mott MacDonald

FIG. 6.2.1



LEGEND :

- CST CATCHMENT
- MSSP CATCHMENT
- MTSP CATCHMENT
- GLOBAL CITY (FORT BONIFACIO)
- NEW SEWERAGE COVERAGE AREA
- SEWERAGE CATCHMENT BOUNDARY
- PROPOSED STP SITE
- STP MTSP
- STP MSSP

GRAPHICAL SCALE

FIGURE 6.3.1

ALTERNATIVE - 1 and 2
11 SEWERAGE CATCHMENT AREAS
(Separate System)

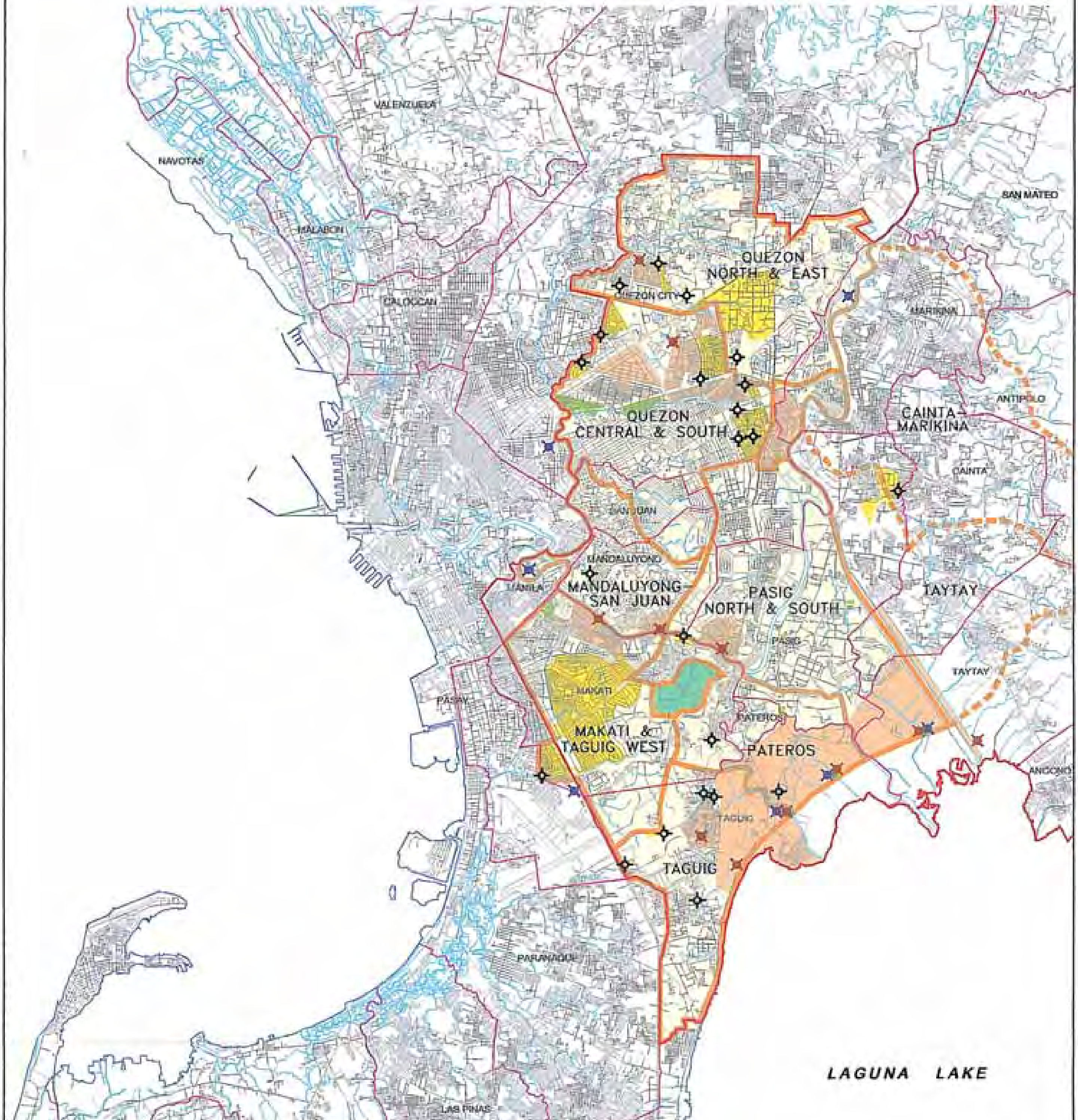
MANILA THIRD SEWERAGE PROJECT

NJS Consultants

CEST, Inc.

Mott MacDonald

FIG. 6.3.1



LEGEND :

- CST CATCHMENT
- MSSP CATCHMENT
- MTSP CATCHMENT
- GLOBAL CITY (FORT BONIFACIO)
- NEW SEWERAGE COVERAGE AREA
- SEWERAGE CATCHMENT BOUNDARY
- PROPOSED STP SITE
- STP MTSP
- STP MSSP

GRAPHICAL SCALE

FIGURE 6.3.2

ALTERNATIVE - 3
7 SEWERAGE CATCHMENT AREAS
(Separate System)

MANILA THIRD SEWERAGE PROJECT

NJS Consultants

CEST, Inc.

