PHILIPPINES
MAYNILAD WATER SERVICES, INC.
WATER CAPITAL PROJECTS

**Sewerage and Sanitation Improvement Project**

# MASTER PLAN

## VOLUME I

## ALTERNATIVE 1

## MAIN REPORT

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PHILIPPINES
MAYNILAD WATER SERVICES INCORPORATION

Maynilad Water Capital Project
Master Plan of Sewerage and Sanitation Project

# 1. Introduction

## 1.1 Planning Purposes and the Necessity of the Master Plan

The Metropolitan Manila (MM) consists of 4 cities and 13 municipalities. It has an area of 636 $km^2$ and the population in this area is projected to grow up to 11.5 million by 2010. Sewerage and sanitation services are the responsibility of the Metropolitan Waterworks and Sewerage Services (MWSS), a public utility established in 1971. Others involved in drainage and sanitation are the MM cities and municipalities, the Department of Public Works and Highways (DPWH), the Environmental Management Bureau of the Department of Environment and Natural Resources (DENR), the Department of Health and the Metro Manila Authority.

Sewerage and sanitation services are provided mainly through 600,000 private septic tanks which serve about 4.7 million people, and by several MWSS separate wastewater systems that serve about 1.3 million people.

In 1979, it prepared a sewerage and sanitation master plan for MM area. The plan provided for a long term sewerage program and an interim non-sewerage sanitation program. The master plan was designed for implementation in five stages, METROS -□ to METROS -□.

In 1991, MWSS carried out a pre-feasibility study which formulates the Second Manila Sewerage Project (MSSP 2) and in 1994, the implementation plan was designed as MSSP 2 mainly for establishing 3 components, such as four septage treatment plants realizing regular base desludging of the septic tanks, improving street drainage in major defective sections, upgrading the existing Central and Ayala sewerage systems. After this plan issued, the maintenance and operation of the sewerage systems has been privatized and separated into two zones, contracted by two concessionaires, that is, Maynilad Water Services Incorporation (MWSI) and Manila Water Company Incorporation (MWCI).

Regarding septage treatment plants (STP), Dagat-dagatan STP has constructed by MWSI, and the other three STPs are under construction in San Mateo, Taguig and Pasig by MWCI, and construction of several sewerage treatment plants is now under implementation as MSSP 3 by MWCI.

Most of the sanitation and sewerage facilities in the territory of MWSI had been put into practical use since 1984 and have serviced for long term, thus much deterioration of the

facilities by the long term aging from very early installation could not be avoided. MWSI has made an effort to maintain and rehabilitate all existing systems to recover the functioning from the beginning of their concession. Rehabilitation program of the central sewerage systems including Tondo Pumping station with seven lift-up stations and sewer lines from 2003 to 2005 has been implemented under MSSP-4 project funded by World Bank. The Dagat-dagatan sewage treatment System (aeration lagoon) has been also enhanced by the rehabilitation under the MSSP-2 project funded by WB. MWSI reviewed their business plan in 2007, and has established their sanitation and sewerage implementation program targeting their service coverage on the projected population up to 2022, in order to cater for population growth speed and grade up of their life styles. This project implementation plan is made to take into consideration renovation and rehabilitation of aged facilities and new facility construction program.

## 1.2 Planning View Point

(1) Development of Sanitation and Sewerage Services by MWSI,
(2) Review on the current sewerage and sanitation services,
(3) Review on the development program of the past projects and the master plans,
(4) Review on the effectiveness and efficiency of the substantial sewerage and sanitation facilities,
(5) Study of the implementation program of the projects in aspect of the MWSI Business Plan reviewed in 2007,
(6) Study of the economical sewerage and sanitation systems and facilities applied to Metro Manila,
(7) Establish rehabilitation program and its renovation program,
(8) Overall coordination with sanitation services and sewerage services, and
(9) Review on the MWSI Business Plan Development Program.

## 1.3 Direct Objectives

(1) Prepare Study Reports of the Sanitation and Sewerage Development Program to cater for the MWSI Business Plan reviewed in 2007,
(2) Prepare rehabilitation and renovation method and design for the existing sanitation and sewerage facilities,
(3) Prepare substantial project plan to improve San Juan River Basin,

(4) Establish feasible project implementation plans with substantial service facilities with technical specifications, and

(5) Justify the MWSI service development plan described in the Business Plan.

# 2 DESCRIPTION OF THE SERVICE AREA

## 2.1 Natural Resource

### 2.1.1 Service boundary of the concessionaire service

The MWSI Service Area covers 7 cities and 9 municipalities of NCR and Cavite with over 623 square kilometers of land area.

MWSI's NCR coverage includes part of the cities of Quezon, Manila, Makati and Marikina. Also included are part of the municipalities of San Mateo and Rodriguez, although these service areas are relatively insignificant.

The boundary between the Service Areas West and East generally runs from north to south coinciding with the MWSS water system boundaries.

The boundary limits (Figure 2 - 1) are defined in Schedule 1 of the Concession Agreement.

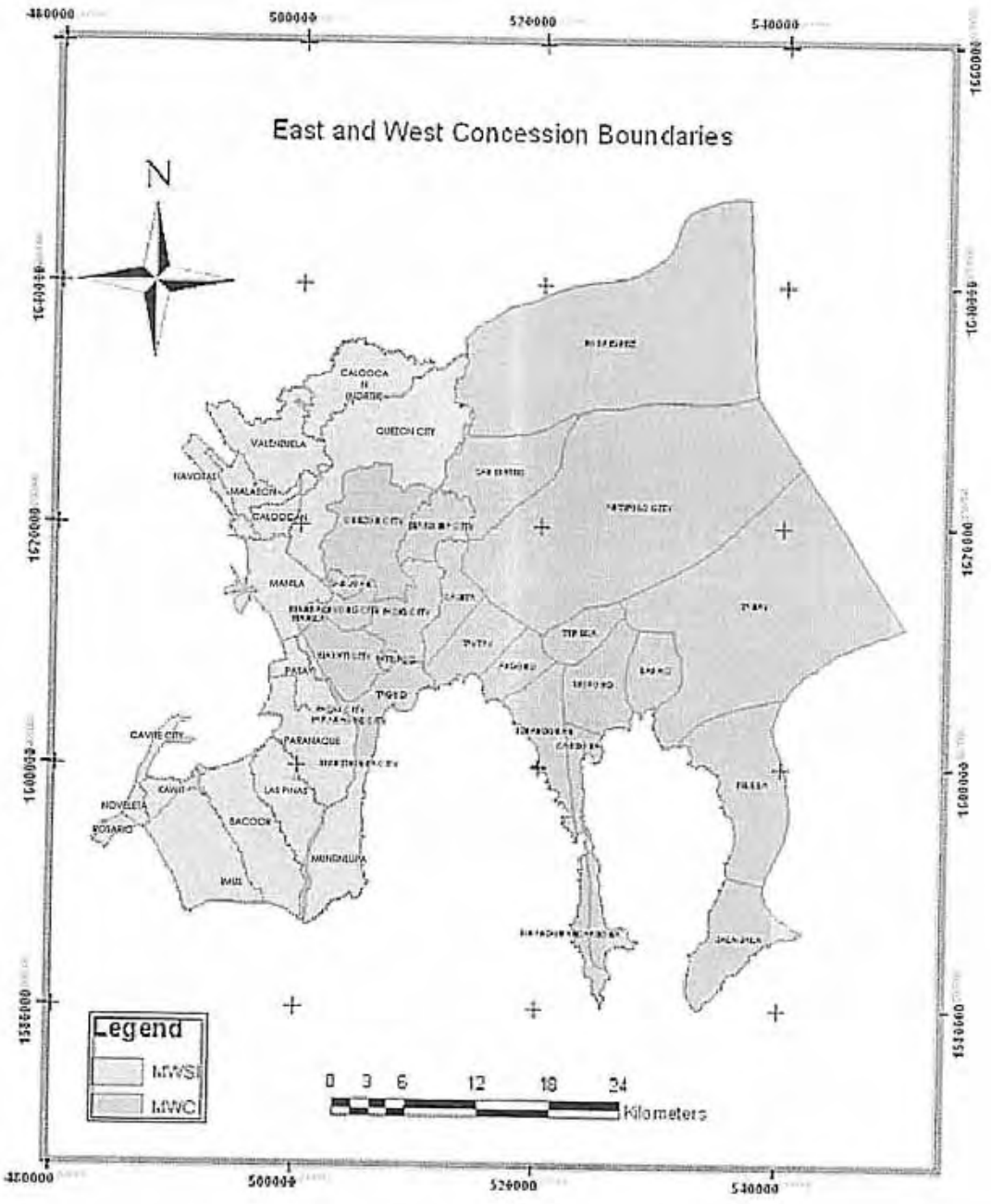



**Figure 2 - 1: MWSS Concession Areas Boundaries**

### 2.1.2 Topography

The total area of Metro Manila is expanding due to reclamation works being done on Manila Bay. The topography of the study area is characterized as Coastal Plain, Guadalupe Plateau and the Marikina-Laguna Valley.

The Coastal Plain includes the western areas of Metro Manila. Intramuros, Fort Santiago and Fort San Antonio Abad were originally constructed along the shorelines prior to the extensive reclamation of the bay. Only a series of canals are left of the once low sandy islands found at the Pasig River delta. Most of the areas in Manila and Pasay are situated at elevations about two meters above sea level.

Guadalupe Plateau rises above the coastal lowlands with summits reaching 90 to 100 m above sea level north of the Pasig River and 30 to 40 m due south. Drainage is directed westward to the San Juan River in the north and directly westward to the Manila Bay down south.

The Marikina-Laguna Valley is relatively flat having a narrow north area which becomes wider towards the south near Laguna de Bay. The flow of the Marikina River takes on a meandering course and the flow becomes slow and the cross-section becomes wider from the Sierra Madre foothills.

Cavite is considered flat being part of the coastal plains. Cavite City extends outwards to the Manila Bay. River systems include Imus River, Julian River and Ilang-Ilang River.

**Slope**

The slopes found within Metro Manila vary for the topographic areas mentioned above. Slopes for the Coastal Plain are relatively flat (zero to one percent) with elevations ranging from zero to two meters. A one to three percent rise can be seen from the Coastal Plain to the Guadalupe Ridge. Slope drops of 20% and greater can be seen towards the Marikina Fault. Moving towards the Marikina-Laguna Valley, slopes become flat.

Slopes near the coastal plains of Cavite do not exceed three percent and elevation is about sea level. The slope slightly increases to about 5% along the southeast with elevations rising to about 70 m above sea level.

### 2.1.3 Climate

**Rainfall**

Meteorology in the study area is characterised by distinct wet and dry seasons. The dry season falls on the months of November to April during the northeast monsoon. The wet season occurs from the months of May to October coinciding with the southwest monsoon. In Metro Manila the annual average rainfall is 2164.5 mm, with an average number of rainy days of 133 per year.

Figure 2-2 shows the monthly average rainfall and number of rainy days in Metro Manila.

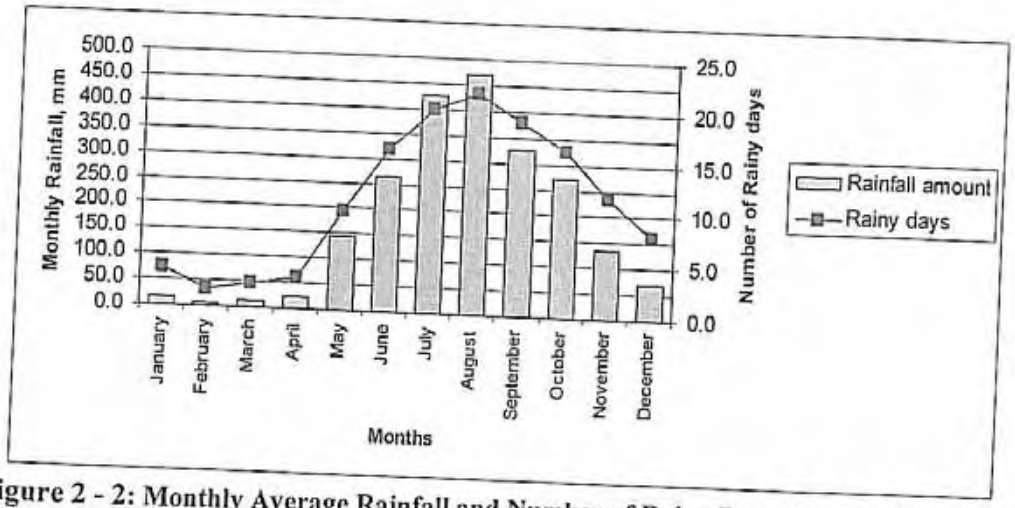



**Figure 2 - 2: Monthly Average Rainfall and Number of Rainy Days in Metro Manila (SKM 2005)**

## Temperature

The overall monthly temperature is about 27.7 °C. Warmest days occur during the summer months of April and May with an average high temperature of 29.6°C while the coolest month is January with low average temperature of 25.9 °C. Figure 2-3 presents the monthly average temperatures in Metro Manila.

The average relative humidity is lowest in April (69 %) and highest in September (84 %).

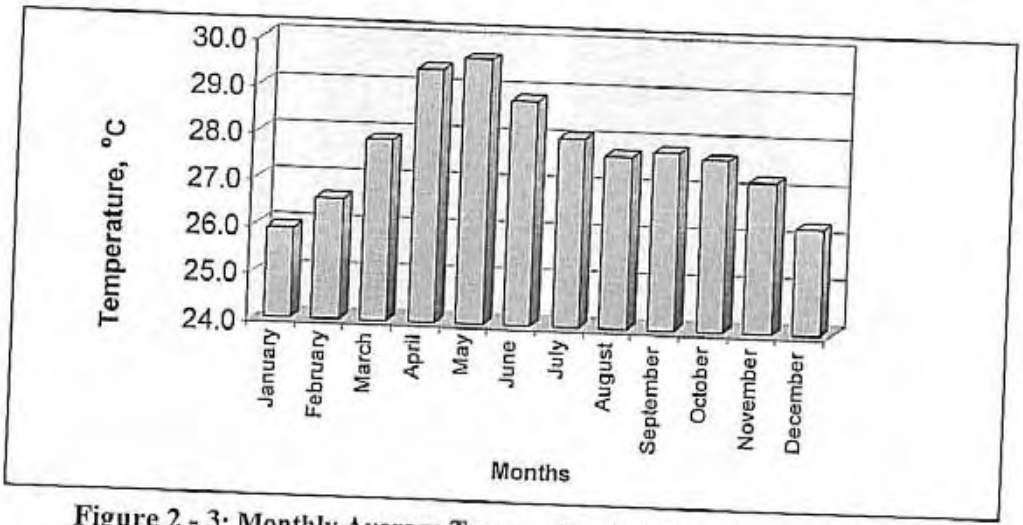



**Figure 2 - 3: Monthly Average Temperature in Metro Manila (SKM 2005)**

### 2.1.4 Geological Characteristics

In the Metro Manila area, the underlying rock strata are composed of three types of sedimentary rock sequentially layered as: Miocene rocks, "Alata" Conglomerate and Guadalupe Tuff. Guadalupe Tuff is the overlaying stratum from the Marikina Valley until Quezon City where layer thickness is about 300 to 2,000 m. A change in overlaying alluvium stratum with a depth of about 25 to 50 m is seen along the coastal plains. Alluvial sediments also overlay the Marikina valley but the depth varies greatly.

A simplified geological cross-section of Metro Manila is presented in Figure 2-4.

The Guadalupe tuff is understood to be water laid, most probably in a shallow sea during the late Tertiary or early Quaternary age. Beds of the tuff are clearly stratified and are composed mostly of comminuted, somewhat altered, vitric volcanic ash although certain layers are composed of rather coarse fragments of volcanic pumice. The tuff layers, which are normally fine-grained and gray to brownish-gray in colour, are often separated by brownish or yellowish soil which is indicative of weathering. Also gravel and sand layers have been found between tuff strata. It would seem, therefore, that deposition of these tuff layers was not a continuous process but rather may have been cycles of deposition. Uplift, weathering and erosion rather than submergence and deposition.

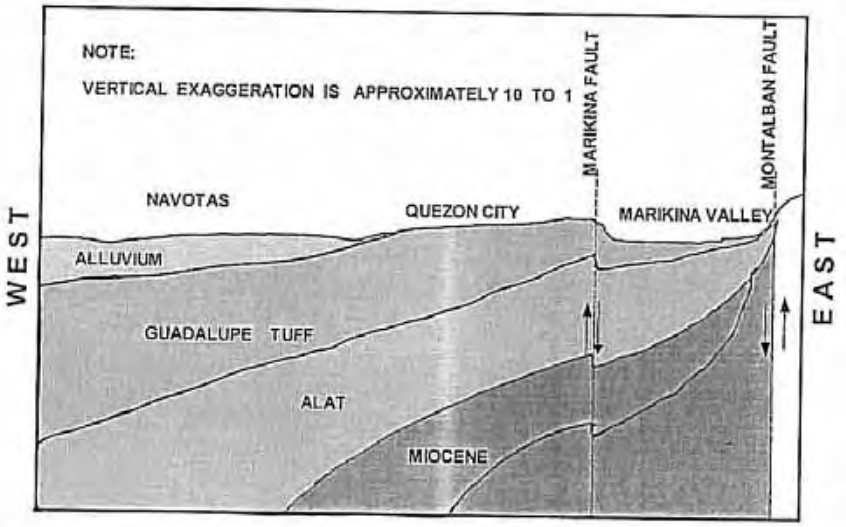



**Figure 2 - 4: Simplied Geological Cross-Section of Metro Manila**

**Earthquakes**

Several hundred tremors are recorded annually in the Philippines. Two sources of structural movement are the Philippine Deep whose axis lies 80 km off the east cost of Luzon and Samar. And the Philippine Rift, which runs from Lingayen Gulf through Polillo Island, Sorsogon, Leyte and Eastern Mindanao. Three active volcanoes (Taal, Makiling and Banahaw) lie within 80 km of Manila.

Construction in the coastal plain alluvium is especially susceptible to seismic damage because of the soft foundation materials and the almost universal use of friction piles. No major pipeline damage has been attributed to earthquakes in the Metro Manila area, although it is possible that seismic action has damaged sewer pipes without external indication.

### 2.1.5 Hydro-geological and Oceanographic Characteristics

The hydro-geologic structure in the MWSI service area was formed due to tectonic and volcanic events during the Late Tertiary and Quaternary periods, along with sea level changes.

In the coastal areas of Manila Bay, Laguna de Bay, and Marikina Valley, the groundwater systems mainly consist of alluvial sediments, while the rest of the areas are underlain by pyroclastic Guadalupe Formation. These aquifer systems extend from 1400 to 1800 sq. km.

The major aquifer systems underlying Metro Manila are as follows:

- Manila Bay Alluvium – found in Caloocan City, Manila, Pasay City, Makati City, Valenzuela, Navotas, Malabon, Parañaque, Las Piñas, Bacoor, Imus, Kawit, Noveleta, and Rosario. The Manila Bay Aquifer System is anisotropic and semi-confined with vertical permeability that is much lower than the horizontal permeability.

- Guadalupe Formation – underlies Quezon City, San Juan, Mandaluyong, part of Makati, and Muntinlupa. The transmissivity coefficient in the Guadalupe Formation ranges from 50 to 100 sq m/ day, with an average of 58 sq m/ day, which means that the aquifer system has slightly moderate water transmitting properties.

The aquifer systems generally have an upper water table aquifer of up to 30 m deep. A semi-confining layer with thickness of up to 45 meters separates this upper water table aquifer from the lower artesian aquifer of more than 500 m thickness. Groundwater velocity within the confined aquifers averages 0.6 m/day, flowing generally from Quezon City towards Caloocan and Manila and from Laguna Lake and Las Piñas towards Makati and Parañaque.

Confined aquifers within the Guadalupe tuff are the source of groundwater for the service area. It is believed that withdrawal of groundwater from the aquifer is in excess of the recharge resulting in the following externalities:

- Aquifer depletion;
- Groundwater pollution;
- Land subsidence; and,
- Saline intrusion.

An indicator of groundwater over-abstraction is the drawdown of piezometric heads. The piezometric heads in the northeast of Manila has gone down from +180 m in 1955 to only +120 m in 1994. At the coastal areas, the piezometric heads fell from –10 m to –100 m within about four decades.

## 2.2 General Characteristics of the Service Area

### 2.2.1 Population in the Service Area

The sources of population data are the various publications of the past censuses issued by the NSO. The NSO is the national agency mandated to collect information on population and its characteristics. The total population of the West Zone in 2007, according to the latest NSO census conducted in August 2007, was estimated to be at 8,893,835. About 53% of the total population reside in the three (3) biggest cities in the West Zone – the cities of Manila, Quezon and Caloocan while only 11% are residents of Cavite.

## Past Population and Growth Rates

The population census in the country is generally conducted by NSO every ten (10) years until 1990, after which, the census was done in five-year interval – in 1995 and 2000. However, the census for 2005 was delayed until 2007 due to budgetary constraint. A total of 12 population censuses have been completed since 1903.

The population figures of the 17 cities/municipalities within the Maynilad's service area in the past area in the past were taken from the NSO for the census years 1990, 1995, 2000 and 2007. In addition, official population projection of the NSO for the regional and city/municipal levels were also collected and used as reference in the population projection.

Table 2 - 1 presents the past population and annual growth rate of the cities/municipalities within Maynilad's service area.

**Table 2 - 1: Past Population and Growth Rates – MWSI Service Area**

| City/Municipality | NSO Census | | | | Annual Growth Rates | | |
|---|---|---|---|---|---|---|---|
| | 1990 (May 1) | 1995 (Sep 1) | 2000 (May 1) | 2007 (Aug 1) | 1990-1995 | 1995-2000 | 2000-2007 |
| *NCR* | *5,353,891* | *6,429,537* | *6,784,704* | *7,884,972* | *3.5%* | *1.2%* | *2.1%* |
| Manila (part) | 1,439,584 | 1,487,707 | 1,416,331 | 1,493,819 | 0.6% | -1.0% | 0.7% |
| Quezon City (part) | 1,027,986 | 1,224,772 | 1,420,653 | 1,805,607 | 3.3% | 3.2% | 3.4% |
| Caloocan | 763,415 | 1,023,159 | 1,177,604 | 1,378,856 | 5.6% | 3.1% | 2.2% |
| Malabon | 280,027 | 347,484 | 338,855 | 363,681 | 4.1% | -0.5% | 1.0% |
| Navotas | 187,479 | 229,039 | 230,403 | 245,344 | 3.8% | 0.1% | 0.9% |
| Valenzuela | 340,227 | 437,165 | 485,433 | 568,928 | 4.8% | 2.3% | 2.2% |
| Las Pinas | 297,102 | 413,086 | 472,780 | 532,330 | 6.4% | 2.9% | 1.6% |
| Makati (part) | 63,059 | 67,373 | 58,616 | 87,200 | 1.2% | -2.9% | 5.6% |
| Muntinlupa | 278,411 | 399,846 | 379,310 | 452,943 | 7.0% | -1.1% | 2.5% |
| Paranaque | 308,236 | 391,296 | 449,811 | 552,660 | 4.6% | 3.0% | 2.9% |
| Pasay City | 368,366 | 408,610 | 354,908 | 403,604 | 2.0% | -3.0% | 1.8% |
| *CAVITE* | *457,021* | *659,255* | *768,923* | *1,008,863* | *7.1%* | *3.4%* | *3.8%* |
| Bacoor | 159,685 | 250,821 | 305,699 | 441,197 | 8.8% | 4.3% | 5.2% |
| Cavite City | 91,641 | 92,641 | 99,367 | 104,581 | 0.2% | 1.5% | 0.7% |
| Imus | 92,125 | 177,408 | 195,482 | 253,158 | 13.1% | 2.1% | 3.6% |
| Kawit | 47,756 | 56,993 | 62,751 | 76,405 | 3.4% | 2.1% | 2.8% |
| Noveleta | 20,409 | 27,306 | 31,959 | 39,294 | 5.6% | 3.4% | 2.9% |
| Rosario | 45,405 | 54,086 | 73,665 | 94,228 | 3.3% | 6.8% | 3.5% |
| *OVERALL* | *5,810,912* | *7,088,792* | *7,553,627* | *8,893,835* | *3.8%* | *1.4%* | *2.3%* |

The final results in the latest Census of Population (POPCEN 2007) conducted by the NSO, which were made official with the signing by President Gloria Macapagal-Arroyo of Proclamation No. 1489 on April 16, 2008, showed that the annual population growth rate from 2000 to 2007 of both the NCR and the province of Cavite at 2.1% and 3.8% respectively are growing faster relative to the national average of 2.04%.

It is interesting to note to that all the cities and municipalities in the West Zone showed a positive annual population growth rate with Makati, Bacoor, Imus, Rosario and Quezon City posting the highest rate at 5.6%, 5.2%, 3.6%, 3.5% and 3.4% respectively.

**Population Projection**

The population of the 17 cities and municipalities in the Maynilad service area was projected up to 2040 using the population census of 2007 as base year.

The population projection for the city/municipality utilized the ratio method, i.e., the levels and trends in the ratios of the population of the city/municipality to the population of their respective provinces as observed in the previous censuses. The derived rations were then projected on the assumption that stability in the trends will be attained after some time. Moreover, 45,000 persons per square kilometer was used as a cap on the maximum population density of any city or municipality.

The cities and municipalities comprising the West zone were classified according to the trend of their ratios as observed in 1990, 1995, 2000, and 2007 and is presented in Table 2-2. The NSO classified the cities/municipalities into four (4) types, as follows:

- **TYPE I** – cities and municipalities that showed unidirectional trend in their ratios (either increasing or decreasing) throughout the observation period
- **TYPE II** – cities and municipalities that had unidirectional trends only during the last two (2) intercensal period
- **TYPE III** – cities and municipalities that had unidirectional trends only during the first two (2) intercensal periods
- **TYPE IV** – cities and municipalities with erratic trends

For each type of city/municipality, the initial rates at which the ratios will change were computed in accordance with the formula suggested by the NSO.

**Table 2 - 2: Historical Ratio of the Population of the City/Municipality to NCR/Cavite**

| City/Municipality | Ratio of the Population to NCR/Province | | | | Type |
|---|---|---|---|---|---|
| | 1990 (May 1) | 1995 (Sep 1) | 2000 (May 1) | 2007 (Aug 1) | |
| *NCR* | *67.86%* | *68.01%* | *68.31%* | *68.25%* | |
| Manila (part) | 18.11% | 15.74% | 14.26% | 12.93% | I |
| Quezon City (part) | 12.93% | 12.96% | 14.30% | 15.63% | I |
| Caloocan | 9.60% | 10.82% | 11.86% | 11.93% | I |
| Malabon | 3.52% | 3.68% | 3.41% | 3.15% | II |
| Navotas | 2.36% | 2.42% | 2.32% | 2.12% | II |
| Valenzuela | 4.28% | 4.62% | 4.89% | 4.92% | I |
| Las Pinas | 3.74% | 4.37% | 4.76% | 4.61% | IV |
| Makati (part) | 0.79% | 0.71% | 0.59% | 0.75% | III |
| Muntinlupa | 3.50% | 4.23% | 3.82% | 3.92% | IV |
| Paranaque | 3.88% | 4.14% | 4.53% | 4.78% | I |
| Pasay City | 4.63% | 4.32% | 3.57% | 3.49% | I |
| *CAVITE* | *39.65%* | *41.12%* | *37.27%* | *35.31%* | |
| Bacoor | 13.86% | 15.64% | 14.82% | 15.44% | IV |
| Cavite City | 7.95% | 5.78% | 4.82% | 3.66% | I |
| Imus | 7.99% | 11.07% | 9.47% | 8.86% | II |
| Kawit | 4.14% | 3.55% | 3.04% | 2.67% | I |
| Noveleta | 1.77% | 1.70% | 1.55% | 1.38% | I |
| Rosario | 3.94% | 3.37% | 3.57% | 3.30% | IV |
| *OVERALL* | *63.9%* | *64.1%* | *63.0%* | *61.7%* | |

The latest available official population projection at the national, regional and provincial levels covering the years 2000-2040 was prepared by the NSO utilizing the Cohort-component method. This methodology is based on the fact that the population change is a factor of three demographic processes namely: fertility, mortality and migration. The base population used in this projection was the population enumerated during the 2000 Census of Population and Housing.

There is no official government population projection yet based on the 2007 Census. These projected growth rates were used as guideline values in the population projections in this business plan to ensure that its results are consistent with official government projections.
presents projected growth rates of the NCR and province of Cavite.

**Table 2 - 3: Projected Annual Growth Rates**

| Region/ Province | Projected Annual Growth Rates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2005-2010 | 2010-2015 | 2015-2020 | 2020-2025 | 2025-2030 | 2030-2035 | 2035-2040 |
| NCR | 1.38% | 1.13% | 0.89% | 0.68% | 0.49% | 0.29% | 0.07% |
| Cavite | 3.11% | 2.67% | 2.43% | 2.21% | 1.95% | 1.70% | 1.45% |

The table shows that the projected growth rate in both the NCR and the province of Cavite will decrease over time from 1.38% to 0.07% and 3.11% to 1.45% in the NCR and the province of Cavite respectively from 2005 to 2040.

Table 2-4 presents the population projection from 2007 to 2022. The table shows that the population in many of the cities/municipalities within Maynilad's service area will continue to increase over time.

**Previous Studies and Reports on Population Projection**

Previous master plans, studies and reports containing data and projections for the MWSS Service Area were reviewed. They were compared for methodology used, proximity of projections to actual census (particularly for the earlier Master Plans) and consistency with this Study's predictions.

The ratio method has been commonly used by previous Master Plans for projecting the sub-national level populations. This is also the most widely used method in many countries because of the lack of appropriate methods yet available to project smaller areas. The ratio method simply means that the sum of the component areas cannot be more than the larger area (i.e. national), which makes use of more accurate estimates such as the rate of birth, death and migration.

It can also be observed, that the projections of the earlier years or the ones closest to the next census of the base year are very close to the actual census of that year and the variance becomes wider as the projections become longer. Hence, this Study's projections were made with precautions that the latter year projections might actually be higher than the actual population for those years and hence, careful study of other parameters such as land use trends and densities were made to compensate for the limitations of the methodology used for predicting future populations of smaller areas.

C

## Table 2 - 4: Population Projection at MWSI Service Area (2008-2022)

| City/ Municipality | Year | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
| *NCR* | *8,036,103* | *8,136,291* | *8,235,690* | *8,324,092* | *8,413,692* | *8,504,508* | *8,597,318* | *8,689,852* | *8,765,928* | *8,842,854* | *8,920,639* | *8,999,293* | *9,078,826* | *9,142,557* | *9,206,862* |
| Manila | 1,499,626 | 1,499,626 | 1,499,626 | 1,499,626 | 1,499,626 | 1,499,626 | 1,499,626 | 1,499,626 | 1,499,626 | 1,499,626 | 1,499,626 | 1,499,626 | 1,499,626 | 1,499,626 | 1,499,626 |
| Quezon City | 1,849,253 | 1,880,191 | 1,910,949 | 1,938,675 | 1,966,805 | 1,995,342 | 2,024,293 | 2,053,664 | 2,078,179 | 2,102,986 | 2,128,089 | 2,153,492 | 2,179,198 | 2,220,191 | 2,221,386 |
| Caloocan | 1,413,929 | 1,439,339 | 1,464,652 | 1,487,639 | 1,510,987 | 1,534,702 | 1,558,789 | 1,583,254 | 1,603,920 | 1,624,857 | 1,646,066 | 1,667,552 | 1,689,319 | 1,707,362 | 1,725,599 |
| Malabon | 370,264 | 374,250 | 378,165 | 381,497 | 384,860 | 388,252 | 391,673 | 395,125 | 397,723 | 400,337 | 402,969 | 405,617 | 408,284 | 410,162 | 412,048 |
| Navotas | 250,086 | 253,081 | 256,030 | 258,582 | 261,159 | 263,762 | 266,391 | 269,046 | 271,107 | 273,183 | 275,276 | 277,384 | 279,509 | 281,079 | 282,659 |
| Valenzuela | 581,601 | 590,248 | 598,817 | 606,440 | 614,160 | 621,979 | 629,897 | 637,916 | 644,462 | 651,075 | 657,757 | 664,506 | 671,325 | 676,737 | 682,193 |
| Las Pinas | 542,974 | 549,831 | 556,594 | 562,490 | 568,447 | 574,468 | 580,552 | 586,701 | 591,540 | 596,419 | 601,338 | 606,297 | 611,298 | 615,070 | 618,866 |
| Makati | 89,098 | 90,379 | 91,646 | 92,385 | 93,130 | 93,880 | 95,400 | 95,400 | 95,400 | 95,400 | 95,400 | 95,400 | 95,400 | 95,400 | 95,400 |
| Muntinlupa | 462,581 | 469,005 | 475,358 | 480,965 | 486,637 | 492,377 | 498,184 | 504,060 | 508,788 | 513,560 | 518,378 | 523,240 | 528,148 | 531,969 | 535,817 |
| Paranaque | 565,788 | 575,021 | 584,194 | 592,440 | 600,804 | 609,285 | 617,886 | 626,609 | 633,857 | 641,189 | 648,605 | 656,108 | 663,697 | 669,860 | 676,081 |
| Pasay City | 410,903 | 415,321 | 419,659 | 423,352 | 427,077 | 430,835 | 434,626 | 438,451 | 441,327 | 444,222 | 447,136 | 450,070 | 453,022 | 455,101 | 457,188 |
| *CAVITE* | *1,052,380* | *1,081,027* | *1,109,383* | *1,135,904* | *1,163,100* | *1,190,990* | *1,219,590* | *1,248,922* | *1,276,175* | *1,304,064* | *1,332,603* | *1,361,809* | *1,391,697* | *1,419,465* | *1,447,826* |
| Bacoor | 463,047 | 478,514 | 493,971 | 508,856 | 523,778 | 539,349 | 555,383 | 571,893 | 587,412 | 603,351 | 619,723 | 636,539 | 653,811 | 670,020 | 686,630 |
| Cavite City | 107,968 | 109,772 | 111,507 | 113,047 | 114,608 | 116,191 | 117,795 | 119,422 | 120,872 | 122,340 | 123,825 | 125,329 | 126,851 | 128,211 | 129,586 |
| Imus | 262,286 | 267,606 | 272,780 | 277,476 | 282,253 | 287,112 | 292,054 | 297,082 | 301,643 | 306,274 | 310,976 | 315,750 | 320,598 | 325,000 | 329,464 |
| Kawit | 79,561 | 81,581 | 83,571 | 85,417 | 87,305 | 89,233 | 91,205 | 93,219 | 95,079 | 96,975 | 98,909 | 100,882 | 102,894 | 104,750 | 106,640 |
| Noveleta | 41,063 | 42,254 | 43,436 | 44,545 | 45,683 | 46,850 | 48,086 | 49,274 | 50,416 | 51,586 | 52,782 | 54,006 | 55,259 | 56,424 | 57,614 |
| Rosario | 98,456 | 101,298 | 104,117 | 106,762 | 109,474 | 112,255 | 115,107 | 118,031 | 120,754 | 123,539 | 126,388 | 129,303 | 132,285 | 135,059 | 137,891 |
| *OVERALL* | *9,088,483* | *9,217,318* | *9,345,073* | *9,459,996* | *9,576,793* | *9,695,498* | *9,816,909* | *9,938,773* | *10,042,103* | *10,146,918* | *10,253,242* | *10,361,102* | *10,470,524* | *10,562,022* | *10,654,688* |

**Opportunities for Sewerage and Sanitation Sector Development**

Approximately 19.4 Million persons or approximately 4.3 Million families will need potable water supply and sewerage services within the MWSS Service Area by 2025. At present, the level of population served by water is about 7.3 Million with total service connections of about 780,000. Only about 15% of these water connections are sewered.

The projected population will be housed in existing residential areas and in the development of new high-density residential/commercial use spaces. Most of the LGUs are planning for medium-density socialized housing for low-income groups that will decide to stay within the region.

There will also be a general increase in commercial and industrial uses that will be requiring new water supply and sewerage systems. Industrial activities within the NCR will likely be of the small and light industries and the large, heavy industries will be relocating outside the region, most likely towards Rizal, Cavite and the adjoining provinces.

Transport projects that will link NCR with Cavite are already underway. This will increase the movement and flow of people and goods within the Service Area and will likely promote more development within the planning period.

The new infrastructure systems required for these anticipated developments may be developed on land that is still available if the government is able to secure them as soon as possible. At least 27% of the total area in Metro Manila is proposed as open space in the individual CLUPs of the different LGUs. These maybe recovered from lands that will be vacated by resettled families, enforcement of easements along rivers and opening up of abandoned and derelict industrial areas.

### 2.2.2 Land Use

**Existing and Proposed Land Uses in NCR and Cavite**

A large portion of the MWSS service area is composed mainly of built-up areas specifically in the central and southern service area and some areas in the north. The built-up areas that include residential, commercial, industrial, institutional and related infrastructure make up about 40% of the MWSS service area. The rest, which lies mostly in the northeastern portion of Rizal, is made up of agriculture, forest, open grassland and some mining/quarrying activities.

The land use trend in the NCR has largely been a response to socio-economic demands of a growing population and not necessarily according to plan. Four trends have been identified to characterize land use in the region:

- Increased density and size of squatter settlements in city centers;
- Development of medium-scale residential subdivisions for the upper and upper-middle income markets up to the peripheries of the inner and intermediate cores; while low-cost housing has moved to the outer core in the provinces of Rizal, Bulacan, Cavite and Laguna.
- The growth of big commercial centers along EDSA and other major thoroughfares; and
- Infilling of the urban area with high-density housing.

Figure 2-5 shows the summary of existing land uses in the NCR.

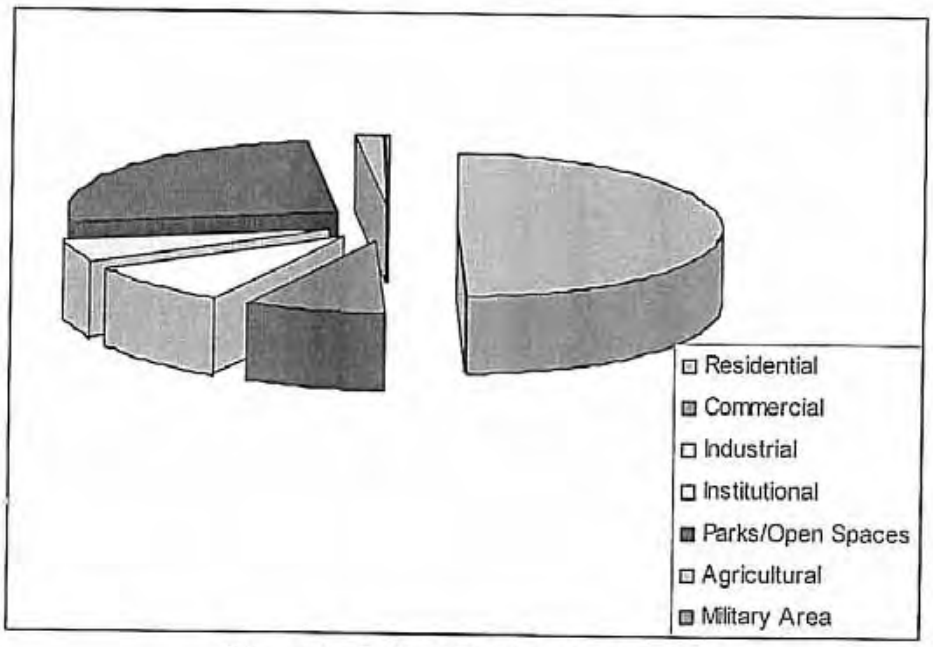



**Figure 2 - 5: Existing Land Uses for NCR**

The Cavite Service Areas have become highly urbanized in the past 20 years because of their proximity to Metro Manila. The largely agro-fishery base of the area was lost to residential, commercial, industrial and institutional uses. The rapid urbanization was also due to the resettlement of informal settlers in Metro Manila by the National Housing Authority in Cavite in the late 1980s. Among the Cavite Service Areas, Imus – the provincial capital has the biggest land area, followed by Bacoor and then Rosario. The smallest is Noveleta. These are all along the coast of Manila Bay.

The residential area has increased over the years, due to the conversion of agricultural lands into residential uses resulting from increased demand for urban land brought about by high population growth. Most subdivisions in the northern portions of Bacoor are now being developed for high- and medium- cost housing while those located on the southern portion are mostly for medium- and low-cost housing. The residential area covers an area of about 6,326 ha or about 30% of the total land area of the six LGUs.

**Proposed Land Use and Urban Trends**

Metro Manila studies show that, historically, the strongest directions of growth have been towards the northeast, or Quezon City and the south, or Muntinlupa. These growth directions, moreover, appear to be canceling each other out, thereby leaving what planners call a "net eastward" movement in the center of the metropolitan population.

Physical development will encroach and intensify potentially in the watershed areas in Quezon City and Marikina Valley, towards Rizal. Rizal province has been experiencing approximately 10% growth rate over the last decade and densities, particularly in the municipalities of Cainta and Taytay are increasing.

People form an important link between the national capital region and the adjoining provinces of Rizal and Cavite more so as the trend to relocate residences to areas outside Metro Manila continues. The people who live in these areas form a "transient" link between their place of work and the urban core. This arrangement also works the other way around. As industries relocate away from the urban core, the population becomes more transitory, traveling back and forth from their residences to their workplace, particularly since mass transport systems are being developed to further increase the link in these areas.

It is anticipated that the transient character of the workforce in both provinces and Metro Manila would subsequently be absorbed by both areas as expansion of human settlements and industries occur on the plane of reciprocity and integration.

Available data on Metro Manila shows that in view of limited urban land resources, the trend for land development – particularly for human settlements – is to move outwards beyond the region's boundaries. According to the most recent MMDA study, there are four emerging development trends within the NCR:

- There are built-up areas within the NCR wherein the uses of certain physical infrastructures could not be maximised and are thus, suitable for redevelopment and alternative land use activities;

- There are areas in Metro Manila where physical development vis-à-vis population density has reached a level wherein additional land using activity will result in negative or adverse effects. Here, further development has to be deferred to deter additional pressure on existing amenities and infrastructure support facilities;

- There are ecologically-sensitive areas in the region which require special types of development that would ensure sustainability and prevent unnecessary loss of life and property due to disasters and adverse effects of pollution; and

- In view of expansion of land development towards Metro Manila's outer core, there is the need to plan and regulate such development to ensure that the carrying capacities of resources therein are respected.

For squatter colonies, the immediate option is resettlement in suburban resettlement areas or sites outside the metropolis. The municipality of San Juan is already undertaking a Resettlement Program in Taytay, Rizal and the Pasig River Project will be relocating squatters along Pasig River in Montalban, Rizal. Other squatter areas, particularly those that will be affected by major infrastructure projects such as the Northrail and McArthur Highway expansion projects will also be relocated within the region, in Bulacan or Rizal.

The difference between the existing and proposed land uses in Metro Manila as reflected in the Comprehensive Land Use Plans (CLUPs) of the LGUs is shown in Figure 2-6.

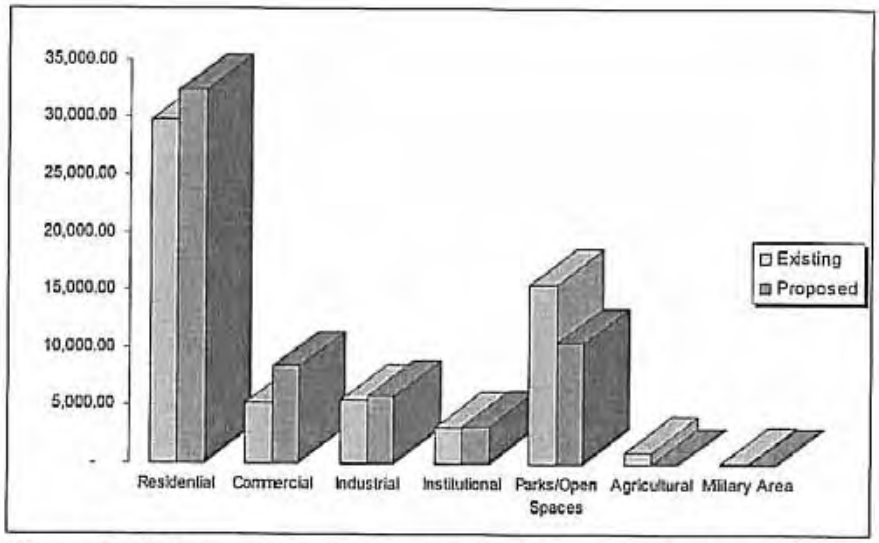



**Figure 2 - 6: Difference between existing and proposed land uses, NCR**

The CLUPs of the Cavite Service Areas are proposing further expansion of the built-up areas except for Kawit, Rosario and. Based on the increasing trend of population in these areas and their adjoining LGUs, it is projected that their built up areas will likewise increase.

Proposed total residential area in the Cavite Service area is estimated to be more than 70 sq.km. or about 40% of the service area's total area – an increase of about 15 % from the existing area devoted to residential.

Commercial land uses will be doubled within the Service Area with the highest commercial land area located in Bacoor.

Most of the municipalities within the Service Area are reducing their industrial land area allocation except for Cavite City which is planning to allocate 98 ha or an increase of 270 percent from the present area allocated for industrial uses. This results in a net increase of industrial areas within the Service Area.

**Availability of Open Space and Vacant Lot for Sewerage and Sanitation Requirements**

In the proposed/approved land use plans in NCR, there are about 10,700 ha of open spaces available which are mostly concentrated in Quezon City and Manila. These are planned for various uses. Most of the cities/municipalities within the region are also planning to enforce the buffer/easement along the riverways and railways which can be developed for public utilities such as treatment plants. Moreover, derelict or abandoned industrial areas scattered around the region can be recovered for other uses such as sewage treatment plants (STPs).

The Pasig River Rehabilitation Commission (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.

The approved/proposed land uses within the MWSS service area provides for a general increase in residential, commercial and industrial area with the residential area increasing with a higher rate than the two other uses. This implies increased water needs and wastewater production in all three major activities. It is estimated that domestic water supply will have a higher proportion than industrial water supply requirements not only because of the high growth rate in residential areas but also because most LGUs in NCR are also limiting their industrial development to light industries which have limited water consumption. In certain areas of the NCR, particularly the cities of Manila, Quezon, Makati, Pasig, Mandaluyong and Las Piñas as well as the municipality of San Juan, industrial activities will be reduced to pave way for the creation of new residential/commercial developments. These new developments will require new infrastructure systems.

New infrastructure systems may be easier installed in Rizal than in the NCR and Cavite province because the density and intensity of development there are still lower. For the latter areas, several issues such as higher costs, traffic congestion, informal settlers relocation and a host of other issues may confront development/installation of new systems particularly sewerage. Further, the Manila Third Sewerage Project (MTSP) report correctly observes that there might be a resistance in putting-up new sewerage systems, particularly STPs in these new residential/commercial areas. In general, industrial zones are considered to be more "compatible" with STP operations.

### 2.2.3 Drainage System as a Major Component of Sewerage and Sanitation

The topography of much of the Metro Manila area is generally flat and stormwater drains slowly during rainfall. Stormwater finds its way into rivers and esteros. The esteros resemble open canals with variable cross-sections, frequently clogged with silt, sediments, solid waste and water hyacinths. In many instances, squatters build houses on stilts over much of these waterways and the esteros become effectively open sewers. Stagnant water and garbage in the esteros serve as ideal breeding grounds for flies and mosquitoes.

As discussed below most of the waste disposal systems (septic tanks) connect to local drains or storm drains and canals. These drains discharge to rivers and esteros and add to the pollution due to the open dumping of solid waste. The water in the esteros during the dry season is generally septic.

Local flooding of these polluted water bodies is also a public health risk and flood control programs being implemented by the LGUs, MMDA and DPWH must be coordinated with the sewerage and sanitation programs to maximise the positive impact on public health. Road construction has in places intensified flooding problems on a local scale due to the practice of elevating streets above stormwater levels. In many instances, inadequate or clogged drainage facilities aggravate the flooding problems in the low-lying areas, especially in the low income/blighted areas.

Local drains are likely to form an important element of the sewerage/sanitation strategy at least for a significant period of the master plan study. Improving the condition of the drainage network to prevent flooding is therefore a key strategy to enable improvements in public health to ensue from implementation of this master plan.

If local drains are to be used as combined sewers to transport septic effluent in the early stages of the master plan, it is important to prioritize drainage improvements in the currently flood-prone areas or provide separate sewerage systems in these areas to ensure sewage is not discharged into the streets during the rainy season. MMDA and DPWH have implemented major drainage projects in the past such as the Mangahan floodway and the Napindan hydraulic control structure that has mitigated the flooding problem in the metropolis.

### 2.2.4 Major River Systems in the MWSI Service Area

There are four main river systems in the MWSI Service Area. Three of which are in Metro Manila, namely, Pasig River, Navotas-Malabon-Tullahan-Tenejeros River Systems, and Parañaque-Zapote River Systems. The fourth river system in the MWSI Service Area is the Imus River in Cavite.

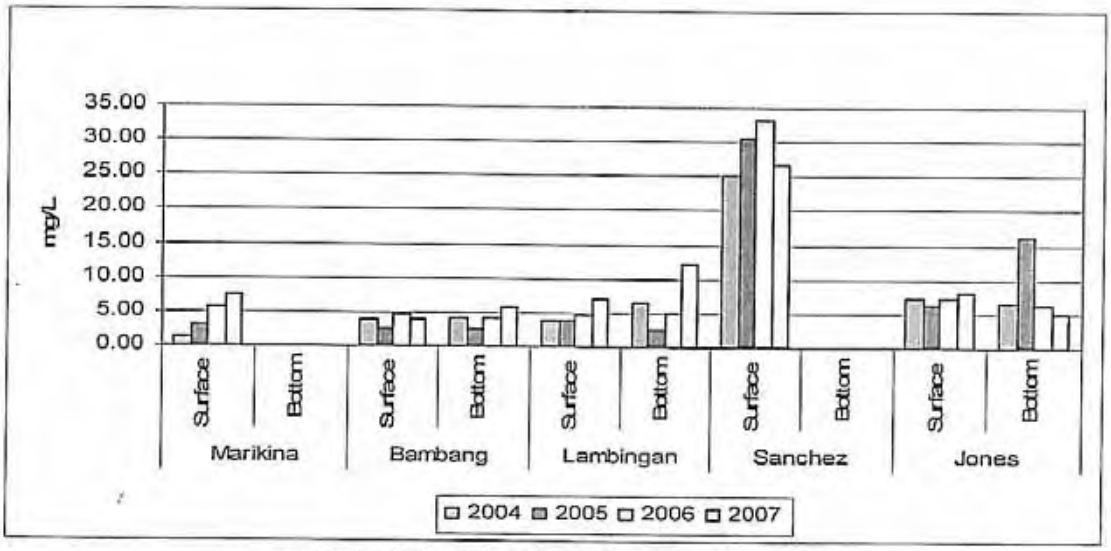
The water quality of the water bodies in the Metro Manila has progressively deteriorated due to domestic, industrial and agricultural wastes being dumped uncontrollably in the waterways. The present state of the river systems is being attributed to inadequate drainage facilities, wastewater collection and disposal facilities.