Mott MacDonald

FIG. 6.3.2

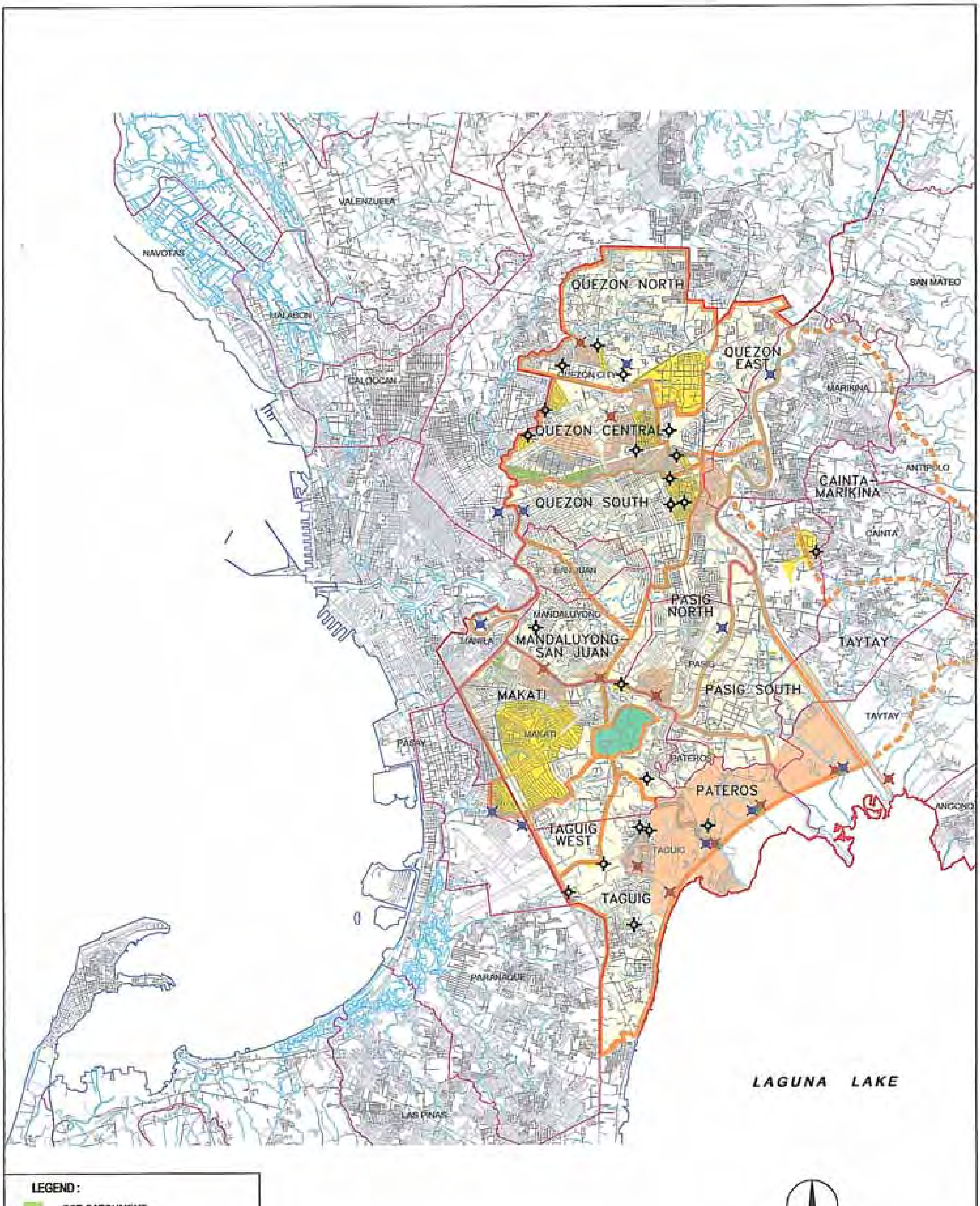
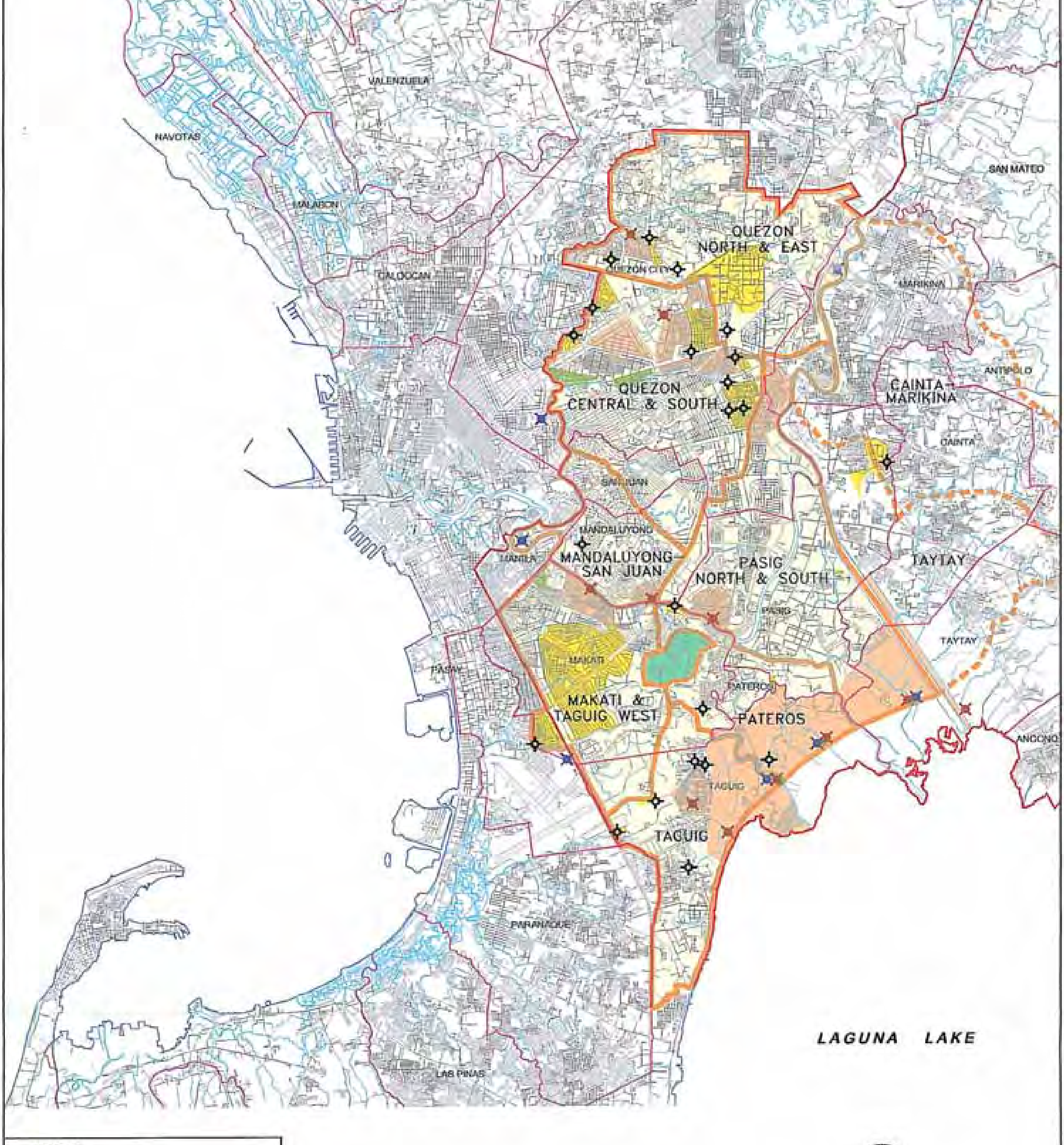