Pasig River System

The Pasig River is the main waterway passing through Metro Manila. It connects Laguna Lake, the largest freshwater lake in Southeast Asia, to Manila Bay, by means of the river's main channel and tributary rivers and creeks. The Pasig River has four major tributaries which are the rivers of San Juan, Marikina, Napindan and Pateros-Taguig. Forty-three canals or creeks, on the other hand, were identified as its minor tributaries. The San Juan River, which drains most of Quezon City, joins the Pasig River about 9 kilometers upstream of Manila Bay. The Marikina River, originating in the Sierra Madres, joins the Pasig River about 19 kilometers upstream of Manila Bay.

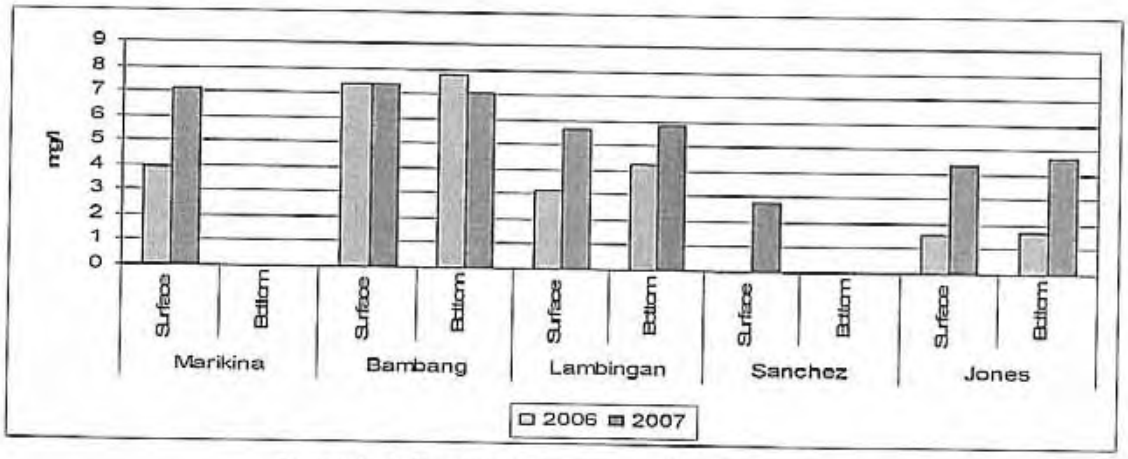
The Pasig River is now one of the world's most polluted river systems. Existing informal settlers along the river banks, solid waste silted at the river bed, and uncontrolled disposal of solid waste and domestic and industrial wastewater have contributed to the degraded water quality of Pasig River.

Figures 2-7, 2-8, and 2-9 present the quality of the river system as presented by the Pasig River Rehabilitation Commission for its 2008 report. The quality of the river system was assessed from five stations. Three of which, Jones, Sanchez and Lambingan sampling stations, are located in and at the boundary of the MWSI Service Area.



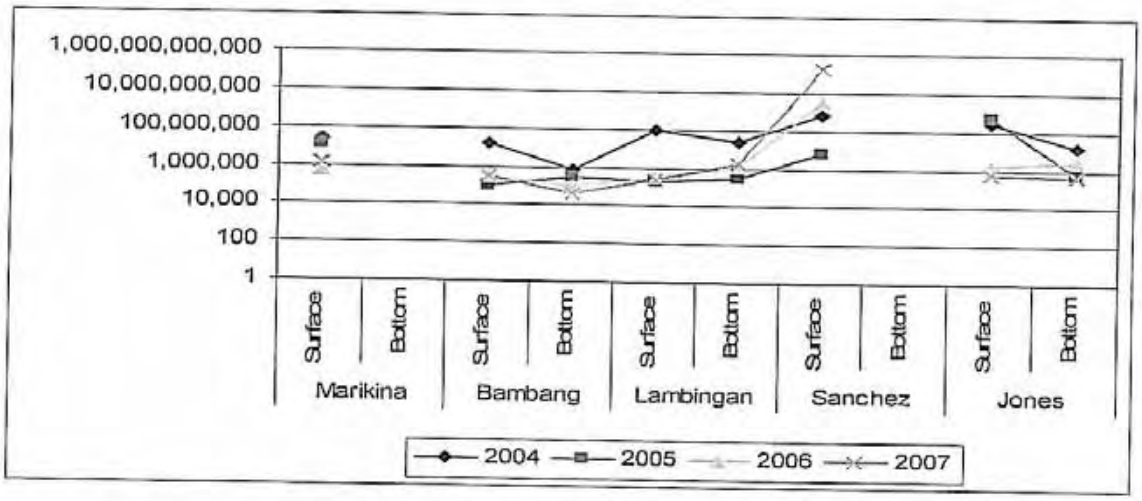

Source: Pasig River Rehabilitation Commission Report, 2008

**Figure 2 - 7: BOD Levels at Various Sampling Points at the Pasig River System**




Source: Pasig River Rehabilitation Commission Report, 2008

**Figure 2 - 8: DO Levels at Various Sampling Points at the Pasig River System**




Source: Pasig River Rehabilitation Commission Report, 2008

**Figure 2 - 9: Coliform Levels at Various Sampling Points at the Pasig River System**

The applicable DENR standards used for the river quality monitoring are ≤7 mg/L for BOD, ≥5 mg/L for DO, and 5000 MPN/L for total coliform. Data gathered by the PPRC in 2007 shows that the average water quality at both Lambingan and Sanchez Station failed the BOD and DO standards. While the average water quality at Jones Station comply to the BOD standard but do not meet the DO standards. Moreover, the qualities of water at all stations exceed the total coliform standards.

The quality of the Pasig River System was also assessed based on its heavy metal concentrations. Table 2-5 shows the gathered data.

**Table 2 - 5: Heavy Metal Concentrations at Various Sampling Points at the Pasig River System (2007)**

| Station | Cadmium | Chromium | Copper | Lead | Nickel | Zinc | Mercury |
|---|---|---|---|---|---|---|---|
| Marikina | 0 | 45.00 | 112.33 | 25.67 | 33.60 | 205.500 | 0 |
| Bambang | 0 | 29.27 | 99.00 | 65.67 | 18.35 | 264.830 | 0 |
| Lambingan | 0 | 42.17 | 109.17 | 37.83 | 42.17 | 246.83 | 0.11 |
| Sanchez | 0 | 51.50 | 167.50 | 180.00 | 32.83 | 948.83 | 0.42 |
| Jones | 0 | 35.33 | 110.50 | 55.33 | 26.10 | 404.67 | 0.19 |

For this sampling, the comparative standards used by PPRC was the Interim Sediment Quality Values of Hong Kong (HK-ISQV) which specified the lower limits for the heavy metals as 1.5 mg/kg for cadmium, 80 mg/kg for chromium, 65 mg/kg for copper, 75 mg/kg for lead, 40 mg/kg for nickel, 200 mg/kg for zinc, and 0.28 mg/kg for mercury.

It is also important to note that the very poor water quality condition of San Juan River, a major tributary of Pasig River has been a major factor affecting the pollution load of Pasig River. San Juan River receives most domestic, commercial and industrial wastewater flow from San Juan and most of Quezon City, which are still largely not sewered. Table 2-6 presents the water quality of San Juan River based on the sampling conducted by PPRC.

**Table 2 - 6: Water Quality of San Juan River at Various Sampling Points (2007)**

| Sampling Station | Total Coliform, MPN/100ml | Fecal Coliform, MPN/100 ml | DO, mg/L | BOD, mg/L |
|---|---|---|---|---|
| Kalentong Creek | 24,000,000 | 8,000,000 | 1.83 | 50 |
| Market Place | 90,000,000 | 2,400,000 | 1.78 | 58 |
| Maytunas Creek | 90,000,000 | 28,000,000 | 1.78 | 56 |
| Ermitaño Creek | 50,000,000 | 5,000,000 | 1.76 | 16 |
| Kamias Creek | 50,000,000 | 17,000,000 | 1.65 | 30 |
| Diliman Creek | 30,000,000 | 11,000,000 | 1.67 | 14 |
| San Francisco Creek | 50,000,000 | 11,000,000 | 1.69 | 26 |
| DENR Standard | 5000 | 400 | $\geq 5$ | $\leq 7$ |

<u>Navotas-Malabon-Tullahan-Tenejeros (NMTT) River System</u>

NMTT is also one of the heavily polluted bodies of water in the country and which also runs through the MWSI Service Area. As based on the Philippines Environment Monitor 2000, NMTT River System along with the Rivers of San Juan, Malabon and Parañaque-Zapote River System has deteriorated over time because of the indiscriminate dumping of raw sewage. Table 2-7 shows the DO levels of NMTT River System from 1980 to 1998.

**Table 2 - 7: DO Levels of Navotas-Malabon-Tenejeros-Tullahan River**

| | DO Level, mg/L |
|---|---|
| 1980s | 6.0 |
| 1991-1995 | 4.5 |
| 1997 | 0 – 6.7 |
| 1998 | 0.1 – 4.7 |

Source: Philippine Environment Monitor, 2000 World Bank

Parañaque-Zapote River System

The Parañaque-Zapote River System passes through the Cities of Pasay, Parañaque and Las Piñas. The following tables show the quality of the river system based on DO, BOD and total suspended solids (TSS). Sampling was conducted by DENR at various points of the river.

**Table 2 - 8: DO Levels in Parañaque-Zapote River System, mg/L (2000)**

| Station | Jan | Feb | Mar | Apr | May | Jun | July | Aug | Sep | Oct | Nov | Dec | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tramo, Pasay | NS | 0.21 | NS | 0.0 | 0 | 0.1 | 0.9 | 1.3 | 1.2 | 0 | NS | 0 | 0.4 |
| MIA Road, Pasay | NS | 0.06 | NS | 3.8 | 0 | 0 | 0.0 | 0.0 | 1.0 | 0 | NS | 0.0 | 0.5 |
| La Huerta, Parañaque | NS | 0.51 | NS | 12.0 | 0 | 4.0 | 13.4 | 0.0 | 2.8 | 0 | NS | 0 | 3.6 |
| Parañaque City | NS | 4.89 | NS | 3.6 | 0 | 1.0 | 9.5 | 4.0 | 5.4 | 0 | NS | 4.2 | 3.6 |
| Zapote, Las Piñas | NS | 0.1 | NS | 0.0 | 0 | 0.8 | 9.4 | 1.2 | 1.6 | 0 | NS | 0 | 1.5 |
| Quirino, Parañaque | NS | NS | NS | 12.0 | 0 | 2.0 | 11.4 | 0.0 | 0.6 | 0 | NS | 0.0 | 3.3 |
| Monthly Average | NA | 1.15 | NA | 5.2 | 0 | 1.3 | 7.4 | 1.1 | 2.1 | 0 | NA | 0.7 | 2.1 |

Source: Comprehensive Land Use Plan of Pasay City: Socio-Economic Profile, 2000
NS – not sampled; NA – not applicable

**Table 2 - 9: BOD Levels in Parañaque-Zapote River System, mg/L (2000)**

| Station | Jan | Feb | Mar | Apr | May | Jun | July | Aug | Sep | Oct | Nov | Dec | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tramo, Pasay | NS | 10 | NS | 15 | 32 | 17 | 26 | 23 | 6 | 23 | NS | 17 | 19 |
| MIA Road, Pasay | NS | 17 | NS | 15 | 38 | 12 | 17 | 32 | 10 | 23 | NS | 13 | 20 |
| La Huerta, Parañaque | NS | 16 | NS | 11 | 39 | 16 | 13 | 32 | 4 | 27 | NS | 20 | 20 |
| Parañaque City | NS | 7 | NS | 22 | 29 | 17 | 26 | 33 | 13 | 14 | NS | 10 | 19 |
| Zapote, Las Piñas | NS | 30 | NS | 32 | 39 | 5 | 12 | 16 | 8 | 21 | NS | 33 | 22 |
| Quirino, Parañaque | NS | NS | NS | 3 | 23 | 14 | 12 | 33 | 2 | 23 | NS | 15 | 16 |
| Monthly Average | NA | 16 | NA | 16 | 33 | 14 | 18 | 28 | 7 | 22 | NA | 18 | 19 |

Source: Comprehensive Land Use Plan of Pasay City: Socio-Economic Profile, 2000
NS – not sampled; NA – not applicable

**Table 2 - 10: TSS Levels in Parañaque-Zapote River System, mg/L (2000)**

| Station | Jan | Feb | Mar | Apr | May | Jun | July | Aug | Sep | Oct | Nov | Dec | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tramo, Pasay | NS | 20 | NS | 20 | 10 | 10 | 20 | 30 | 40 | 40 | NS | 30 | 24 |
| MIA Road, Pasay | NS | 20 | NS | 80 | 30 | 20 | 30 | 30 | 40 | 40 | NS | 20 | 34 |
| La Huerta, Parañaque | NS | 30 | NS | 100 | 30 | 10 | 30 | 20 | 30 | 40 | NS | 40 | 37 |
| Parañaque City | NS | 20 | NS | 70 | 30 | 20 | 20 | 30 | 30 | 30 | NS | 20 | 30 |
| Zapote, Las Piñas | NS | 30 | NS | 60 | 20 | 10 | 70 | 30 | 30 | 30 | NS | 40 | 36 |
| Quirino, Parañaque | NS | NS | NS | 50 | 10 | 20 | 50 | 40 | 40 | 30 | NS | 20 | 33 |
| Monthly Average | NA | 21 | NA | 63 | 22 | 15 | 37 | 30 | 35 | 35 | NA | 28 | 32 |

Source: Comprehensive Land Use Plan of Pasay City: Socio-Economic Profile
NS – not sampled; NA – not applicable

The applicable DENR standards for the sampling conducted are ≥5 mg/L for DO, ≤7 mg/L for BOD, and not more than 30 mg/L increase for TSS. In comparison with the tabulated data, Parañaque-Zapote River System falls below the DO standard and is above the BOD standard.

**Imus River System**

Imus River has shown a significant sign of improvement in its water quality from 2003 to 2005. As based on the National Water Quality Status Report of EMB (2001-2005), its DO level has increased from 3.0 mg/L in 2003 to 5.3 mg/L in 2005.

Together with the river systems of Pasig, NMTT and Parañaque-Zapote, Imus River is included in the Operational Plan for the rehabilitation of Manila Bay.

### 2.2.5 Existing Sanitation Condition in MWSI Service Area

According to the NSO 2000 Census of Population and Housing, about 84% of the households in Metro Manila have septic tanks but maintenance is poor and inadequate. For both Rizal and Cavite provinces, about 72 % have septic tanks. The use of septic tanks is specified in the National Plumbing Code for those not connected to a sewerage system. Table 2-11 below shows that the estimated number of households in the MWSS service area was about 2.17 million in the year 2000.

Table 2 - 11: Population and Number of Households with Septic Tanks (NSO 2000)

| City/ Province/ Municipality | Population | Number of Household | Household with Septic Tanks | Average Household | % Household with Septic Tank |
|---|---|---|---|---|---|
| *NCR* | *9,862,978* | *2,132,989* | *1,798,672* | *4.60* | *84* |
| Manila | 1,568,092 | 333,547 | 294,902 | 4.70 | 88 |
| Caloocan | 1,174,673 | 249,567 | 212,939 | 4.71 | 85 |
| Las Piñas | 470,154 | 97,962 | 74,769 | 4.80 | 76 |
| Makati | 442,144 | 103,981 | 95,267 | 4.50 | 92 |
| Mandaluyong | 275,106 | 59,628 | 52,284 | 4.61 | 88 |
| Marikina | 389,763 | 80,160 | 70,111 | 4.86 | 87 |
| Muntinlupa | 370,333 | 78,016 | 55,910 | 4.75 | 72 |
| Parañaque | 446,766 | 94,109 | 76,840 | 4.75 | 82 |
| Pasay | 353,798 | 78,180 | 70,692 | 4.53 | 90 |
| Pasig | 503,013 | 107,835 | 93,541 | 4.66 | 87 |
| Quezon | 2,158,367 | 480,624 | 408,548 | 4.49 | 85 |
| Valenzuela | 481,047 | 106,382 | 88,350 | 4.52 | 83 |
| Malabon | 336,516 | 74,137 | 63,726 | 4.54 | 86 |
| Navotas | 229,717 | 49,450 | 36,746 | 4.65 | 74 |
| Pateros | 57,172 | 12,029 | 10,921 | 4.75 | 91 |
| San Mateo | 117,398 | 24,605 | 22,887 | 4.77 | 93 |
| Taguig | 462,591 | 102,723 | 70,239 | 4.50 | 68 |
| *Cavite* | *768,923* | *163,865* | *117,902* | *4.70* | *72* |
| Bacoor | 305,699 | 64,067 | 47,897 | 4.80 | 75 |
| Cavite City | 99,367 | 21,342 | 15,324 | 4.70 | 72 |
| Imus | 195,428 | 42,232 | 31,095 | 4.60 | 74 |
| Kawit | 62,751 | 13,510 | 10,759 | 4.60 | 80 |
| Noveleta | 31,959 | 6,934 | 4,208 | 4.60 | 61 |
| Rosario | 73,665 | 15,780 | 8,619 | 4.70 | 55 |

Within the MWSI Service Area, the use of septic tanks is most likely to continue, particularly in those areas not covered by a sewerage system. Even with an existing sewerage system, customers are reluctant to connect to the sewers because of the additional 50% surcharge that is imposed on water bills for connected properties. Under existing conditions, the storm drainage system directly receives overflow of the septic tanks due to poor or non-existent absorption fields as shown in Figure 2-10. This is exacerbated by the design of some septic tanks that allows seepage from the bottom. The existing drainage system therefore often functions effectively as a "combined sewerage system."

Figure 2-10 also indicates the typical characteristics of sullage and septage. For those tanks not cleaned regularly, high strength septage may be discharged into the storm drains, instead of the sullage overflow from a correctly functioning septic tank.

It was estimated that 26 % of the existing septic tanks in Metro Manila (James Montgomery 1991) are inaccessible for desludging, primarily for the following reasons:

- Poor building practice (beneath other structures);
- Absence of manholes; and
- Access roads to the houses are too narrow.

In the willingness-to-pay survey conducted for MWSS in 2005, only 32% of respondents could recall having had their septic tank emptied. When asked whether their septic tank had a manhole for pumping out sludge, many appeared unaware, although 90% of those who answered the question, believed a manhole were available.

A number of master plans had been prepared since 1969 in order to address the sewerage and sanitation requirements of Metro Manila. However, none of these master plans was fully implemented due to mostly financial, social and institutional constraints. The delay in sewerage and sanitation development contributed to the rapid deterioration of the natural water systems in the region.

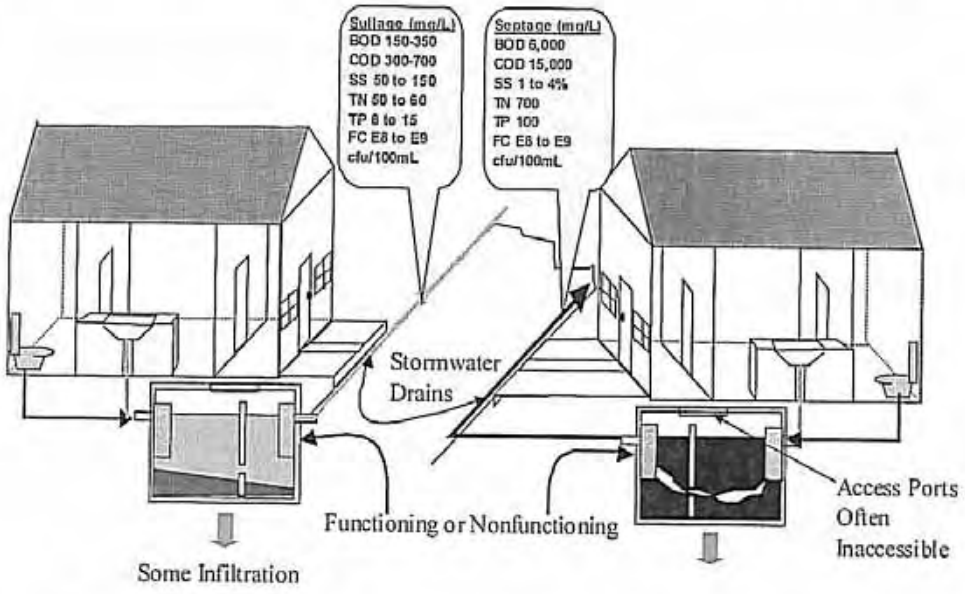



**Figure 2 - 10: Septic Tanks in an Urban Environment (SKM, 2005)**

In terms of sanitation service, MWSS provided limited desludging services while the private contractors provided the bulk of the desludging services. The main constraints in the desludging program were the inaccessibility of many septic tanks, unavailability of vacuum tankers and identifying sludge disposal sites acceptable to the DENR. Since September 1995, the only inland disposal site previously used by MWSS (near Marilao, Bulacan) became unavailable and the desludging work ceased. The MWSS equipment had also exceeded their useful life with the desludging units becoming only partly operational. Dagat-Dagatan was used for disposal of septage before it was rehabilitated in 2003.

## Sanitation Facilities

Maynilad is also operating sanitation facilities for the implementation of sanitation program of the company. Regular desludging of customers' septic tanks is being conducted once every 5-7 years to help in the reduction of pollution loading entering the public drain and waterways.

A septage treatment plant (STP) with capacity of 450 cubic meters per day was constructed as pilot plant under MSSP 2 project. It is located at the existing wastewater treatment site in Dagat-dagatan, Caloocan City. Regular desludging of customers' septic tanks is being conducted once every 5 to 7 years to help in the reduction of pollution loading entering public drain and waterways. All septage collected by vacuum vehicles is brought to this plant for dewatering and excluded sewage water during dewatering.

The STP is Certified ISO 9001:200 (Quality Management System) and ISO 14001:2004 (Environmental Management Systems). The plant was a recipient of Lopez Achievement Awards in 2006 for "Asset From Waste Project," and also of LLDA's "Blue Award" for consistently meeting the effluent standards.

Table 2-12 summarizes the technical information of the system.

**Table 2 - 12: Specification of the Maynilad's Septage Treatment Plant**

| | |
|---|---|
| **Capacity** | 450 $m^3$ |
| **Facility Components** | 2 acceptance units<br>400 cubic meter equalization tank<br>Polymer dosing unit<br>3 Dewatering system |
| **Equipment for Septage Collection from Septic Tanks** | Mobile Dewatering Unit (MDU)<br>Vaccum Truck Unit (VTU) |
| **Treatment Processes** | Screening<br>Grit Removal<br>Flocculation<br>Coagulation<br>Dewatering |
| **Sludge Quality** | 20 to 25% dry cakes |

Management of the septage sludge or biosolids produced by the STP involve utilization of the biosolids as soil conditioner in sugarcane plantations in Pampanga. Maynilad has provided sugar cane farmers in Floridablanca and Bacolor, Pampanga with 10,000 cubic meters of biosolids in 2006, and 6,000 cubic meters in 2007. To date, Maynilad is working on other beneficial uses of biosolids.

## MDU Operation

There are currently seven (7) MDU. These trucks can desludge and dewater the septage on-site. The dry septage or biosolids are temporarily stored at the Dagat-dagatan Sewage Treatment Plant and later hauled and disposed to farmlands in Pampanga.

**Vacuum Truck Operation**

There are six (6) units of 4 cubic meters and nineteen (19) units of 10 cubic meter capacity of VTU. Each 4 cubic meter VTU can desludge an average of 2 septic tanks per trip while each 10 cubic meter VTU can desludge an average of 4 septic tanks per trip.

Once the tank gets filled, the collected septage is discharged and processed at the Dagat-dagatan Septage Treatment Plant.

### 2.2.6 Existing Sewerage Facilities in MWSI Service Area

When the MWCI and MWSI Concessionaires took over the MWSS operations in August 1997, the environmental infrastructures of MWSS were inadequate. At that time, the areas with sewerage service represented less than 10 % of the total MWSS service area. The sewered areas were the Manila Central System, the Dagat-Dagatan System, the Magallanes System, and isolated systems in Quezon City.

**Error! Reference source not found.**13 presents the NHA Systems and the private systems within the West Zone.

**Table 2 - 13: NHA Systems in Metro Manila and Private Systems – West Zone**

| System/Location | Owner | Year Built | Service Area | Communal Septic Tank |
|---|---|---|---|---|
| 1. Tangos System, Daang Hari, Tangos, Navotas | NHA | 1980s | | Septic Tank |
| 2. Capri System, Novaliches, Quezon City | NHA | 1980s | | Septic Tank |
| 3. Maricaban System, Maricaban, Pasay City | NHA | 1980s | | Septic Tank |
| 4. Leveriza System, Malate, Manila | NHA | Now connected to Manila Central system | | |
| 5. Juan Luna System, Tondo, Manila | NHA | Now connected to Manila Central system | | |
| 6. Bangkal System, Bangkal, Pasay City | NHA | MWSS PROGRESS pilot project | | |
| 7. Quezon Institute, E.Rodriguez Ave, QC | Quezon Institute | | | Septic Tank |
| 8. Veterans Memorial Hospital, QC | Veterans Memorial | 1953-55 | 55 hectares; 200-600 mm diameter & 2,581 length | Septic Tank |
| 9. Philam Life, Las Piñas | Private | | | Imhoff Tank |

MWSI is responsible for operating the Central Sewerage System, the Dagat-Dagatan System and a portion of the Quezon City system. The Quezon City System consists of several communal septic tanks serving residential developments.

Prior to the completion of the septage treatment plant at Dagat-Dagatan, MWSI continued its collection, treatment, and disposal of septage using the Mobile Dewatering Units (MDU). Private contractors transported the dry sludge to lahar areas in Pampanga and Tarlac. Starting May 2005, the septage treatment plant in Dagat-Dagatan became operational and can treat 200 m3/day of septage. Seven MDUs and 25 vacuum tankers will be fully utilised in desludging activities.

As of July 2005, MWSI is in the final stage of Fertilizer and Pesticide Authority (FPA) registration. A pilot study is now on-going in Floridablanca in coordination with Luzon Agricultural Research Center (LAREC). MWSI intends to secure a permanent license as manufacturer-distributor similar to MWCI.

For the West Zone, the Maynilad took over the operations of three (2) sewerage systems (Central Sewerage System, and Dagat-Dagatan ) and communal system in Quezon City, with a total service area coverage of 3,270 ha and a total treatment capacity of 402.1 MLD.

As shown in Table 2-14, the existing sewerage systems comprised of only the three at the time of privatization.

**Table 2 - 14: Existing Sewerage Systems in Metro Manila**

| System | City/Municipality | Service Area (ha) | Remarks |
|---|---|---|---|
| Central System | Manila City | 2,620 | No treatment. Outfall to Manila Bay |
| Dagat-Dagatan System | Caloocan, Malabon, Navotas Manila | 333 | Only STP is turned over to MWSS |
| Communal System | Quezon City | 1000 | |
| *TOTAL* | | *4,553* | |

## Central Manila Sewerage System (CMSS)

Built in 1902, the Manila Central Sewerage System consists of two collection networks, one north and one south of Pasig River. It has about 305 km of sewer ranging in size from 125 mm to 1425 mm and seven lift stations, Legarda, Luneta, Malate, Paco, Port Area, Sta. Ana and Sta. Cruz.

The CMMS covers 70% of the total area of the city of Manila. The system currently serves around 47,000 sewer service connections. The wastewater generated within the area is collected through sewer service connections, conveyed to the Tondo terminal pumping station and pumped out to about 3.9 km away from the shore of Manila Bay through 1,800mm diameter sea outfall. The system is newly rehabilitated under MSSP-4 project funded by the World Bank.

Both networks end at the Tondo pumping station, which pumps the water through a 1800 mm outfall into Manila Bay. Screened raw wastewater is discharged through this outfall via a 300 mm diffuser

section at a depth of about 11 m. The design flow capacities of the Tondo Pumping Station are 5.0 m3/s at peak flow and 3.3 m3/s at average flow. Average flow equals 280 ML/s as designed.

The system has undergone three major rehabilitations. The last one was carried out in 2004 under the MSSP 4 and was funded by the World Bank. The works being implemented under the MSSP rehabilitation included (i) Improvement of the Tondo Pumping Station; (ii) Rehabilitation of all 7 Lift Stations; (iii) Sewer lines improvement consisting of cleaning and CCTV inspection and repair of sewer lines and raising of buried manholes; and (iv) Installation of 10,000 service connections. Notable in this program has been the difficulty in securing the new connections, with only 730 out of the proposed 10,000 having been installed as of September 2005.

Table 2-15 summarizes the technical information of the CMSS.

**Table 2 - 15: Specification of Central Manila Sewerage System**

| | |
|---|---|
| **Capacity** | 432,000 $m^3$/day |
| **Average Loading** | 100,000 $m^3$/day |
| **Facility Components** | 1800 mm diameter diffuser outfall which extends 3.5km offshore<br>300 km sewer network |
| • **Tondo Terminal Pumping Plant** | 2 units 750 kW variable speed pump<br>2 units 480 kW fixed speed pump<br>1 mechanical bar screen<br>1 mechanized bar screen |
| • **Lift Stations (7 stations)** | |
| **Sta. Cruz Lift Station** | 5 units 63 kW submersible pumps |
| **Legarda Lift Station** | 3 units 25 kW submersible pumps |
| **Port Area Lift Station** | 3 units 4.6 kW submersible pumps |
| **Luneta Lift Station** | 4 units 43 kW submersible pumps |
| **Malate Lift Station** | 4 units 43 kW submersible pumps |
| **Paco Lift Station** | 3 units 25 kW submersible pumps |
| **Sta. Ana Lift Station** | 3 units 25 kW submersible pumps |

<u>Dagat-Dagatan Sewerage System</u>

The Dagat-Dagatan Wastewater Treatment Plant (WWTP) was originally developed by the National Housing Authority (NHA) from 1979 to 1986 and featured lagoons made from the natural clay on-site. It has a 332 ha service area in a reclaimed land. It comprises 67 km of sanitary sewers, with diameters ranging from 200 to 750 mm; a pumping station equipped with four pumps; and WWT ponds that occupy approximately 5 ha. Only two of the three planned modules of the treatment ponds were constructed. Each module consists of one aerated lagoon, one facultative lagoon, and a polishing pond. Since construction, only module 1 and the aerated lagoon of module 2 were commissioned. The design flow for the two modules is 26 MLD, with peak flow of 52 MLD. The detention time of sewage is 44 days.

Under MSSP, rehabilitation work was carried out on the Dagat-Dagatan sewerage system, which included the following:

- Dewatering of and sludge removal from the four lagoons, replacement of riprap embankment and construction of baffled walls, and installation of a total of eight floating mechanical aerators on the two aerated lagoons (with an OTR of 50 kg/hr).

- Removal and replacement of four major pumps and associated piping, complete replacement of all mechanical and electrical systems, and a wide variety of general site improvements.

- Construction of a 200 m3/day Septage Treatment Plant

Table 2-16 summarizes the technical information of the Dagat-dagatan sewage treatment system.

**Table 2 - 16: Specification of Dagat-Dagatan Sewerage Treatment System**

| | |
|---|---|
| **Capacity** | 13,000 $m^3$/day |
| **Average Loading** | 4,000 $m^3$/day |
| **Facility Components**<br>• **Sewage Treatment Plant**<br>• **Oxidation Ponds** | 67 km sewer network<br>1.5 km forced main<br>2 modules of a unit with<br>Aerated ponds<br>Facultative and polishing ponds<br>Detention time of 8 days |

**Quezon City Communal System**

The Quezon City communal system serves Project 7 and Project 8 in Quezon City. There are about 3,999 sewer service connections in this area. Wastewater generated in the area is collected by the system through sewer service connections and conveyed to a communal septic tank. The effluent is discharged to Culiat/Duria Creek.

The main components of the system include:

- Four (4) communal septic tanks
- One (1) imhoff tank
- 18 km sewer line

The imhoff tank is planned to renovate and install a small sized sludge treatment system in the same site under another project.

These communal systems are not designed to meet the effluent standards set by the government. Part of the maintenance requirement is the regular desludging of these communal septic tanks (twice a year). However, due to accessibility problems, i.e., a squatter living within the area, Maynilad was unable to desludge them. Currently, Maynilad, in coordination with MWSS and other government agencies, is in the process of clearing the said facilities in preparation for its planned upgrading. On the other hand, the Project 7 Imhoff tank was rehabilitated in April 2003 and regular desludging is being done thereafter.

For the Makati Isolated System, wastewater generated by the residents of the Magallanes Village is being conveyed to the Ayala Sewage Treatment Plant, which serves other parts of Makati City and is operated by Manila Water.

## 2.3 Proposed Targets

### 2.3.1 Water Service Coverage

The service coverage assumption on the person per service connection and the estimation of privately served population will be the subject of review and proposed revisions for more realistic coverage targets.

The revision will cover the revised assumption of an average of 7.4 persons per connections based on the Public Assessment of Water Services (PAWS), instead of the 9.2 person per connection based on the IFC-Sogreah Report in the numerator, and the use of total population instead of total population net of the privately served in the denominator.

Moreover, Maynilad used the population projection based on the recently released results of the 2007 Census of Population and Housing conducted by the NSO which is far higher than the population projection earlier calculated by Radian + Halcrow. These enhancements in the coverage framework will surely coverage but will result in a much lower percentage of population served. The sharp increase in the population within the service area will translate to a higher number of service connections to attain the desired service coverage targets.

Based on the enhanced assumptions and framework, Maynilad will improve its water service coverage target in the entire service area by an average of 17 percentage points from 68% in EO2006 to 85% in EO2011. The growth in the NCR of about 15 percentage points for the same period is modest compared to the growth in the Cavite area where there will be a significant expansion of water service of about 40 percentage points. Maynilad will attain the 98.4% water service coverage in 2021 stated in the Consession Agreement and now includes the privately served population.

**Table 2 - 17: Proposed Water Service Coverage**

| City/Municipality | Water Service Coverage | | | | |
|---|---|---|---|---|---|
| | Actual | | Projected | | |
| | 2006 | 2007 | 2011 | 2016 | 2021 |
| *NCR* | *73%* | *77%* | *88%* | *94%* | *100%* |
| Manila | 95% | 99% | 100% | 100% | 100% |
| Quezon City | 96% | 100% | 100% | 100% | 100% |
| Caloocan | 68% | 74% | 85% | 94% | 100% |
| Malabon | 72% | 73% | 75% | 85% | 100% |
| Navotas | 49% | 54% | 64% | 81% | 100% |
| Valenzuela | 57% | 62% | 68% | 83% | 100% |
| Las Pinas | 24% | 30% | 58% | 81% | 98% |
| Makati | 100% | 100% | 100% | 100% | 100% |
| Muntinlupa | 8% | 13% | 80% | 88% | 95% |
| Paranaque | 69% | 69% | 99% | 100% | 100% |
| Pasay City | 81% | 82% | 88% | 98% | 100% |
| *CAVITE* | *25%* | *26%* | *65%* | *83%* | *91%* |
| Bacoor | 18% | 17% | 74% | 89% | 95% |
| Cavite City | 87% | 97% | 100% | 100% | 100% |
| Imus | 6% | 5% | 52% | 69% | 72% |
| Kawit | 54% | 56% | 73% | 100% | 100% |
| Noveleta | 26% | 22% | 35% | 79% | 100% |
| Rosario | 16% | 16% | 24% | 58% | 90% |
| *OVERALL* | *67.6%* | *71.1%* | *85.2%* | *92.7%* | *98.4%* |

Source: MWSI Business Plan September 2008

### 2.3.2 Sewerage Service

Maynilad will work on compliance with Clean Water Act (CWA). In the next five years, the five (5) communal/imhoff tanks under its jurisdiction will be rehabilitated and its treatment capability will be enhanced. To date, in coordination with MWSS, clearing of four communal septic tanks occupied by informal settlers is on going in preparation for its upgrading/rehabilitation.

For Maynilad to maintain its present service coverage of 9% up to end of concession, it needs to install more than 60,000 additional sewer service connections. With the present tariff structure, this would be an impossible task. To date, the high connection charges and the higher tariff for sewered accounts (which is expected to increase as a result of the 2nd rate rebasing exercise) remain a deterrent for customers to connect.

In this rate rebasing exercise Maynilad proposes the following rationalization schemes in order to translate the unused capacity of its existing sewerage facilities into additional connections, Maynilad is confident that the said scheme will encourage more customers to avail of the sewer services:

- Maynilad's capitalization of the cost of connection which to date amounts to an average of Php60,000 per connection.
- Rationalization of existing sewerage and environmental charges. Maynilad will immediately reduce the 50% sewer charge to 20% starting 2009 and moving forward.

In the absence of the above schemes, Maynilad will still continue to effectively operate and maintain its existing sewerage facilities. To maximize its utilization, Maynilad will intensify its campaign to offer its services to customers within sewered areas and work on partnership with the concerned government agencies and LGUs to implement that compulsory connection as provided under the CWA. Without any significant increase in its sewer service connections, the total service coverage will gradually decrease from its existing 9% coverage to 6% at the end of the concession due to the continuously increasing water served population.

Maynilad will implement combined system in the West Zone. This project will be done in the vicinity of San Juan River catchment within Maynilad Service Area. The proposed San Juan River Wastewater Treatment Plant (WTP) is a project recommended by the Chairman of MMDA aimed at reducing the pollution load in San Juan River. Drainage water in some parts of the vicinity of San Juan River will be intercepted and then treated within the standards before discharge. A full-blown study will be conducted on this proposed project. With this scheme, it is expected that the combined population coverage for customers connected in the existing separate system plus those that would be served by the combined system will be approximately 13.3.

Table 2-18 shows the sewerage service coverage for both actual and projected.

## Table 2 - 18: Proposed Sewerage Service Coverage

| City/Municipality | Sewerage Service Coverage | | | | |
|---|---|---|---|---|---|
| | Actual | | Projected | | |
| | 2006 | 2007 | 2011 | 2016 | 2021 |
| *NCR* | *10%* | *9%* | *9%* | | |
| Manila | 35% | 34% | 34% | 43% | 53% |
| Quezon City | 2% | 2% | 17% | | |
| Caloocan | 0% | 0% | 0% | | |
| Malabon | 2% | 1% | 1% | | |
| Navotas | 9% | 10% | 8% | | |
| Valenzuela | 0% | 0% | 0% | | |
| Las Pinas | 0% | 0% | 0% | | |
| Makati | 9% | 8% | 8% | | |
| Muntinlupa | 0% | 0% | 0% | | |
| Paranaque | 0% | 0% | 0% | | |
| Pasay City | 0% | 0% | 0% | | |
| *CAVITE* | *0%* | *0%* | *0%* | | |
| Bacoor | 0% | 0% | 0% | | |
| Cavite City | 0% | 0% | 0% | | |
| Imus | 0% | 0% | 0% | | |
| Kawit | 0% | 0% | 0% | | |
| Noveleta | 0% | 0% | 0% | | |
| Rosario | 0% | 0% | 0% | | |
| *OVERALL* | *9%* | *9%* | *13%* | *29%* | *39%* |

Notes:

1. From 2009-2012, additional sewer service connections per year will be installed.
2. Pilot combined wastewater/drainage treatment plant will be implemented in Quezon City and expected to cover around 27% of the water served population of Quezon City by 2012. By the end of 2012, the overall sewerage coverage will reach 14% as a result of the expansion of combined system in Quezon City.
3. From 2013-2021, additional 4,000 sewer service connections per year will be installed and expected to increase the coverage in Manila to 53% by 2021.
4. From 2013-2021, the combined wastewater/drainage system will be expanded and expected to increase the sewer covered population from 14% in 2012 to 43% in 2021.
5. Exact areas to be served by the proposed combined wastewater/drainage system from 2013 to 2021 could not be determined at this point pending result of the study to be conducted within 2008. To maximize benefits from the said system, area prioritization shall be based on the following:
    a. Areas not yet covered by Sanitation Program
    b. Areas with operating drainage system
    c. Areas that would complement to the efforts being done by Manila Water relative sewerage
    d. Results of coordinations with LGU's, MMDA, community and LLDA
        i. Proposed areas
        ii. Arrangements on drainage maintenance and repair
        iii. Provision for WTP sites

### 2.3.3 Sanitation Service

Maynilad will intensify its sanitation activities to compensate for the shortfall in the sewerage coverage. It will meet the targets of 43% in 2011, 50% in 2016, and 55% in 2121. The new targets of 2016 and 2121 are much higher compared to what are outlined in the CA.

Maynilad will continue with its systematic approach in the implementation of the Sanitation Program to ensure compliance with committed targets and maximize environmental benefits. Selection of program areas will be coordinated with Business Centers and concerned community/barangay leaders. Program briefing will be done to explain the importance of the program and to get cooperation/assistance of community leaders during the actual desludging operation.

In addition, the following will be implemented:

- Continue with its effective operation and maintenance of its existing sanitation facilities.
- Additional septage treatment capacity in the southern portion of the concession to facilitate services to customers in the south.
- Increase its existing fleet of desludging trucks to handle additional load.
- Improve capability to provide services to "hard to reach" or inaccessible areas.
- Implement an effective "refleeting" program.
- Research on other beneficial uses of biosolids. To date biosolids from its septage treatment facility is being used as soil conditioner in sugar cane plantations in Pampanga.

Customers who request for sanitation services will continue to be prioritized as provided in the Concession Agreement. Maynilad will continue to implement the Septic Desludging by Request (STDR) Program to cater to those customers outside the programmed areas who have problems with their septic tanks. Dedicated teams will be made available to ensure quick reaction to septic tank related request/complaints. The sanitation coverage is exclusive of the accomplishments under the STDR Program.

**Table 2 - 19: Proposed Sanitation Service Coverage**

| City/Municipality | Sewerage Service Coverage | | | | |
|---|---|---|---|---|---|
| | Actual | | Projected | | |
| | 2006 | 2007 | 2011 | 2016 | 2021 |
| *NCR* | *22%* | *28%* | *43%* | *50%* | *55%* |
| Manila | 13% | 13% | 43% | 50% | 55% |
| Quezon City | 28% | 27% | 43% | 50% | 55% |
| Caloocan | 23% | 38% | 43% | 50% | 55% |
| Malabon | 33% | 43% | 43% | 50% | 55% |
| Navotas | 5% | 18% | 43% | 50% | 55% |
| Valenzuela | 33% | 46% | 43% | 50% | 55% |
| Las Pinas | 31% | 48% | 43% | 50% | 55% |
| Makati | 14% | 14% | 43% | 50% | 55% |
| Muntinlupa | 3% | 11% | 43% | 50% | 55% |
| Paranaque | 26% | 46% | 43% | 50% | 55% |
| Pasay City | 15% | 29% | 43% | 50% | 55% |
| *CAVITE* | *8%* | *20%* | *43%* | *50%* | *55%* |
| Bacoor | 20% | 41% | 43% | 50% | 55% |
| Cavite City | 7% | 12% | 43% | 50% | 55% |
| Imus | 0% | 24% | 43% | 50% | 55% |
| Kawit | 0% | 11% | 43% | 50% | 55% |
| Noveleta | 0% | 1% | 43% | 50% | 55% |
| Rosario | 0% | 1% | 43% | 50% | 55% |
| *OVERALL* | *22%* | *28%* | *43%* | *50* | *55%* |

# 3. LEGAL AND REGULATORY FRAMEWORK

## 3.1 Key Agencies and Institutions Involved in Sewerage and Sanitation

### Department of Health

The Department of Health (DOH) is the principal government organisation responsible for planning, implementation, and coordination of the policies and programs for public health protection and sanitation. DOH is mandated to ensure access to basic health services to all Filipinos through the provision of quality health care services. Its mission is to guarantee equitable, sustainable, and quality health for all Filipinos, especially the poor and to lead the quest for excellence in health.

The DOH is mandated to implement Presidential Decree 856 or the Sanitation Code of the Philippines which includes regulations that impact on residential, commercial, institutional, and industrial wastewater discharges to the environment.

### Department of Environment and Natural Resources

The DENR is the primary government agency responsible for the promulgation of rules and regulations for the control of water, air, and land pollution in the Philippines. The DENR was created through Executive Order 192, which reorganised and merged the then National Pollution Control Commission (NPCC) and the National Environmental Protection Council (NEPC). All functions of NEPC and NPCC are now being implemented by the DENR through the Environmental Management Bureau (EMB) and its regional offices.

The DENR has five (5) staff bureaus, namely: (1) Environmental Management Bureau (EMB), (2) Forest Management Bureau (FMB), (3) Land Management Bureau (LMB), (4) Ecosystems Research and Development Bureau (ERDB), and (5) Parks and Wildlife Bureau (PAWB).

EMB is a line bureau of DENR and is mandated to formulate policies on environment and implement environmental laws such as the Clean Water Act (RA 9275), Clean Air Act (RA 8749), Solid Waste Management Act (RA 9003), Environmental Impact Statement System (PD No. 1586), Toxic and Hazardous Waste Act (RA 6969), and other mandates originally assigned to NEPC and NPCC. The DENR, EMB and its regional offices have the most important regulations with respect to pollution control. The classification of water bodies and the task of water quality monitoring are being undertaken by the EMB.

### Laguna Lake Development Authority (LLDA)

The LLDA is a quasi-government agency organised in 1966 by virtue of Republic Act 4850. The LLDA is empowered to provide regulatory and proprietary functions. The LLDA is mandated to lead, promote and accelerate the development and balanced growth of the Laguna de Bay Region within the context of national and regional plans and policies.

LLDA reports directly through its Board of Management to the Secretary of DENR. However, unlike the DENR, the rules and regulations adopted by LLDA allow the agency to levy and retain any charges, other than fines and permit fees, for environmental protection programs.

LLDA operates an Environmental User's Fee (EUF) system in the cities and towns in its jurisdiction. In terms of environmental standards and regulations for wastewater discharges, the LLDA follows the water quality criteria and effluent standards imposed by DENR, that is, DENR Administrative Order Nos. 34 and 35, respectively.

### Department of Public Works and Highways

The Department of Public Works and Highways (DPWH) is the government agency that is in-charge of infrastructure construction. The agency is responsible for the planning, design, construction and maintenance of infrastructure facilities, particularly national highways and water resources development systems, and other national development objectives. DPWH's responsibility extends to the major areas of infrastructure development and construction such as highways, ports, flood control, water supply, school buildings, and urban community infrastructures.

Under the Clean Water Act (CWA), the DPWH is given the lead role with regards to the preparation of the national program on sewerage and septage management.

**Metropolitan Waterworks and Sewerage System**

The Metropolitan Waterworks and Sewerage System (MWSS) was created in 1971 by virtue of Republic Act No. 6234. MWSS is responsible for domestic sewage collection, disposal, and treatment in Metro Manila and the surrounding municipalities. The agency is also responsible for septic tank desludging. MWSS is an attached agency to the DPWH.

The privatisation program of the MWSS, which was implemented on August 1, 1997, divided the MWSS service area into the East and West zones. The operations of the facilities of MWSS were turned over to the two private operators, namely, the Maynilad Water Services, Inc. (MWSI) for the West zone and the Manila Water Company, Inc. (MWCI) for the East zone. The operators have a 25-year concession period and have divided the overall MWSS service area.

**Pasig River Rehabilitation Commission**

The PRRC was created by virtue of Executive Order No. 54, series of 1999, as amended by Executive Order No. 65, series 1999. PRCC is mandated to ensure that the Pasig River is rehabilitated to its historically pristine condition conducive to transportation, recreation, and tourism.

PRRC is tasked to coordinate, plan, implement, supervise, monitor and/or evaluate programs, projects and activities, enforce laws, rules and regulations, where appropriate, and perform such other functions as are necessary to ensure the rehabilitation of the Pasig River system. Its plans and programs include sanitation improvement components especially within the easement areas along Pasig River presently occupied by informal settlers.

The PRRC is chaired by the Secretary of the Department of Budget and Management (DBM) and co-chaired by the chairman of the Metro Manila Development Authority (MMDA). The PRRC operates under the Office of the President. Its organisational structure is composed of other government agencies such as the DBM, MMDA, DENR, MWSS, DPWH, DOH, LLDA, and HLURB, among others. The primary structure for environmental matters is defined as the Environmental Management Committee (EMC) of PRRC that is chaired by the DENR.

**Housing and Land Use Regulatory Board**

The Housing and Land Use Regulatory Board (HLURB) is the government's regulatory body responsible for land use and housing. Its role is defined in specific legislation and directives: Letter of Instruction (LOI) 729, series of 1978, PD 933, EO 648, series of 1981 as amended by EO 90, series of 1986, PD No. 1396, RA No. 7160, EO 72, series of 1993 and RA No. 7279.

The HLURB's functions are comprehensive and include:

- prescribing the standards and guidelines governing the preparation of land use plans;
- extending technical and related forms of planning assistance to the local government units (LGUs) including programs on sanitation and sewerage;
- reviewing and approving the comprehensive land use plans of highly urbanised cities, independent component cities, provinces, and the cities and municipalities of Metro Manila;
- monitoring the implementation of such plans; and
- adjudicating and settling disputes over these plans.

These functions are complementary with the mandate of all LGUs under RA 7160, the Local Government Code, to prepare their land use plans. These plans are enacted through zoning ordinances and stand as the primary and dominant bases for the use of land resources in their respective localities.

**Local Government Units**

Through the Local Government Code of 1991 (RA 7160), the Philippines has implemented a decentralised form of government. As such, there are two main levels of government: central or national government and local government units. The policy described in the Local Government Code is to devolve authority to LGUs who will operate autonomously under the regulatory supervision of the National Government.

LGUs are responsible for the provision of basic services, such as water supply systems, sewerage, and sanitation, either directly or through contracts with the private sector. They are also empowered to collect taxes and fees necessary for providing these services.

**Department of Agriculture**

The Department of Agriculture (DA) was created by virtue of Presidential Decree No. 461 which reorganized the then Department of Agriculture and Natural Resources (DANR) into two separate departments, namely, the Department of Agriculture, and the Department of Environment and Natural Resources. DA is principally tasked to promote the country's agricultural growth and development, including the sustainability of resource productivity over the long term and the enhancement of life of small farmers and fishermen in support of the Comprehensive Agrarian Reform Program (CARP).

The Fertilizer and Pesticides Authority (FPA), an attached agency of the DA regulates the manufacture, use and application of agricultural products such as fertilizers and pesticides. It also has regulatory function over the importation of such products to protect domestic agricultural producers from unfair competition of imports made cheap through subsidies by exporting countries. Currently, the MWSS concessionaires have licenses as fertiliser manufacturers for their domestic liquid wastes and sludges.