VALENZUELA
NAVOTAS
MALABON
CALOOCAN
SAN MATEO
QUEZON NORTH
QUEZON EAST
QUEZON CITY
MARIKINA
QUEZON CENTRAL
QUEZON SOUTH
ANTIPOLO
CAINTA-MARIKINA
CAINTA
SAN JUAN
PASIG NORTH
MANDALUYONG
MANILA
MANDALUYONG-SAN JUAN
TAYTAY
PASIG
MAKATI
PASIG SOUTH
PASAY
PATEROS
ANGONO
TAGUIG WEST
TAGUIG
PARAÑAQUE
LAGUNA LAKE
LAS PIÑAS
LEGEND:
CST CATCHMENT
MSSP CATCHMENT
MTSP CATCHMENT
GLOBAL CITY (FORT BONIFACIO)
NEW SEWERAGE COVERAGE AREA
SEWERAGE CATCHMENT BOUNDARY
PROPOSED STP SITE
STP MTSP
STP MSSP
GRAPHICAL SCALE
FIGURE 6.3.3
ALTERNATIVE - 4
11 SEWERAGE CATCHMENT AREAS
(Combined System)
MANILA THIRD SEWERAGE PROJECT
CEST, Inc.
Mott MacDonald

FIG. 6.3.3



LEGEND :

- CST CATCHMENT
- MSSP CATCHMENT
- MTSP CATCHMENT
- GLOBAL CITY (FORT BONIFACIO)
- NEW SEWERAGE COVERAGE AREA
- SEWERAGE CATCHMENT BOUNDARY
- PROPOSED STP SITE
- STP MTSP
- STP MSSP

GRAPHICAL SCALE

FIGURE 6.3.4

ALTERNATIVE - 5
7 SEWERAGE CATCHMENT AREAS
(Combined System)

MANILA THIRD SEWERAGE PROJECT

NJS Consultants

CEST, Inc.

Mott MacDonald

FIG. 6.3.4