Under the Clean Water Act (CWA), the DA is tasked to coordinate with DENR in the formulation of guidelines for the reuse of wastewater for irrigation and other agricultural purposes and for the prevention, control, and abatement of pollution from agricultural and aquaculture activities. The DA is also tasked to review and propose guidelines for domestic sludge and septage management particularly on land application of bio-solids.

## 3.2 Important Regulations Governing Sewerage and Sanitation

The national legislative framework governing sanitation and sewerage in the Philippines is principally governed by three (3) main laws, namely: (1) PD 856 or the Code on Sanitation of the Philippines, (2) PD 984 or the Pollution Control Law, and (3) RA 9275 or the Clean Water Act (CWA).

These main laws are further supported by a number of presidential decrees, republic acts, and administrative orders. Such support regulations include: the National Building Code, National Plumbing Code, the Local Government Code, and DENR Administrative Orders 34 and 35, among others. Enforcement of these laws rests with government agencies such as the Environmental Management Bureau of the Department of Environment and Natural Resources, Department of Health, Department of Public Works and Highways and the various local government units (LGUs).

These environmental regulations and their pertinent provisions that may have impacts on the implementation of sanitation and sewerage services have been summarized for consideration in the development of the MWSI Sewerage and Sanitation Master Plan.

### 3.2.1 PD 856, 1995 IRR and 2004 Supplemental IRR (Code on Sanitation)

The Code of Sanitation (PD 856) was promulgated in December 23, 1975 by then President Ferdinand E. Marcos. Since its promulgation, it has been the basis of rules and regulations imposed for health and sanitation. Chapter XVII of the Code of Sanitation particularly contained provisions on the collection, handling, transport, treatment and disposal of sewage, domestic sludge and septage.

In 1995, the DOH issued the Implementing Rules and Regulations (IRR) of Chapter XVII of the Code. The IRR prescribed guidelines on proper handling, treatment and disposal of sewage. Specifically, the IRR contains the following:

- Approved individual excreta and sewage disposal systems
- Proposed design and construction of septic tanks, leaching tile field and house sewers
- Requirements on public sewerage systems

With the continuous degradation of the river systems due to indiscriminate dumping of septage collected from individual septic tanks and the results of pollution surveys indicating that up to 70% of pollution loading comes from domestic sources, the DOH in 2004 issued a supplemental IRR to cover stricter guidelines on collection, handling, transport, treatment and disposal of domestic sludge and septage.

The IRR and the supplemental apply to all individuals, firms, public and private operators, owners and administrators engaged in the collection, handling and transport, treatment, and disposal of excreta and sewage and domestic sludge from cesspools, communal septic tanks, Imhoff tanks, domestic sewage treatment plants/facilities and septage from household septic tanks.

Some of the key provisions of the Code and the 1995 IRR of Chapter XVII on sewage and sewerage systems include:

- Sewage disposal shall be by means of a municipal or city sewerage system whenever available.
- Where a public sewerage system is not available, sewer outfalls from residences, schools, and other buildings shall be discharged into a septic tank.
- The effluent from septic tanks shall be discharged into a sub-surface soil, absorption field where applicable or shall be treated with some type of purification device. The treated effluent may be discharged into a stream or body of water if it conforms to the prescribed quality standards (now prescribed by DAO 35 series of 1990).

- Properly designed grease traps shall be provided for sewers from restaurants or other establishments where the sewage carries a large amount of grease.

- Septic tanks in new subdivisions are prohibited unless the site is considered to be impractical and inadvisable to install a public sewage collection system with the required treatment.

- Septic tanks shall be cleaned before excessive sludge or scum is allowed to accumulate and seriously reduce settling efficiency. Septic tanks shall be inspected at least once per year and be cleaned when the bottom of the scum mat is within 7.5 cm of the bottom of the outlet device or the sludge and scum has reduced the liquid capacity by 50%.

- Stormwater shall be discharged to a storm sewer, sanitary sewage shall be discharged to a sewerage system carrying sanitary sewage only; but this should not prevent the installation of a combined system.

- Section 3 specifies that any individual, firm or operator, government or private, who are engaged or will be engaged in the collection/desludging, handling, transport, treatment and disposal of sludge and septage is required to secure Environmental Sanitation Clearance (ESC) prior to operation. The ESC shall be issued by the Secretary of Health or the Director of the concerned Center for Health Development (CHD) as his duly authorized representative.

- The ESC application will require the operator's submission of project description (including handling, transport, storage, treatment and disposal operations) and some environmental baseline information of the project site such as topography, geologic condition and hydrology.

- Proper septage and domestic sludge collection and transport system, including vehicle registrations and specifications i.e., vehicle must be enclosed with leak proof body and lock.

- Mandatory septage and domestic sludge processing and treatment are required prior to disposal.

### 3.2.2 Presidential Decree 984 (Pollution Control Law)

PD 984 or 'The Pollution Control Law' sets up the administrative and regulatory mechanisms for pollution control and establishes air and water quality standards that define maximum allowable limits of emissions and effluents from domestic, commercial and industrial activities.

PD 984 created the National Pollution Control Commission (NPCC) and gave them the powers with respect to control of air, water and land pollution from point sources. The function of NPCC was subsequently passed on to the DENR by virtue of the department reorganization as per Executive Order 192. P.D. 984 requires the issuance of permits for wastewater treatment facilities.

In 1967, the first set of water quality criteria and effluent standards were promulgated by the NAWAPCO. The 1978 rules and regulations of PD 984 included provisions on air, water, land, noise, and odor pollution, including the ambient water quality criteria. The Effluent Standards was developed in 1982.

After the DENR reorganization in 1987, a review/revision of the standards was again undertaken, hence, developing what we now have as the Revised Water Quality Criteria of 1990 (DENR Administrative Order No. 34) and the revised Effluent Standards (DENR Administrative Order No. 35).

### 3.2.3 Republic Act 9275 (Clean Water Act)

RA 9275, otherwise known as the Philippine Clean Water Act was enacted into law in March 22, 2004. The act provides a comprehensive national water quality program to protect, preserve, and revive the quality of the country's fresh, brackish, and marine waters. The act primarily addresses the abatement and control of pollution from land-based sources and covers all water bodies (natural and man-made), bodies of fresh, brackish, and saline waters, and includes but not limited to aquifers, groundwater, springs, creeks, streams, rivers, ponds, lagoons, water reservoirs, lakes, bays, estuarine, coastal and marine waters.

Provisions of PD 984 relative to wastewater discharges were subsumed by CWA. Under the CWA, development projects including subdivisions, commercial establishments and manufacturing plants which generate and discharge wastewater into the environment are required to secure from the DENR the Discharge Permit and pay the corresponding load based fees to DENR.

The computation of the discharge fee in the IRR of the CWA is based on a net waste load which considers the situation that water to be used by a facility already contains certain pollutants and therefore the discharge fee will be based on the net wastewater load to be discharged.

The CWA integrates the management and control of wastewater and water quality policies that were previously issued through various laws and are currently being implemented among various agencies. The CWA enables the creation and delegation of new regulatory, planning and infrastructure development functions to agencies and subsidiary multi-sectoral bodies and on streamlining inter-agency coordination.

**Impacts on Domestic and Commercial Effluents**

The following are the major provisions in the CWA-IRR that would have an impact on domestic and commercial effluents:

- Mandatory connection of establishments to existing sewerage systems which reiterates the provisions of the Sanitation Code. If establishments are tapped into the sewer lines of MWSI/MWCI, the concessionaires need to observe the provisions of the Effluent Standards of the DENR in the treatment of effluent prior to disposal into any body of water.

- For MWSS/MWSI/MWCI treatment facilities, a Discharge Permit needs to be secured from DENR or LLDA.

- Domestic and commercial establishments are required to connect sewage lines to existing sewerage systems. Although MWSS does not have the authority to sanction establishments that refuse to connect, the CWA now allows the DENR to initiate actions against these establishments in coordination with the LGUs and DOH. Regulatory actions may include the withholding of permits or denial of issuance of ECC.

- Domestic and commercial establishments that are not connected to existing sewerage systems of MWCI/MWSI should treat their own effluents and comply with the Effluent Standards outlined in DENR Administrative Order No. 35
- Disposal of septage or domestic sludge should comply with the standards and guidelines issued by the DOH.

- Disposal of sludge through land application should comply with the standards of the DA.

- Use of low-cost sanitation options to augment the sewerage program is promoted in the CWA.

**Impacts on Industrial Effluent**

The provisions that would have impacts on industrial effluent are the following:

- Mandatory connection of sewage lines to existing sewer lines
- Pre-treatment standards for industrial sources that would discharge into the sewerage system needs to be developed by MWSS (See Section 5.6)

**Mandatory Connection to Sewer Lines**

Under the CWA, the MWSS through its concessionaires should provide the sewerage and sanitation facilities and enforce the mandatory connection of sewage lines from domestic, commercial or industrial establishments to available sewerage system. In doing so, the accountability in terms of compliance with the effluent standards and the payment of wastewater discharge fee will rest with the MWCI/MWSI as operator of the sewerage system.

In the case of commercial and industrial companies, the MWSS needs to develop discharge standards to sewers to account for the pre-treatment of wastes.

**Sanctions for Refusal to Connect to Existing Sewer Lines**

The provision on mandatory connection in the CWA basically supplements the Sanitation Code. Despite the presence of this provision in the Sanitation Code, there is resistance to connect due to the following:

1. MWSS has a policy that the house owner shall pay for the implementation of the connection even in the street area with surface restoration.
2. The sanitary surcharge of 50% on the water bill is only imposed if the houses are physically connected.

In implementing the mandatory connection to existing sewerage system based on the CWA, the MWSS and concessionaires should clearly identify commercial and industrial establishments and households connected to existing sewerage systems.

MWSS is not mandated to take any action against establishments refusing to connect into the system under the CWA-IRR. Meanwhile, the DENR can initiate sanctions against an establishment that would fail to connect to available MWCI/MWSI sewer lines in coordination with LGUs and DOH. Sanctions would include the following; (i) DENR can withhold permits or deny the issuance of an ECC; (ii) DENR can request LGUs and other agencies in writing about the sanctions for the establishment based on applicable laws; and (iii) DOH can refuse the issuance of the Environmental Sanitation Clearance

The sanctions that would be initiated by DENR are relatively considered as low-impact actions in terms of implementing the mandatory connection of establishments. Given the constraints and resistance to connect, this particular provision of the law may face difficulties in implementing. Development of guidelines for the implementation of this particular provision is necessary to strengthen the enforcement and define the roles that other government agencies may render.

**Pre-treatment Standards**

Under the CWA, pre-treatment standards can be recommended by MWSS and the water concessionaires to DENR to manage effluents (i.e., industrial effluents) that are channeled into sewerage systems. In the absence of pre-treatment standards, the MWSS and the concessionaires can impose pre-treatment standards to establishments tapped into the system through contract with the particular establishment.

Since commercial and industrial wastes vary from domestic sewage, MWSS/MWCI/MWSI may need to consider whether their system can accommodate these sources of pollution. In this case, the design of the sewage treatment facilities should take into consideration pre-treatment standards and appropriate surcharges for non-compliance with the pre-treatment standards.

A fee system should be designed and set-up by MWSS to regulate quality from commercial and industrial sources that would be channeled into the sewerage system.

**Compliance with Effluent Standards**

The sewage treatment facilities of MWCI/MWSI are required to comply with the guidelines on sanitation of the DOH and the Effluent Standards of DENR. The same standards apply for domestic, commercial or industrial effluents.

In the interim, DENR Administrative Order No. 35 applies as the Effluent Standards while DENR Administrative Order No. 34 will serve as guideline for the water usage and classification and water quality criteria.

**Conflict with LGUs in Imposing Fees**

The CWA underscores the role of the LGU in presenting priorities for sewerage and septage management. In the IRR, LGUs are mandated to maintain and shoulder the maintenance of sewerage facilities which overlaps with the mandates of the service providers. It is further stated that LGUs may enact ordinances to impose service fee system. The CWA creates mechanisms for funding through a fee system – property taxes and sewerage system. However, this duplicates the fee being charged by MWCI/MWSI, hence, this may need further review/study.

The fact that the CWA gives the LGUs the responsibility for the provision of rights-of-way and road access, the importance of local political support should likewise be emphasized. However, the imposition of fees to locators should be clearly defined with the LGUs.

While the MWSS can insist on implementing the right to eminent domain as embodied in its Charter, the important role of the LGUs in the implementation of sewerage projects should be taken into account.

Although Metro Manila LGUs have already a long history of good cooperation with MWSS, a pass-on fee to LGUs may be discussed to resolve any potential conflict that may occur with LGUs due to this particular provision of the CWA.

**Incentives to Connect to Existing Sewer Lines**

While the CWA reinforces the provision on mandatory connection of the Sanitation Code, the sanctions designed in the CWA-IRR are considered as low-impact and may once again face the usual resistance from consumers of MWSI/MWCI. The MWSS needs to discuss with the DENR and DOH stringent sanctions and more importantly attractive incentives to consumers to connect to the sewerage system.

**Water Supply Disconnection**

Rule 27.6 of the CWA-IRR stipulates that the DENR Secretary may issue an order to the Local Water Districts or to private water supplier such as MWCI or MWSI to disconnect the water service of a violator of any provisions of the CWA. This particular rule may need further legal analysis by MWSS.

# 4. REVIEW ON PREVIOUS MASTERPLANS

## 4.1 Black and Veatch 1969 Sewerage Master Plan for a Sewerage System

This Master Plan was prepared by Black and Veatch during 1968-69. A diverse centralized concept for a separate sewerage system for Metro Manila was envisioned and proposed. Consideration was given to a combined sewerage system but was not recommended due to the extent of the existing sewerage system, the high intensity rainfall in Manila and the consequent increased cost of a combined system. Collection of wastewater was centralized at three disposal points in Manila Bay. Inland treatment was not considered due to the negligible assimilative capacity of the streams.

Major interceptor sewers were proposed adjacent to drainage paths to transport sewage to the disposal points. A significant feature of the plan was construction of a major sewer which would run along the bed of the Pasig River and intercept dry weather flows from the stormwater system. By the year 2000 it was felt that the assimilative capacity of Manila Bay would have been reached and treatment would be necessary.

It was proposed to implement the Master Plan in three stages – Phase 1 was to be the Central Sewerage System upgrade and the North and South Manila Basins, Phase 2, the lower San Juan Basin and portions of the Parañaque Basin and Phase 3, the major sewerage construction in the remainder of the Study area.

Sanitation was not considered in this Master Plan. The Master Plan was never implemented and was superseded by a further Master Plan prepared in 1979.

## 4.2 Montgomery 1979 Sewerage and Sanitation Master Plan for Metro Manila

The next Master Plan was prepared by James Montgomery/Kampsax Kruger/DCCD in 1979. This plan discarded the previous plan on the basis of cost and from many options recommended a plan based on:

- A sewerage expansion program involving rehabilitation of existing facilities and a monitoring system called METROSS. (Metro Manila Sewerage and Sanitation)
- Combined sewers;
- Secondary treatment of sewage with four outfalls into Manila Bay
- A sanitation programme comprising minor drainage projects for the depressed areas (PROGRESS) and a septic tank desludging programme (STAMP). Part of PROGRESS and STAMP were implemented as a component of METROSS - 1

Only METROSS – 1 was implemented, although rehabilitation of the Central Sewerage System remained uncompleted.

## 4.3 Manila Second Sewerage Project (1994)

The Manila Second Sewerage Project (MSSP) was envisaged to begin addressing the increasing water pollution in Metro Manila. MWSS proceeded with the implementation of the MSSP in 1994 with World Bank assistance. Although based on the 1991 Second Manila Sewerage Feasibility Study, changes in the proposed project components were made due to the high cost of implementation.

MSSP sought to provide specific measures for the following objectives:

- Improve the quality of sanitation services
- Reduce environmental pollution
- Minimize the health hazards from wastewater

In order to achieve these goals, the project was divided into four components. These were as follows (i) Septage Management Plan, (ii) Ayala Sewage Treatment and Sewerage System Rehabilitation, (iii) Manila Central Sewerage System Rehabilitation and (iv) Supply of Laboratory Equipment, Vacuum Trucks and Other Vehicles. These components are discussed below:

**Septage Management Plan**

The Septage Management Plan of the MSSP provided the means for immediate action to be taken with the septage collection and hauling using specific collection vehicles. The collected septage was to be handled through interim and permanent solutions by means of open sea disposal and establishment of septage treatment plants (SpTP), respectively.

Barge loading of the collected septage for sea disposal was to be done through the use of loading stations to be constructed at Napindan and Estero de Vitas. The typical capacity of each loading station was to accommodate 760 $m^3$/day of septage. The sea disposal of septage was proposed to continue until 2004, when the construction and rehabilitation of proposed SpTPs were to come on-line.

The rehabilitation and upgrade of the Dagat-Dagatan Lagoons to include a SpTP was planned to ultimately have a 900 $m^3$/d septage treatment capacity in addition to its current 52 Mld sewage treatment capacity. Septage treatment would involve dewatering and aerated lagoons for biological treatment processes. It was projected that the Dagat-Dagatan, along with two other SpTPs, would have combined capacities of 1,700 $m^3$/d by 2004 when the open sea dumping operations would cease.

**Ayala Sewage Treatment and Sewerage System Rehabilitation**

The Ayala Sewage Treatment Plant (STP) was in need of major rehabilitation with most of the structures and equipment already past the end of their designed lives. Although the plant generally met effluent standards, it was found to be overloaded especially during periods of rainfall.

The construction of a grit chamber and concrete sludge thickener tank were to comprise two phases of the plant rehabilitation. A separate structure was also included in the second phase of construction to provide dewatering of the sludge produced during treatment. Service lines such as the Amorsolo Inverted Siphon, Edsa Trunk Line Alternate Route and Valero-de la Costa Sewer Connection were also in need of proper maintenance.

These maintenance works coupled by improvements in sewer manholes, cleaning of sewer lines, and repair or replacement of damaged lines, were deemed to be adequate to enable the sewers to accommodate both dry and wet weather flows.

**Manila Central Sewerage System Rehabilitation**

Expansion works proposed for the existing Manila Central Sewerage System included the extension of catchments in Pasig and the retrofitting of the Manila Bay outfall to the Tondo Pumping Station. The sewer lines, equipment and pumps were assessed to be in more deteriorated states than what was

observed during the inspection for the 1991 feasibility study. Other problems involved the observed backflow during high tides due to damaged flap gates and the clogged Pasig River Inverted Siphon.

Rehabilitation recommendations included for the Manila Central Sewerage System were as follows:

- Automatic gate opener to replace manual inlet and outlet gates ;
- Gate boxes to be provided for bypass for grit chamber;
- An aeration grit chamber before the main pump to be installed;
- A ventilation system for the pump pit room to be installed;
- Main pumps to be repaired and spare parts for impellers procured;
- Flow meters to be repaired;
- Installation of odour control systems; and
- Backup electrical power to be provided.

**Supply of Laboratory Equipment, Vacuum Trucks and Other Vehicles**

More effective monitoring of the wastewater, from collection to final discharge, through laboratory analyses was deemed to be needed to establish proper treatment processes. Although MWSS utilized the Central laboratory, which began operations in 1983, added load from the proposed numerous sewage and septage treatment plants was considered likely to render the laboratory overloaded.

In order to facilitate continuous effluent monitoring of the proposed treatment plants, establishment of adequate on-site laboratories for every plant was deemed to be required. The laboratories were to be outfitted with adequate testing facilities and mobile testing units. This equipment would enable testing of effluent quality from the treatment plants and would also enable samples to be tested on-site from septic tanks and sea septage dumping. In conjunction with the laboratories and other testing equipment, the addition of laboratory staff and proper training also were also proposed.

## 4.4 NJS 1996 Study on Water Supply and Sewerage Master Plan of Metro Manila

The projected rise in the population of Metro Manila in the last decade of the millennium prompted the need for an increase in water supply. This projected increase in water consumption would result in an increase in generated wastewater volumes from the service area. Despite the rehabilitation and development being implemented under MSSP, the sewerage and sanitation programs for Metro Manila were still insufficient in terms of the increased environmental load. This 1996 Study on Water Supply and Sewerage Master Plan of Metro Manila by Nippon Jogesuido Sekkei (NJS) addressed the pressing issues on both water supply and wastewater generated.

The options between separate and combined sewer systems were evaluated. Other concerns were the drainage system improvement and expansion, septage management, maintenance of overflow chambers and household service connections.

Proposals for systems comprising smaller service areas were introduced to enable more immediate implementation of the sewerage plans. The proposed smaller-scale treatment plants were to be eventually integrated thereby forming a centralized system.

**Sewage Treatment Development**

Wastewater treatment methods were to be narrowed to any of the following applicable processes:

- Stabilization Pond (SP);
- Aerated Lagoon (AL);
- Oxidation Ditch (OD);
- Conventional Activated Sludge (AS).

The trade off in the above alternatives was between the increase in the capital cost needed for the construction, operation and maintenance for the more mechanized alternatives such as activated sludge and the increase in required land area for treatment methods such as stabilization ponds.

Inland treatment systems as well as ocean outfall systems were also compared. Alternatives for inland treatment were based on the size of catchments for small, medium or large-scale treatment systems. Improved ocean outfall systems were also studied but proved to be unacceptable in terms of environmental impacts and implementation. The Medium Scale Inland Treatment System (MSITS) was found to be more advantageous than the other options. Optimization plans for the MSITS were further explored.

Sewerage Systems

Considerations in some of the catchments were made in accordance with the improvements being done in MSSP. The development of the identified catchments and the recommended individual treatment methods were based on key priority factors such as development of the area, cost per capita, cost-recovery, and environmental impact. The priority sewerage areas were individually discussed as follows (i) Ayala System, (ii) North Manila System, (iii) Central Manila System, (iv) South Manila System and finally, (v) West Mangahan. Recommended sewerage systems for the remaining catchments were discussed collectively.

**Figure 4-1** presents the sewerage catchments, proposed STP locations and the recommended treatment methods.

- **Ayala System**
  Since Makati has an existing sewerage system which extends to residential and commercial buildings, the benefit cost is low. However, the high income populace made this a priority area for improvement of the sewerage system.

  The importance of the rehabilitation works of the wastewater treatment plant through MSSP was emphasized. No further rehabilitation works for the treatment plant or the sewerage system were recommended.

- **North Manila System**
  Cost-recovery for improvement of the system was also low because of the population's incapacity to pay. However, the high population density of the area resulted in a lower cost per capita. The environmental impact of the development of the North Manila System was considered to have the potential to bring about an improvement in water quality of the Pasig River which was considered to be the most polluted in the Metro Manila region.

  The North Manila System covers the San Juan River Basin. Communal septic tanks scattered within the boundaries of Quezon City were to be connected by an interceptor system to the treatment plant.

Recommendations for sewage treatment were constrained by the available land area. As aerated lagoons may take up as much as 120 ha of land, the use of an oxidation ditch was suggested.

- **Central Manila System**
  The service area of the Central Manila System is mostly covered by the already established sewerage system. The high population increases the need to expand the service area due to the high environmental impact from unsewered households. However, the large population translates into a lower cost per capita for the rehabilitation works.

  The developments in the Sampaloc, Balut, Dagat-Dagatan and Caloocan areas could be connected with the Dagat-Dagatan treatment plant which would be upgraded in the MSSP. The upgrading includes more efficient means of treatment such as aerated lagoons and an accompanying increase in treatment capacity. The Tondo Pump Station was proposed to continue operation.

- **South Manila System**
  The South Manila System was characterized as a highly populated area with an equally high degree of commercial activity. Because of this, cost per capita is the lowest in the considered areas and recovery of investments should be easier. Development of the sewerage system was deemed important due to the high population and commerce thereby generating increased pollution loading for Manila Bay.

  Portions of the Central Manila System were to be transferred to the South Manila System including the Pandacan area. The total area of the STP would cover about 94 ha for an aerated lagoon system while an area of only about 23 ha was specified for an oxidation ditch treatment method. The selected treatment method would depend on the available area.

- **West Mangahan**
  The area of West Mangahan experienced a considerable increase in development, especially in the Ortigas area which is projected to be sustained in the following years. Cost per capita and the project recovery will largely depend on the high-income capacity of the residents in the Ortigas area.

  As with other developed regions of Metro Manila, sewage from the Ortigas area was proposed to be collected via an interceptor system. Land acquisition for West Mangahan was seen to be less difficult thereby making an aerated lagoon treatment method viable.

- **Remaining Catchments**
  The use of aerated lagoons for sewage treatment of the East Mangahan, Muntinlupa and Parañaque catchments was assessed to be favorable in reducing operation and maintenance costs This was due to the availability of the required land area in these catchments. The Marikina basin was proposed to utilize an oxidation ditch to reduce the required area. However, an activated sludge treatment process was proposed for the Bonifacio basin due to the intended high density development in this area.

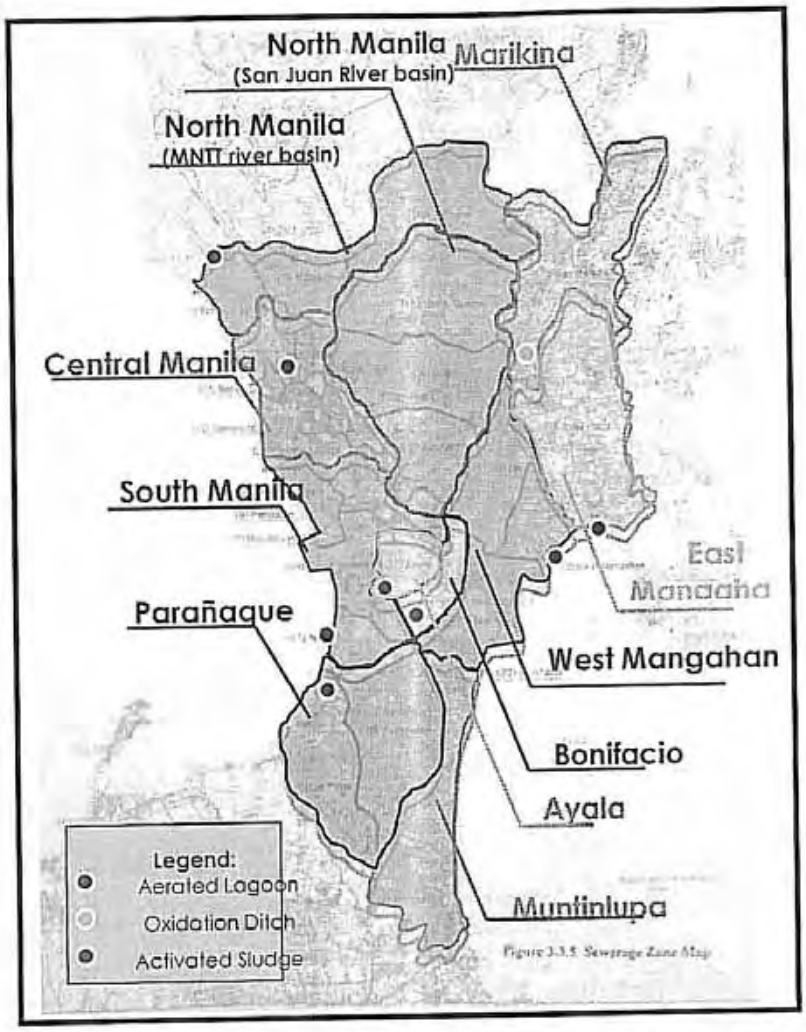



**Figure 4-1: Proposed Catchments, STP Location and Treatment Method (1996 NJS MP)**

## Septage Management Plan

Because sanitation is critical in any wastewater strategy, a sanitation development plan was prepared. Although drainage was considered to be part of the sanitation project, details of this were omitted in the study. The sanitation development plan was divided into on-site treatment facilities and the septage management plan development stages.

A review of existing septic tanks was conducted and recommendations for the type and construction. Communal septic tanks using anaerobic processes were recommended. Other facilities based on different technologies such as the Japanese type JOHKASOU bio module, Anaerobic Sludge Blanket Reactor, and the Korean type treatment were suggested for applicability trials.

Four SpTPs dividing the service area of the unsewered locations were considered. These were the Dagat-Dagatan, Quezon City, Taguig, and Las Pinas setpage treatment plants. The septage plan was to be continued even after the 2010 target period for sewerage coverage. The septage management plan involved the septage cycle from collection to treatment through added rehabilitation programs included as part of MSSP.

Implementation of this Master Plan was overtaken by the privatization of the operations of MWSS in 1997. Since this time the concessionaires, while taking into consideration some of the

recommendations of the Master Plan especially related to sanitation, have largely pursued their own sewerage and sanitation strategies. The 2003 rate rebasing exercise resulted in a further deviation from the sewerage strategies which in the case of the East Zone resulted in an emphasis on sanitation rather than sewerage for economic/financial reasons and in the West Zone the deferral of all sewerage targets due to financial constraints.

## 4.5 2000 West Zone Sewerage Master Plan

A draft sewerage master plan (SMP) for MWSI was prepared by PhilAqua Consultants Inc in 2000. Due to a misunderstanding between the concessionaire and the consulting firm, the draft proposal was not recognized by MWSI as an official document.

The items presented below are parts of the draft SMP. The draft recommended the use of centralized sewerage systems in the West Zone until 2011. After then a decision should be made on whether centralized or decentralized systems would be more advantageous. A comparison between sewerage and sanitation (septic tanks) was also presented as a short special topic.

### Sewage Management

#### i. Identification of New Catchments

The West Zone was delineated into relatively small catchments in parts where sewerage coverage was specified in the Concession Agreement. A total of 150 new catchments were identified based on the following guidelines:

- the catchment should each have a resident population of about 50,000
- the sewer lay-outs identified in previous master plans are to be followed where appropriate
- trunk sewers or interceptors were expected to follow natural waterways in order to avoid the need for small pumping stations.

#### ii. Construction of Sewage Treatment Plants

The draft SMP recommended the construction of sewage treatment plants (STPs) for treatment of sewage collected from the various identified catchments. Many combinations of alternative sites and processes were reviewed.

Under the proposed plan, the existing Dagat-Dagatan STP would continue to operate until 2016. The Dagat-Dagatan site was found to be too small for a regional STP. It was also deemed inappropriate, the site being residential with constrained access. In the medium term, a new Central STP would have to be constructed. In the absence of available land with sufficient area, reclaimed land in Manila Bay would be utilized for the development of this Central STP. Alternative decentralized fallback options in the North and South were also proposed.

- From a roster of twenty choices, five short-listed alternatives were compared:
- No specific cost advantage was identified for any of the options. All ranked similarly with the Net Present Value analysis based on the 2000 cost data.
- For the medium term, the North and South STP option was identified to be most expensive.

The proposed sewage treatment process included primary & secondary treatment and disinfection. The identified primary treatment consisted of screening, de-gritting, oil/grease removal, and primary settling. Secondary treatment could either be using activated sludge, trickling filters, or bio-aerated filters. Enhanced Primary Treatment, the addition of a chemical flocculants, was proposed for STPs

that would discharge into Manila Bay. Secondary Treatment would be required for STPs that would discharge to inland bodies.

Treatment alternatives for the bio-solids accumulated from the sewage treatment process were: gravity thickening, stabilization, and dewatering. Some combinations of processes were proposed for both on-site and off-site sludge treatment facilities.

The draft SMP recommended that sludge from primary treatment processes be thickened prior to its transfer to an off-site treatment facility. The off-site treatment facility should be located where transport costs could be minimized and where market for the treated bio-solids could be optimized.

It was also recommended that MWSI should plan to accept industrial wastewater as the sewers are extended to areas where these industries are located provided that the industries treat their effluent to strengths equivalent to those found in typical domestic sewage.

**Septage Management Program**

The septage management program adopted by MWSI is part of the implementation of the MSSP components. Throughout the concession period, septage removed from the septic tanks in the concession area will be treated at the recently completed Dagat-Dagatan Septage Treatment Plant (SpTP). Except for this facility, no other SpTP was proposed for construction.

In the draft SMP, two septic tank gravity system (STGS) alternatives were presented and compared with conventional sewerage. These were: STGS requiring construction of new septic tanks and STGS requiring new interceptors but utilizing the existing septic tanks. Cost comparison of the three alternatives revealed there was no clear leader in terms of required financing. Other criteria for comparison were risks involved and technical & operational requirements. Both STGS options were not recommended because of the need for a septage desludging program which would be required even after the laying out of the sewers.

## 4.6 2005 East Concession Area Master Plan Update

The 2005 East Concession Master Plan Update was based on a study undertaken by NJS in 2000. The updated master plan has integrated some of the packages proposed in the Manila Third Sewerage Project (discussed below in 6.3) to form an overall strategy in the implementation of the sewerage and sanitation programs for the service area of MWCI. The proposed sewerage and sanitation development in the East Concession master plan update is discussed briefly below.

### Sewerage Development

In the updated master plan, a total of 11 catchments were delineated, based on topography, drainage patterns, and the potential STP sites. Although previous studies provided recommendations for STP locations, most of these sites have given way to other development and have thus become unavailable. Other site locations were considered as replacements for the occupied sites.

Alternatives were chosen to allow a proper assessment of cost, tariff, technical constraints and benefits. Based on the target adjustments given by the 2003 Rate Rebasing, the implementation of an extended implementation schedule was considered. Also, separate and combined sewerage systems were compared. Water quality of the major rivers was set to improve with the implementation of the combined sewer system in the recommended scheme. Creeks and drains, however, will not benefit from any water quality improvement.

### Septage Management and Sanitation Development

Septage management programs considered the 586 $m^3$/day North and 814 $m^3$/day South SpTPs proposed in the Manila Third Sewerage Project (MTSP) complemented by a SpTP in Antipolo for the Rizal province service areas. Given that combined sewerage systems were to be implemented, the initially proposed septage capacity of 600 $m^3$/day for the Antipolo SpTP would eventually become inadequate. To accommodate the lack of a separate sewer system for the Rizal service area, two alternatives were proposed:

- The planned capacity of the proposed Antipolo SpTP should be increased to a total treatment capacity of 1,689 $m^3$/day by the year 2020.
- Construction of a separate SpTP in Binagonan or Cardona to accommodate the 1,089 $m^3$/day load from the projected increase in development of the Rizal service areas.

## 4.7 2005 MWSS Master Plan

**Get from Executive Summary**

## 4.8 Implementation of the MSSP for the West Zone

The majority of the components of the MSSP are implemented in the West Concession area. These tasks were originally targeted to be completed in 2001. However, some were completed just recently and others are still under construction.

The major tasks specified in the project included the following:

- *MSSP 1- Construction of barge-loading stations at Estero de Vitas (760 $m^3$/day) and Parañaque*

  The barge loading station in Estero de Vitas was completed in 2002. The planned construction of the Parañaque barge station was aborted because the identified site was no longer available.

- *MSSP 2-Construction of a 200 $m^3$/day Pilot Septage Treatment Plant in Dagat-Dagatan*

  This project had been completed and the facility became fully operational by April 2005.

- *MSSP 3-Strengthening of the central laboratory through acquisition of specialized equipment and materials*

  All the laboratory equipment, vehicles, and sewer maintenance equipment for both MWSI and MWCI have been delivered.

- Strengthening of the technical capabilities in the operation of sewerage systems and in the construction and supervision of a pilot septage management program.

- *MSSP 4-Upgrade of the Central Sewerage System*

  Repair and construction works are currently on-going.

- *MSSP 4-Construction of 10, 000 new sewer connections in Metro Manila*

- MSSP 7 & 8- *Construction of pilot vermiculture and aerated composting facilities.*

In 2001, an invitation for a pre-qualifying bid for the vermiculture project was posted by MWSI. GHD completed the design and bid documents for this project. None of those who responded to the invitation qualified for the requirements set by the MWSI. This project has since been aborted. The composting project was aborted due to the failure in acquiring the lot intended for the facility.

The remainder of the project had been completed and the facility was fully operational by April 2005. As such, the scope of work in the West Zone as defined in the MSSP components are heavily concentrated in the Central and Dagat-Dagatan Sewerage Systems. The status of the project implementation is discussed below.

## Manila Central Sewerage System

The scope of work identified in the rehabilitation of the Manila Central Sewerage System under MSSP was:

- Improvement of the Tondo Pumping Station covering (i) construction of a new grit chamber, odor control facility, supply/install a stand-by generating set including a generator house, and associated mechanical and electrical works, (ii) repair of existing facilities like screen gates, pumps, flow meter and instrumentation controls, and (iii) general refurbishment of the station building;
- Rehabilitation of all seven Lift Stations consisting of: (i) replacement of pumps and associated electrical / instrumentation controls, (ii) installation of new odor control facilities, and (iii) refurbishment of station house;
- Sewer lines improvement consisting of: (i) cleaning and CCTV inspection of sewer lines including the Pasig River siphon and Bay outfall, (ii) repair of sewer lines and raising of buried manholes, and (iii) supply / install flap gates.
- Installation of 10,000 service connections including acquisition of excavation permits from concerned government agencies;
- Various additional works identified during the project construction.

As of closure of the World Bank loan on 30 June 2005, the rehabilitation works by the Contractor were substantially complete. The Contractor started work on 5 October 2001 for a contract duration of 540 days, but this was extended five times, to end similarly with the loan closure. Remaining minor works are assumed by the MWSI.

## Dagat-Dagatan Sewerage System

The system upgrade and rehabilitation of the Dagat-Dagatan wastewater treatment plant, the upgrade of the pumping system, and the construction of the Septage Treatment Plant are under the project entitled "Construction of Septage Treatment Plant and Rehabilitation/Upgrading of Existing Sewage Treatment Plant at Dagat-Dagatan". The funding for the project was part of an MWSS loan from the IBRD (Loan no. 4019 PH). Consultancy services were provided by SKM, in association with TCGI Engineers. The construction contract was awarded to JVACC-JEMCO Joint Venture.

Rehabilitation work included the following:

- Dewatering of and sludge removal from the four lagoons, replacement of riprap embankment and construction of baffled walls, and installation of a total of eight floating mechanical aerators on the two aerated lagoons (with an OTR of 50 kg/hr).
- Removal and replacement of four major pumps and associated piping, complete replacement of all mechanical and electrical systems, and a wide variety of general site improvements.
- Construction of the Septage Treatment Plant.

Over 20,000 $m^3$ of sludge was removed from the lagoons since desludging operation started in December 2003. Desludging operations was contracted to MV Vidal Co, which hauled the sludge to Batangas for application to agricultural land. The sludge removed from the lagoons in excess of the 20,000 $m^3$-contracted volumes is currently stockpiled within the WWTP site. Only the aerated lagoon of module 1 remains undesludged. Desludging operation is expected to be completed by the end of April 2005.

The four old pumps in the pumping station have been removed and replaced with four new pumps equipped with an emergency power generator. The pumping station features two rising mains: two pumps are normally allocated to the 500 mm diameter main, and the other two to the 700 mm diameter main. The normal operation of the pumps will provide alternate use of the two rising mains,

with the 500 mm main directed to module 1 and the 700 mm main directed to module 2. A reconstructed inter-connecting valve array at the downstream end of the rising mains just prior to the lagoons at the WWTP allows this selection to be varied.

The SpTP occupies approximately 1.2 ha within the vicinity of the WWTP. It has a design capacity to dewater approximately 200 kL of sludge in an ordinary working day (1 8-hr shift). Over a year, it can treat septage from 10,000 septic tanks. The SpTP was commissioned in 17 January 2005 and operated 5 days each week. This was part of the 3-week commissioning period which ended in February 4, 2005. Currently four operators operate the plant on each of the 2 8-hour shifts. The SpTP became fully operational in 1 April 2005. In all, 32 vehicles are available: 7 dewatering units, 19-$10m^3$ vacuum trucks, and 6-$4m^3$ vacuum trucks. Typically, a $4m^3$ truck can accommodate septage from 2-3 households. The current fleet has 14 new vehicles, of which, only 5 were used during the commissioning period.

# 5. UPDATED MWSI SEWERAGE and SANITATION PROGRAM

## 5.1 Current Situation of MWSI Sanitation and Sewerage Services

Maynilad is now operating four sewerage systems serving around 10 % of the total population under the West Concession Area and a Septage Treatment Pilot Plant serving around 28%. These are the followings;

- Central Manila Sewerage System (CMSS)
- Dagat-dagatan Sewerage System
- Quezon City Communal System
- Makati Isolated Sewerage System
- Dagat-dagatan Septage Treatment Plant

(1) Central Manila Sewerage System (CMSS)

The CMSS covers 70 % of the total area of the City of Manila. The system currently serves around 47,000 sewer service connections. The wastewater generated within the area is collected through sewer service connections, conveyed to the Tondo terminal pumping station and pumped out to about 3.9 km away from the shore of Manila Bay through a 1,800 mm-diameter sea outfall. The system is newly rehabilitated under MSSP-4 project funded by the World Bank.

The rehabilitation of Tondo Sewage Pumping and seven lift stations improved the overall performance of sewage collection in the Central Manila Sewerage System. The replacement of old pumps by new ones; additional mechanical bar screens, aerated grid removal plant, instrumentation equipment, and introduction PLC systems not only into Tondo pump control but seven lift stations, enhanced its pumping functioning and ensured uninterrupted sewage collection. Thus, there is a significant reduction of pollution discharged in inland creeks via the closure of bypasses, repair of damaged sewer line and installation of flap gate. The bay outfall system was also inspected and repaired which enhanced the sewage dispersion capability of the outfall.

The current technical information of the CMSS is as follows;

**Central Manila Collection System**

- Capacity 432,000$m^3$/d
- Average Loading 100,000$m^3$/d
- Components

  1,800mm diameter Diffuser Outfall w/c extends-3.5 km offshore,

300 km sewer network,

Tondo Terminal Pumping Plant 750 kW x 2 variable speed pumps
480 kW x 2 fixed speed pump
1 mechanized bar screen
1 mechanized grid chamber

Seven Lift Stations (submersible pump)

| | |
|---|---|
| Sta. Cruz L.S. | 5 units of 63 kW pumps |
| Legarda L.S. | 3 units of 25 kW pumps |
| Port Area L.S. | 3 units of 4.6 kW pumps |
| Luneta L.S. | 4 units of 43 kW pumps |
| Malate L.S. | 4 units of 43 kW pumps |
| Paco L.S. | 3 units of 25 kW pumps |
| Sta. Ana L.S. | 3 units of 25 kW pumps |

(2) Dagat-dagatan Sewerage System

Dagat-dagatan sewerage system covers an area of 332 Ha serving some parts of Malabon, Navotas, and Caloocan. It has more than 2,800 sewer service connections. Wastewater generated at the area is collected by the system through sewer service connections, conveyed and pumped to a lagoon system where it will stay for more than 20 days to undergo biological treatment. The effluent is eventually discharged to the Maypajo Creek. The system has rehabilitated under the MSSP 2 project, and the rehabilitation of the sewage pumping station, installation of new surface aerators, construction of baffle walls, and desludging of the lagoon led to the reduction of pollution being discharges to Maypajo Creek has addressed problems in the past on non compliance with effluent standards in terms of total coliform and oil and grease.

The technical information about the system are as follows.

**Dagat-dagatan Sewage Treatment System**

- Capacity 13,000$m^3$/d
- Average Loading 4,000$m^3$/d
- Component

  67 km sewer network

  Sewage Pumping Plant

  1.5 km forced main

  Oxidation Ponds Two modules of a unit with;
  Aerated pond, facultative and polishing pond,
  Detention time of 8 days.

(3) Quezon City Communal System

The Quezon City communal system serves Project 7 and Project 8 in Quezon City. There are about 3,999 sewer service connections in this area. Wastewater generated in the area is collected by the system through sewer service connections and conveyed to a communal septic tank. The effluent is discharged to Culiat Creek/Dario River.

**The main components of the system include:**

- Four Communal Septic Tanks
- One Imhoff Tank
- 18 Km Sewer Line

The imfoff tank is planned to renovate and install a small sized sludge treatment system in the same site under another project.

(4) Makati Isolated System

The wastewater generated by around 900 customers from Magallanes Village is being conveyed to the Magallanes Sewage Treatment Plant, which being operated by the Manila Water. This plant has been renovated following the recommendation by MSSP 2 project.

(5) Dagat-dagatan Septage Treatment Pilot Plant

A septage treatment plant with capacity of 450 $m^3$ per day was constructed as a pilot plant under the MSSP 2 project. It is located at the existing wastewater treatment site at Dagat-dagatan, Caloocan City. Regular desludging of customers' septic tanks is being conducted once every 5 to 7 years to help in the reduction of pollution loading entering public drain and waterways. All septage collected by vacuum vehicles is brought to this plant for dewatering and excluded sewage water during dewatering. The septage sludge or biosolids produced by the plant is being used as soil conditioner in sugar cane plantations. Around 10,000$m^3$ /year of the biosolids are provided to sugar cane farmers in Floridablanca and Bacolor Pampanga. This research project started in 2004 in cooperation with the Sugar Regulatory Administration, and now the biosolids is now recognized and certified by the Fertilizers and Pesticides Authority as a soil conditioner. The followings are the technical information of the system

- Main Equipment 2 acceptance units with screening and grit removal capability.
  400$m^3$ equalization tank.
  Polymer dosing unit.

3 dewatering units

- Type of Treatment — Flocculation/Coagulation, Dewatering
- Capacity — 450 $m^3$ (16 hour-operation/day)
- Sludge Quality — 20 to 25% dry cakes

## 5.2 MWSI Business Plan

MWSI reviewed their business plan in 2007. The development plan was established in 2002 and reviewed in 2007. The actual data for 2007 showed lower achievement figures than the target values made in 2002. When the each five year development project plan starts from 2006, the target years to identify their achievement level against the development plan are 2006, 2011, 2016, and final target year of 2021, As of year of 2008, the project implementation plan should base on the plan of 2002, that is, catching up the plan of 2002 in the year of 2011 shall be prepared. Therefore, the service coverage development plans are keen to the year of 2011 for sanitation services and keen to the year of 2016 for sewer services. According to the plan, the projected population of their service territory, and the sanitation and sewerage service coverage gradation in percentage, are as shown in Table. 5-1 to 5-3.

**Table. 5-1 Projected Population**

| PROVINCE,CITY & MUNICIPALITY | Population of Districts | | | | |
|---|---|---|---|---|---|
| | Actual (Year of) | | Projected (Year of) | | |
| | 2006 | 2007 | 2011 | 2016 | 2021 |
| NCR (MWSI) | 7,776,321 | 7,939,993 | 8,324,092 | 8,765,928 | 9,142,557 |
| Manila | 1,486,603 | 1,497,440 | 1,499,626 | 1,499,626 | 1,499,626 |
| Quezon City | 1,766,674 | 1,825,394 | 1,938,675 | 2,078,179 | 2,200,191 |
| Caloocan | 1,359,220 | 1,388,780 | 1,487,639 | 1,603,920 | 1,707,362 |
| Malabon | 361,351 | 364,852 | 381,497 | 397,723 | 410,162 |
| Navotas | 243,947 | 246,046 | 258,582 | 271,107 | 281,079 |
| Valenzuela | 560,778 | 573,047 | 606,440 | 644,462 | 676,737 |
| Las Piñas | 526,620 | 535,208 | 562,490 | 591,540 | 615,070 |
| Makati | 84,107 | 88,789 | 92,385 | 95,400 | 95,400 |
| Muntinlupa | 445,696 | 456,610 | 480,965 | 508,788 | 531,969 |
| Parañaque | 542,411 | 557,857 | 592,440 | 633,857 | 669,860 |
| Pasay City | 398,914 | 405,970 | 423,352 | 441,327 | 455,101 |
| CAVITE (MWSI) | 983,852 | 1,021,636 | 1,135,904 | 1,276,175 | 1,419,465 |
| Bacoor | 426,724 | 448,616 | 508,656 | 587,412 | 670,020 |
| Cavite City | 104,096 | 104,824 | 113,047 | 120,872 | 128,211 |
| Imus | 247,277 | 256,151 | 277,476 | 301,643 | 325,000 |
| Kawit | 75,050 | 77,092 | 85,417 | 95,079 | 104,750 |
| Noveleta | 38,563 | 39,665 | 44,545 | 50,416 | 56,424 |
| Rosario | 92,143 | 95,288 | 106,762 | 120,754 | 135,059 |
| OVERALL - MWSI | 8,760,173 | 8,961,630 | 9,459,996 | 10,042,103 | 10,562,022 |

**Table. 5-2 Sewer Service Coverage**

| PROVINCE,CITY & MUNICIPALITY | Sewer Service Coverage (%) | | | | |
|---|---|---|---|---|---|
| | Actual (Year of) | | Targeted (Year of) | | |
| | 2006 | 2007 | 2011 | 2016 | 2021 |
| NCR (MWSI) | 10% | 9% | 12% | 35% | 49% |
| Manila | 35% | 34% | 34% | 43% | 53% |
| Quezon City | 2% | 2% | 17% | 47% | 58% |
| Caloocan | 0% | 0% | 0% | 32% | 63% |
| Malabon | 2% | 1% | 1% | 31% | 51% |
| Navotas | 9% | 10% | 8% | 52% | 77% |
| Valenzuela | 0% | 0% | 0% | 33% | 53% |
| Las Piñas | 0% | 0% | 0% | 0% | 0% |
| Makati | 9% | 8% | 8% | 8% | 8% |
| Muntinlupa | 0% | 0% | 0% | 55% | 66% |
| Parañaque | 0% | 0% | 0% | 0% | 0% |
| Pasay City | 0% | 0% | 0% | 10% | 19% |
| CAVITE (MWSI) | 0% | 0% | 0% | 0% | 0% |
| Bacoor | 0% | 0% | 0% | 0% | 0% |
| Cavite City | 0% | 0% | 0% | 0% | 0% |
| Imus | 0% | 0% | 0% | 0% | 0% |
| Kawit | 0% | 0% | 0% | 0% | 0% |
| Noveleta | 0% | 0% | 0% | 0% | 0% |
| Rosario | 0% | 0% | 0% | 0% | 0% |
| OVERALL - MWSI | 9% | 8.93% | 11% | 31% | 43% |

**Table.5- 3 Sanitation Service Coverage**

| PROVINCE,CITY & MUNICIPALITY | Sanitation Service Coverage (%) | | | | |
|---|---|---|---|---|---|
| | Actual (Year of) | | Targeted (Year of) | | |
| | 2006 | 2007 | 2011 | 2016 | 2021 |
| NCR (MWSI) | 22% | 29% | 45% | 51% | 54% |
| Manila | 13% | 13% | 50% | 53% | 51% |
| Quezon City | 29% | 1% | 19% | 51% | 46% |
| Caloocan | 23% | 38% | 47% | 47% | 41% |
| Malabon | 33% | 43% | 38% | 47% | 52% |
| Navotas | 5% | 18% | 53% | 43% | 26% |
| Valenzuela | 33% | 46% | 78% | 64% | 50% |
| Las Piñas | 31% | 48% | 50% | 61% | 100% |
| Makati | 14% | 14% | 0% | 0% | 92% |
| Muntinlupa | 3% | 11% | 88% | 32% | 37% |
| Parañaque | 28% | 48% | 53% | 66% | 100% |
| Pasay City | 15% | 29% | 66% | 58% | 84% |
| CAVITE (MWSI) | 8% | 20% | 52% | 54% | 100% |
| Bacoor | 20% | 41% | 60% | 61% | 100% |
| Cavite City | 7% | 12% | 84% | 96% | 100% |
| Imus | 0% | 24% | 15% | 29% | 100% |
| Kawit | 0% | 11% | 61% | 57% | 100% |
| Noveleta | 0% | 1% | 39% | 40% | 100% |
| Rosario | 0% | 1% | 23% | 25% | 100% |
| OVERALL - MWSI | 22% | 29% | 45% | 52% | 60% |

### 5.2.1 MWSI Business Territories

Concession areas of MWSI include 12 cities and 5 municipalities. In the cities, Manila, Quezon City and Makati City are partially under MWCI concession. The cities and municipalities and population in 2007 are shown in Table.5-1.

These areas are divided into 15 business units as follows.

North Caloocan

Navaliches

Valenzuela

Malabon/Novotas

Commonwealth

Fairview

Quirino

Roosevelt

South Caloocan

Tondo

Sanpaloc

South Manila

Pasay/Makati

Paranaque/Muntinlupa

Cavite/Las Pinas

Sanitation and sewerage service facilities are difficult to separate in relation with this categorized business units, however, sanitation and sewerage service management plan would be defined by the business unites.

Fig. 5-1 and Fig. 5-2 show MWSI concession areas and their business units.

### 5.2.2 Basic Strategy of Development of the Business Plan for Sewerage Services

As the business plan for sanitation and sewerage service development shown in table. 5-2 and 5-3, the principal sanitation and sewerage system shall be of the septage treatment and management service. Therefore the basic strategy of service development plan is as follows.

(1) Basic Sewerage Treatment Plan

Basically the houses/buildings shall facilitate their own septic tank systems. In the sense, the septic tank systems (conventional septic tanks) for the sewerage treatment will be prevailing in the territory. Desludge shall be done by Maynilad septage collection system by using vacuum vehicles (septage collection vehicles), and septage collected will be sent to the central septage treatment plant for the final treatment. At this moment, only Dagat-dagatan treatment plant is under operation as a test pilot plant.

In order to cover all septage generated in Maynilad service area, another septage treatment plants should be constructed to accept total septage predicted through the business plan.

Manila Water Corporation established three septage treatment plants for their service treatment of the septage generated in their territory, however, it might be studied that septage treatment plants would independently be managed to accept all septage generated in Metro Manila. At that time, the collection vehicles and septage treatment plants would be managed in monogenetic management by a new independent company.

(2) Existing Separate Sewerage Systems

Central Manila, a part of Tondo in Dagat-dagatan area, the north part of Quezon City, four communal plants, and a part of Ayala area are applying separate sewerage systems. In the Central Manila, sea outfall system through Tondo Terminal Pumping Station with seven lift-up stations is used. This system would be contribute to Manila bay area water contamination in future, therefore improvement of effluent water quality at Tondo Pumping Station shall be planned, which also expand the collecting capacity to accept the wastewater generated in the outer areas.

Dagat-dagatan sewerage system is applying aeration pond system, and the sewage plant could expand its treatment capacity by replacing the existing system to more effective process.

The four communal plants shall be rehabilitated to recover the functioning and renovated by superseding them by advanced prpocess to cater for sufficient effluent water qualities of the recent regulations.

(3) Wastewater Treatment of the Congestion Areas

There are many places where septage collection by the collection vehicles is difficult. Those areas shall basically introduce separate or combined sewerage system as communal plants. Especially San Juan River area will be urgently required to establish appropriate sewerage systems. In case that rainwater drainage system is poor or insufficient in congestion areas, separate sewerage system might be considered.

## 5.3 Basic Conception of Sanitation and Sewage Treatment Systems

Metro Manila has already been developed as a mega police with about 10 million inhabitants, which requires a big investment to cater for improving and protecting environmental conditions. Many areas in Metro Manila are massed populations and many squatters settlement are curious obstruction to develop sewerage systems. As mentioned in Section 5.2.1, many communal sewage treatment plants should supplement the areas to which the septage collection and treatment systems could not address, because of access difficulty of the collection vehicles or far distance from the septage treatment plants and not effective or economical because of small population.

The followings are the basic conception to proceed the business plan by establishing the sanitation and sewerage service facilities.

### 5.3.1 Appropriate Share of the Services by Sepatge and Sewage Management System

The main factor of the appropriate share of the services is how much level of inaccessible situation by the septage collection vehicle.

Before privatization of sanitation and sewerage service operation, According to the pre-feasibility conducted in 1991 before starting MSSP-2 project, the F.3 report summarized the septic tank parameters for Metro Manila as follows.

| | |
|---|---|
| Number of septic tanks Ng (ea) | 600,000 |

| | |
|---|---|
| Number of accessible septic tanks Na (ea) | 441,000 |
| Average septic tank volume Vs (m) | 6 |
| Septage production rate (l/cap.yr) | 32 |

Desludging activity at that time before introduction the new septage management system with 10t vacuum vehicles and septage treatment plant, desludging was done by using an engine-driven sucking pump transported to the houses by a pick-up van. This is the case.

According to the above data, inaccessible septic tank rate is 26.5% in all targeted tanks. The situation in Metro Manila would not be improved as far as septage collection circumstances, the sanitation services (desludging) should be less than 70% of service population.

Table. 5-4 shows MWSI business plan by combination of sewerage and sanitation services. (At the year of 2007, population covered by the sanitation service is much less than 2006, because the figures in year of 2006 is a prediction or target plan made in 2002, but the figures in 2007 is ones revised by actual activities). According to this table, the service sharing by the sanitation and sewerage management systems will be around 58% of overall service population by sanitation against 38% by sewerage service at the year of 2021. It seems feasible. Taking consideration Metro Manila residential area situations, expanding the sanitation service deems more efficient. However, when the septic tank is installed in congestion areas and/or a vehicle access to households is hampered by narrow roads, or when the tank is installed some distance from a road where a work vehicle can be parked, a small work vehicle can be used as a relay to a large vehicle to increase sludge collection efficiency. However, it may require a small pick-up van with an engine driven pump unit to pump up the sludge. With this system, at least 4 workers are required for each group, thus it is inefficient.

- **Fig. 5-1 MWSI Concession Areas**

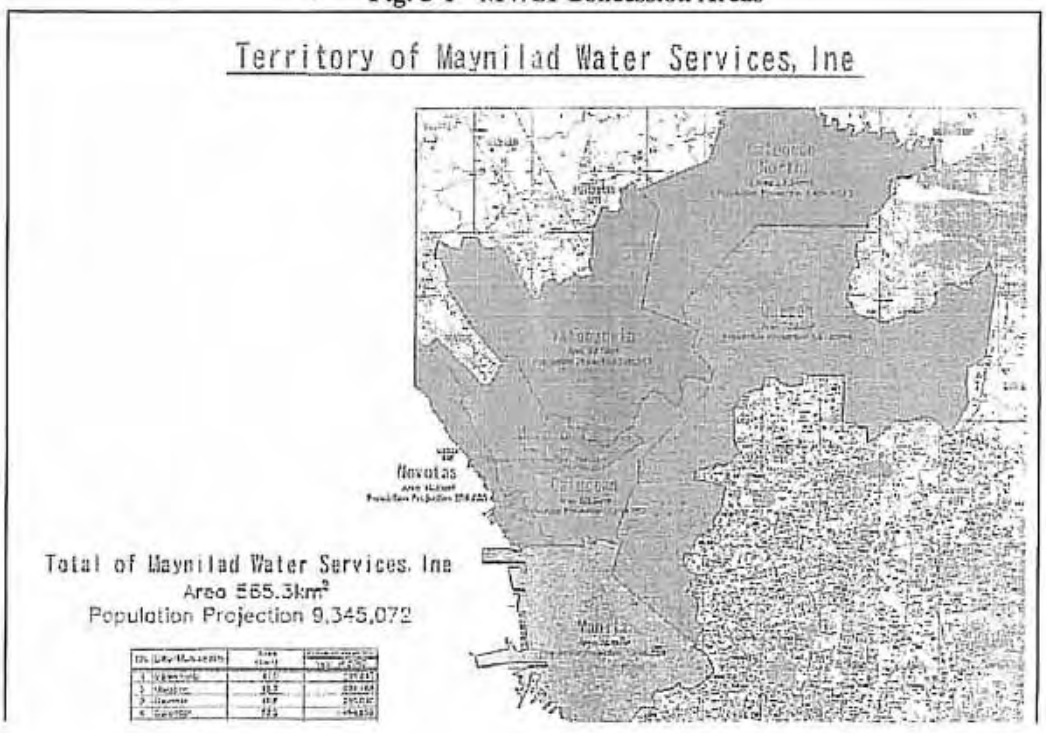


**Fig. 5-2 MWSI Business Units**

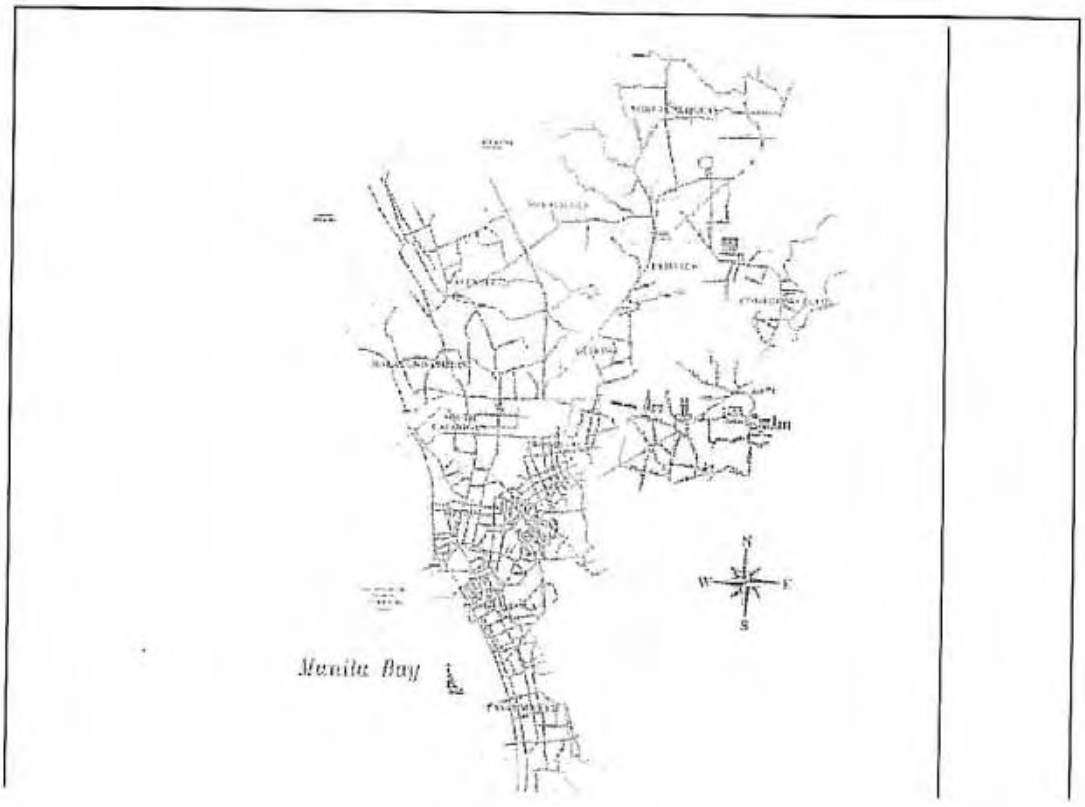


**Table.5-4 Business Plan of Development of Sanitation and Sewerage Services**

| PROVINCE,CITY & MUNICIPALITY | Population Covered by Sanitation and Sewer Service | | | | |
|---|---|---|---|---|---|
| | Actual (Year of) | | Targeted (Year of) | | |
| | 2006 | 2007 | 2011 | 2016 | 2021 |
| | Sanitation | Sanitation | Sanitation | Sanitation | Sanitation |
| | Sewerage | Sewerage | Sewerage | Sewerage | Sewerage |
| NCR (MWSI) | 1,240,716 | 457,888 | 3,085,889 | 4,014,012 | 4,438,239 |
| | 538,342 | 544,639 | 849,507 | 2,704,072 | 4,032,225 |
| | | | | | |
| Manila | 179,544 | 2,094 | 730,005 | 783,679 | 756,651 |
| | 479,958 | 486,393 | 508,135 | 631,339 | 776,284 |
| Quezon City | 470,478 | 14,083 | 336,641 | 986,552 | 960,886 |
| | 31,539 | 31,662 | 314,789 | 923,497 | 1,192,997 |
| Caloocan | 208,905 | 174,498 | 586,543 | 655,789 | 615,315 |
| | 4,373 | 4,472 | 4,472 | 439,140 | 933,690 |
| Malabon | 83,650 | 28,163 | 106,978 | 184,632 | 208,963 |
| | 4,922 | 2,410 | 2,410 | 120,112 | 208,122 |
| Navotas | 6,473 | 17,024 | 88,302 | 115,286 | 72,525 |
| | 10,436 | 12,562 | 12,562 | 140,041 | 215,641 |
| Valenzuela | 103,939 | 59,491 | 318,910 | 402,485 | 329,701 |
| | - | - | - | 204,581 | 351,161 |
| Las Piñas | 37,089 | 37,513 | 166,083 | 243,731 | 431,400 |
| | - | - | - | - | - |
| Makati | 11,879 | 400 | 400 | 0 | 86,457 |
| | 7,097 | 7,122 | 7,122 | 7,122 | 7,122 |
| Muntinlupa | 992 | 5,351 | 295,388 | 115,069 | 148,831 |
| | - | - | - | 196,146 | 262,714 |
| Parañaque | 91,254 | 72,241 | 197,780 | 273,626 | 450,589 |
| | - | - | - | - | - |
| Pasay City | 46,513 | 47,030 | 258,859 | 253,163 | 376,921 |
| | 17 | 17 | 17 | 42,094 | 84,494 |
| | | | | | |
| CAVITE (MWSI) | 17,364 | 26,798 | 360,539 | 541,328 | 1,173,326 |
| | - | - | - | - | - |
| | | | | | |
| Bacoor | 13,001 | 14,056 | 217,164 | 299,929 | 581,450 |
| | - | - | - | - | - |
| Cavite City | 4,363 | 4,966 | 74,212 | 92,325 | 103,511 |
| | - | - | - | - | - |
| Imus | | 3,322 | 21,604 | 50,276 | 210,405 |
| | - | - | - | - | - |
| Kawit | | 4,223 | 35,538 | 51,753 | 100,475 |
| | - | - | - | - | - |
| Noveleta | | 86 | 6,106 | 20,075 | 56,196 |
| | - | - | - | - | - |
| Rosario | | 146 | 5,916 | 26,970 | 121,288 |
| | - | - | - | - | - |
| | | | | | |
| OVERALL - MWSI | 1,258,080 | 484,687 | 3,446,428 | 4,555,340 | 5,611,565 |
| | 538,342 | 544,639 | 849,507 | 2,704,072 | 4,032,225 |
| GROUND TOTAL | 1,796,422 | 1,029,326 | 4,295,935 | 7,259,412 | 9,643,790 |

By the field test report in 1979, 20 septic tanks were tried to desludge by JET-VAC system and VAC-ALL system, but it did not work well. Because the technology required maintaining the machine is complex and the equipment is too large. Therefore the development project plan should not be undifferentiated in the service coverage to each district.

### 5.3.2 Parameters for Sanitation and Sewerage Projects

(1) Septage Production Rate

According to the 1991 F.3 Report, the septage production rate in Metro Manila is 32 l/cap.year. Table. 5-5 shows per capita generation rate in the other countries, including Japan.

**Table. 5-5 Per Capita Septage Generation Rate in Foreign Countries**

| Country | USA □ | Norway □ | Sweden □ | Japan □ | Korea |
|---|---|---|---|---|---|
| Per cap.year (l) | 273 | 250 | 225 | 438 | 140 |

Notes:
□ to □ :Quoted from "Handbook of Septage Treatment and Disposal, ERA (USA)
□ :In Japan, by law the sludge must be removed from combined-type septage tanks at least once a year. Also as its structure is the separated cell type, the amount removed is large. Septic tanks which treat toilet flushing only reach at 0.75 l/cap.day (274 l/cap.year).

In actual septage pumped process, 30% of the liquid zone at the lower part of the tank is pumped as well. Therefore total extracted sludge rate shall be 96 l/cap.year.

Similar type of septic tanks is also used in Korea, however, because of the life style difference and 5 to 7 year interval of the extract of sludge by MWSI, the septage generation rate shall be **100 l/cap.year.**

(2) Sewage Water Generation Rate

According to MWSI business plan reviewed in 2007, water demand at 2021 is assumed to reach at 166 l/cap.d in average. The influent water volume into sewage treatment process is assumed to include 15% ground water infiltration in the system. If 80% of water supply is discharged into the sewer lines, the wastewater generation rate should be 152 l/cap.d. As described in another chapter hereafter, new expansion or established treatment system shall use a combined sewer lines, thus actual influent into the treatment process could be 10% and more reduced. Therefore actual design parameter for the wastewater generation rate to be treated would be 136 l/cap.d. Actually to say, saving water activity in the citizen life will be encouraged more in future, so the design value for wastewater generation rate shall assume **130 l/cap.d** in average.

Taking consideration that food customs and materials in Metro Manila is similar to Korea or Japan, wastewater quality level in the countries would be applicable. Actual field analysis of the

sewage water quality was done October and November at four pumping stations in CMSS in 2007. Water qualities on $BOD_5$ base varies from 40 to 72 mg/l except one sample of Paco lift station in October, which was reported of $BOD_5$, 140 mg/l. The sampling months of November and October are still in rainy season and sewer collection system is still in perfect, the water quality might to show lower contamination than actual values. Therefore **200mg/l of $BOD_5$** of influent water quality level adopted in Japan and Korea would be applicable here in Metro Manila.

The effectiveness of septic tanks kept under good maintenance, 40% to 60% reduction of $BOD_5$ could be expected. Thus, the septic tank functioning shall be taken the value of 60% reductive pollution on $BOD_5$. In the case of combined sewer system applied, which has been used in mega towns in Tokyo, Osaka in Japan, Seoul Inchon in Korea, any counter measures for oil or grease mixture in sewage water would not be needed. Oil or grease discharge into sewer lines should be prohibited by appropriate laws. In the case of separate sewer line system applied in amusement area with lot of restaurants, oil removal process would be installed. The analysis for the oil or grease mixture in the influent of the lift stations in CMSS shows rather high level of oil or grease as much as 509 mg/l at Paco Lift Station, CMSS separate sewer line system might need oil removal process, even though Paco has any specific situation for that.

### 5.3.3 Design Conception for the Sanitation and Sewerage System Improvement

Because of lots of hampering conditions when implementing sanitation and sewerage projects in MWSI concession area, several counter measures for mitigate those situation in the master planning shall be taken.

Principal hampers against development of sanitation and sewerage projects are as follows.

(a) Difficulty to procure land for facility construction,
(b) Many congestion areas scattering in the Metro Manila to obstruct accessing to households,
(c) Difficulty for installation of new sewer lines with political and economical problems,
(d) Garbage trashing behavior into waterways,
(e) Lots of squatters settlements occupying waterways,
(f) Big traffic in the cities which would deny the traffic limitation while construction,
(g) Low perception of the residents for improving their environmental conditions, etc.

In order to address these hampers against sanitation and sewerage project implementation,

following policy shall be taken.

(a) As much as existing creeks, esteros, drainage culverts or troughs shall be used as combined sewer lines,
(b) Many communal plants of compact type and underground construction shall be planned in congestion areas,
(c) Renovate or upgrade of existing sewerage facilities,
(d) Encourage and urge septage management system by expanding or newly establishing septage treatment plants and increase the collection vehicles.

#### 5.3.3.1 Combined Sewer Application

There are many creeks, drainage culverts or troughs and esteros installed in Metro Manila. These could be as combined sewer lines for collecting and treating wastewater.

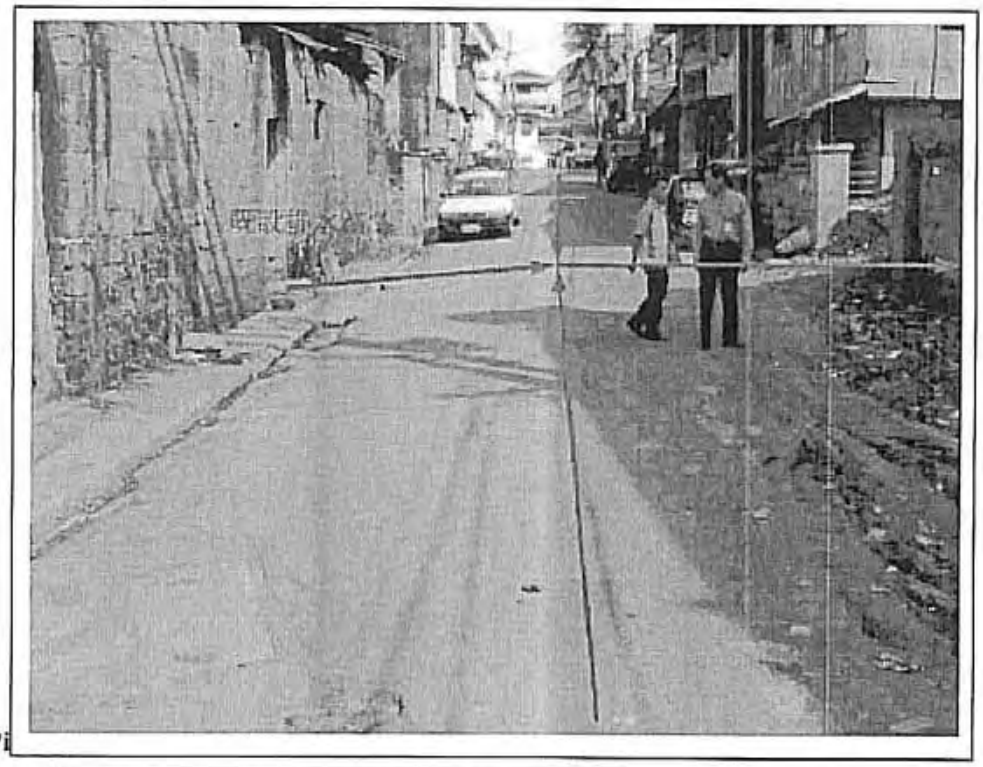
Pictures 5-1 to 5-7 show typical drainage situation in the cities.

Picture. 5-1 shows downstream of a drainage passing through the balangay and Picture. 5-2 shows crossing point at the street. Picture. 5-3 shows the downstream flow discharging to the main river. Picture. 5-4 shows the discharging point of the creek (red line), and Picture. 5-5 shows the detail of the mouth of creek to the river blue line). Picture. 5-6 shows another bigger and deeper creek discharging point into the river. Ordinarily the creek discharge point is located lowest ground level, so garbage casted out in the street are flowing on the road and gathered into the open culvert (creek). Picture. 5-7 shows the garbage accumulation at the creek discharge point.

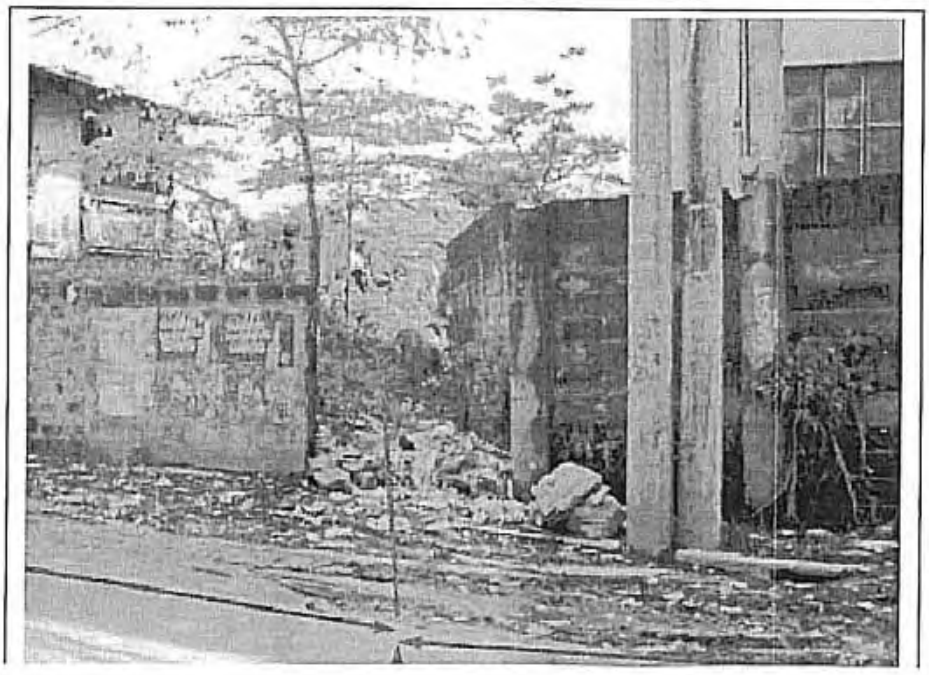
In order to get rid of the garbage, it is possible to install a screen in the creek, however, garbage clogging in the screen also block the water flow, and it would become the reason subsequently to make over flood in the upstream area. Therefore, any screens should not be installed in the creek except the case with special reason.

**Picture. 5-1 Downstream of a Creek Passing Through a Barangay**

Picture. 5-2 Crossing Point Under the Road beside the River



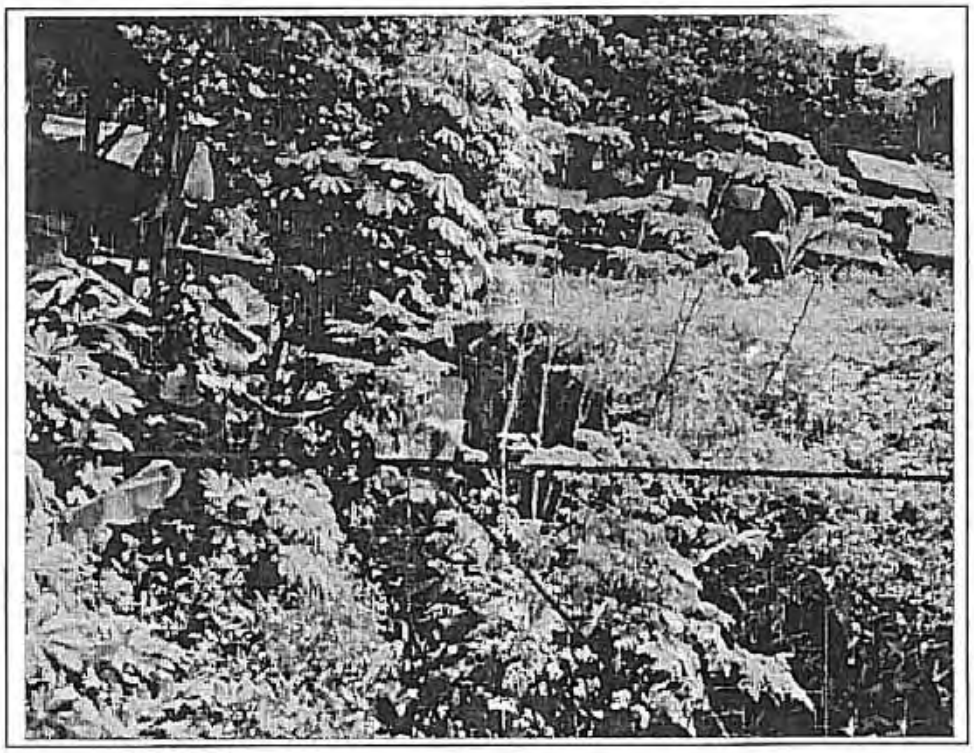
Pi



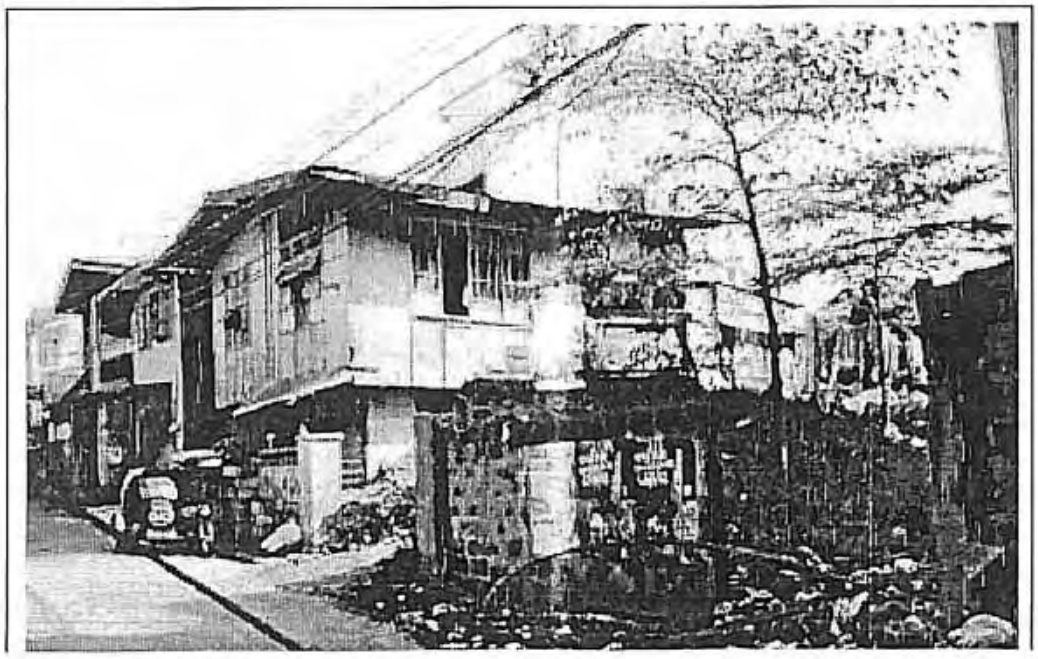
Picture. 5-4 Discharging into the River (Red: Creek, Blue: Main River)

Picture. 5-5 Detail of the Creek Discharging Mouth

Picture. 5-6 Another Creek (bigger) Meeting Point to the River

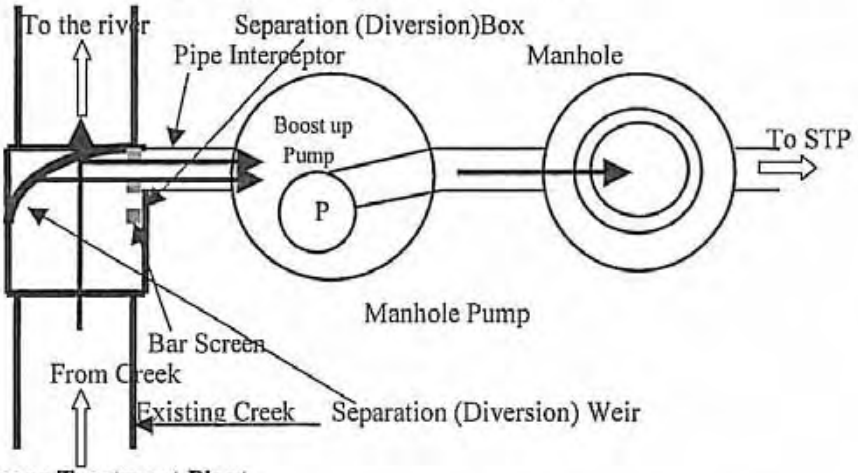


Picture. 5-7 Garbage Accumulated at the Creek Discharging Culvert



Where this creek is used as a collection sewer of sewage water, separation (diversion) manhole or box is installed at the cross point of the creek and the road (refer Picture. 5-2). In most cases, this point is lowest ground level; therefore, the pipe interceptor flow is enforced by boost-up manhole pump. Fig. 5-3 shows Separation Manhole Pump (MHP).

**Fig. 5-3 Separation (Diversion) Manhole**



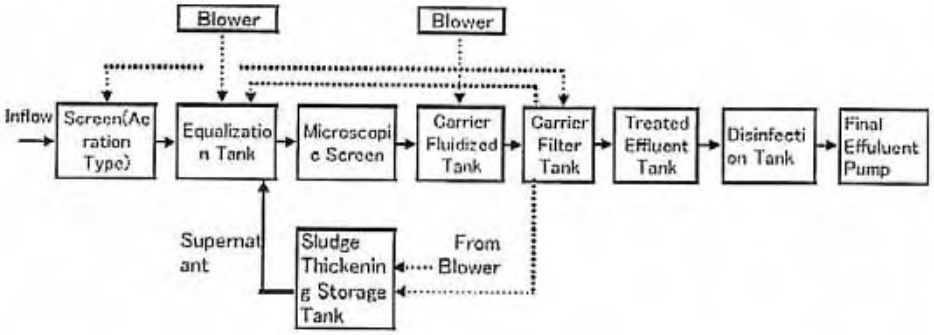

**5.3.3.2 Sewage Treatment Plant**

Because of difficulty of land procurement for the sewage treatment plant (STP), compact communal plant like small size sequential batch process (SBR), Jokasou system, etc., shall be applied. These plants could be installed underground such as public space (parks, basketball coats, etc.), parking lots or something like that, if the plant space is not found.

Fig. 5-4 shows Jokasou Process Flow, Fig. 5-5 shows a reference outline of Jokasou (100$m^3$/d) installed underground, Picture.5-8 shows Jokasou underground installation. Reference layout of SBR (2,000$m^3$/d) installed under basketball court is shown in Fig. 5-6.

**Fig. 5-4 Jokasou Process Flow**

JOKASO TREATMENT PROCESS (Carrier Fluidized Type)




JOKASO TREATMENT PROCESS (Membrane Type)

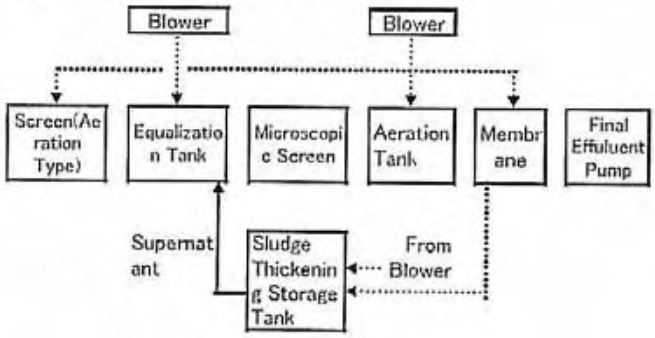
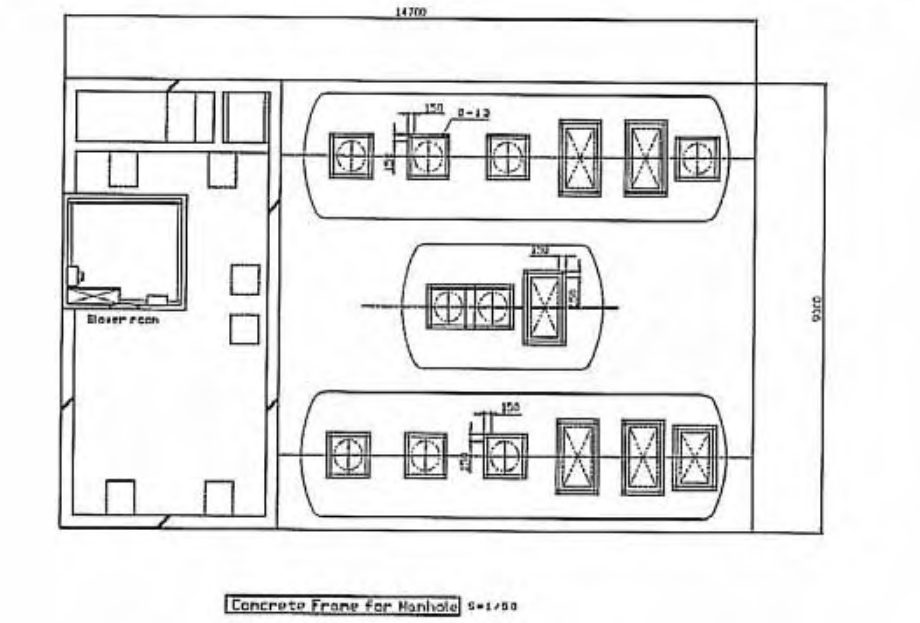
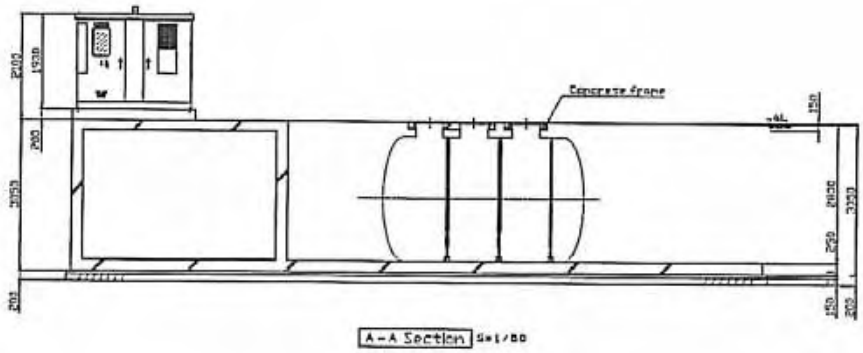
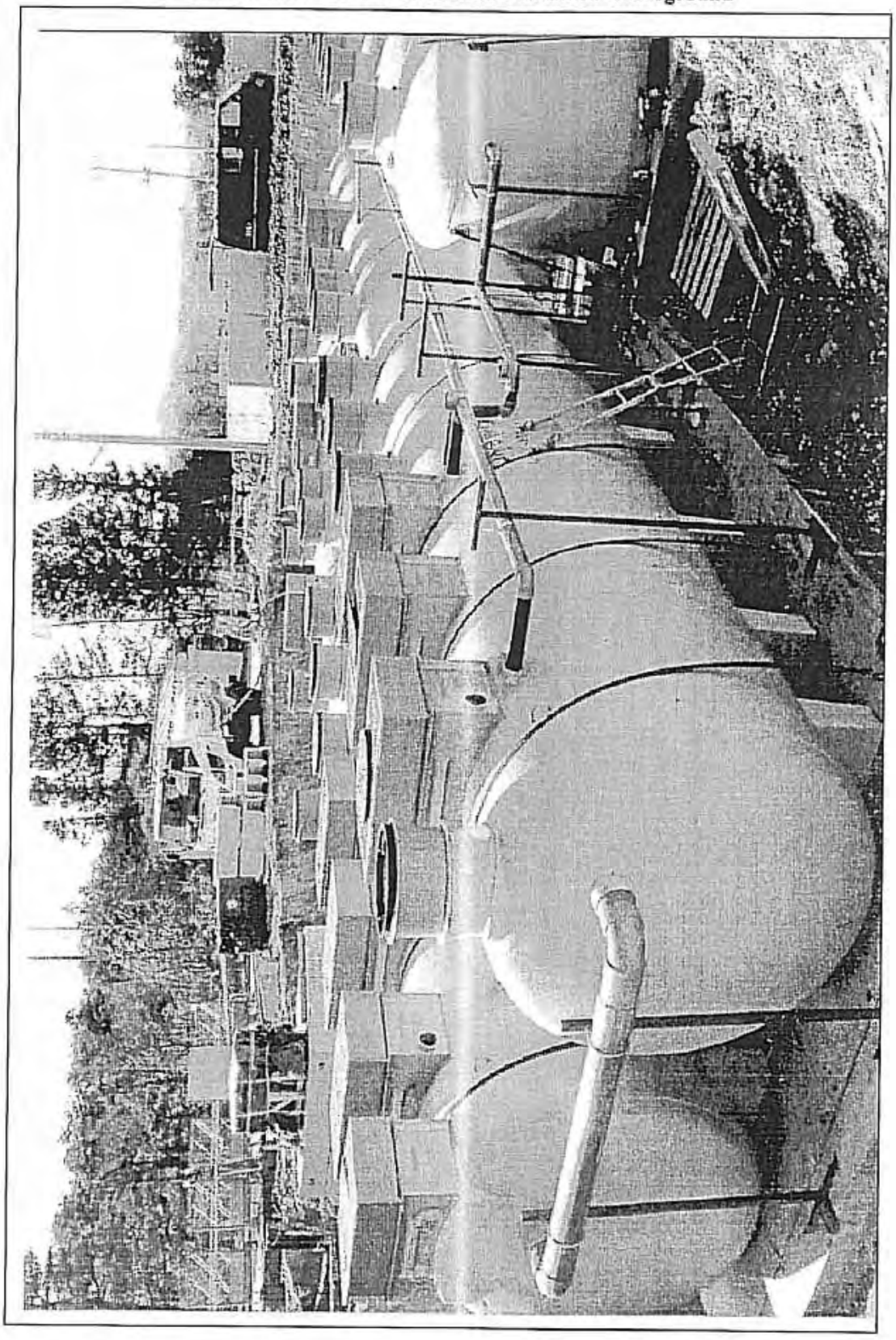


**Fig. 5-5Reference Jokasou Outline undergrounded**



Picture. 5-8Construction of Jokasou Installed Underground



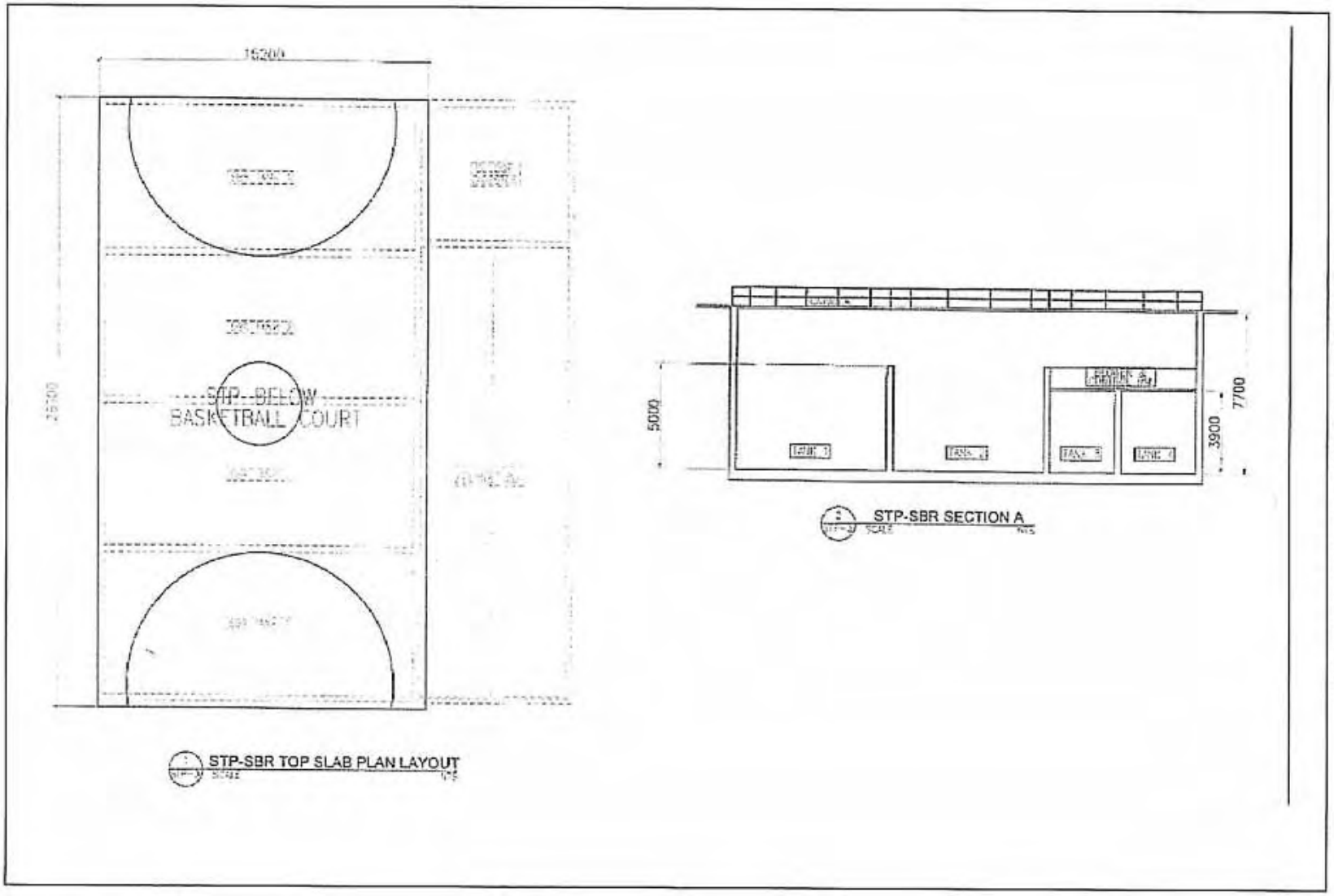



Fig. 5-6Example of SBR Installed under Basket Coat

### 5.3.3.3 Septage Treatment Plants

As far as the septage management system is applicable, this should be prioritized to cater for water pollution problems with non-treated wastewater.

Provision shall be made for septage treatment plant design to cater for random collection vehicle access to the plant, keeping continuous operation of the plant in any case of traffic accidents, laborers absent, weather troubles like typhoon attack, two or 3 shift working condition, removal stones or small materials like hairs, etc.

Because of the septage vehicle interval time to the plant, maximum commuting times to the plant should be limited under 6 times per hour. Therefore, very large septage treatment plant is not efficient and effective in aspect of distance of the houses from the plant, noise pollution and traffic problems caused by the septage collection vehicles. Fig. 5-6 shows septage treatment plant conception outline.

**Fig. 5-6 Conception of Septage Treatment Plant**

Conception Flow of Septage Treatment

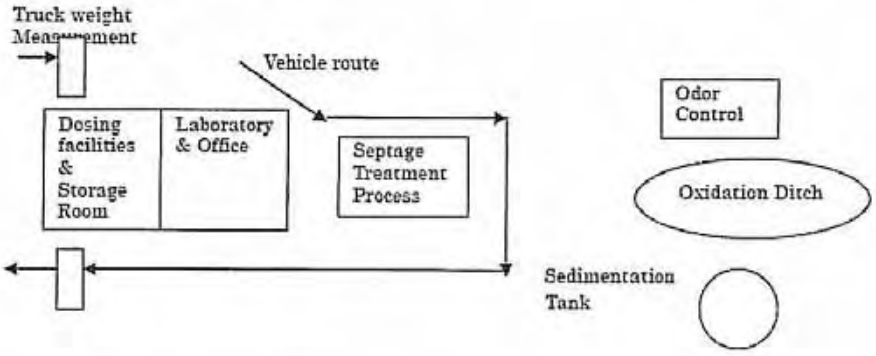
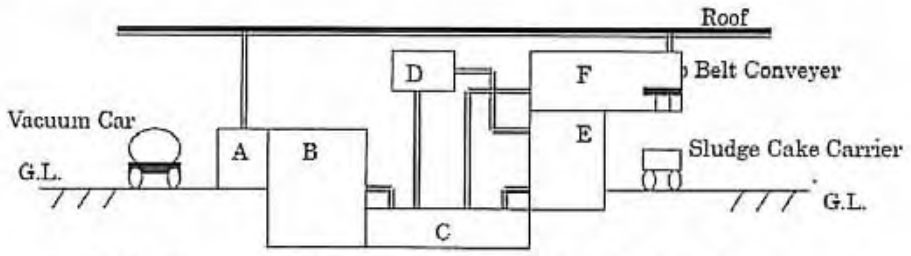



Image of Septage Treatment Plant




A: Acceptance Tank with grit collector, B: Acceptance Storage Tank, C:: Sludge Pumps,
D: Drum Screen E: Dosed Sludge, F: Dewaterers

# 6. Renovation and Development of Sewerage Systems

Maynilad is now operating four sewerage treatment systems serving 9% and a septage treatment plant serving 29% of the total population under the West Concession Area.
These are as follows;

Central Manila Sewerage System (CMSS)
Dagat-dagatan Sewerage Treatment System
Quezon City Communal Septic Tanks (4 areas)
Dagat-dagatan Septage Treatment Plant

These facilities should be renovated or upgraded to expand their service coverage. Tondo terminal Pumping Station for sewage sea outfall has the maximum capacity of 351,000$m^3$/d, but after rehabilitation of the system including 7 Lift-Up stations and collection sewers completed in 2005, the system still only covers 34% of the residential though sewer lines covering over about 70%. Regarding Dagat-dagatan sewage treatment plant has the maximum 13,000$m^3$/d against actual loading 4,000$m^3$/d in average. Quezon City communal plants have already deteriorated and reduced much of the functioning through long term operation.
Dagat-tagatan Septage Treatment Plant is well under operation, and the site and the collection vehicle access still have much tolerance.

The rehabilitation, renovation and grade-up performances should be put into practical project plans together with new establishment of the sanitation and sewerage facilities.

## 6.1 Sanitation and Sewerage Improvement Project Plan

### 6.1.1 MWSI Long Term Business Plan

According to MWSI business plan reviewed in 2007, their grand plan is summed up in Table. 6-6 (also refer table. 5-1 to 5-5):
Their plan also defines the service coverage development in percent rate for each district, however, each area has its own situation or specific hampers to implementation. Thus the overall service coverage should have more importance to follow the figures in order to develop environmental improvement in Metro Manila with Manila Bay or main rivers with tributaries.

**Table. 6-6 MWSI Long Term Development Plan for Sanitation and Sewerage Services**

| Year of | | 2007 | 2011 | 2016 | 2021 |
|---|---|---|---|---|---|
| Total Population | | 8,961,630 | 9,459,996 | 10,042,103 | 10,562,022 |
| Service Population | | 1,029,326 | 4,295,935 | 7,259,412 | 9,643,790 |
| Service Category | Sanitation | 29% | 45% | 52% | 60% |
| | Sewerage | 9% | 11% | 31% | 43% |

According to table. 6-6, the service coverage of Maynilad service in the final stage at 2021 will reach at 88.6% of overall population predicted in the year of 2021.

Judging from the foreign countries environmental improvement after their sanitation and sewerage service coverage accomplished as their plan, MWSI plan would be evaluated as follows.

56% (45%+11%) would be appreciably perceived by resident feeling much environmental improvement. 70% coverage of the services is sufficiently good for people to feel the environmental conditions or pollution significantly improved. And after this, spontaneous recovery could be expected on the remaining pollutants. Thus 82%(52%+31%) coverage in the year of 2016 would be sufficient.

### 6.1.2 Implementation of Sanitary and Sewerage Service Project Plan

The plans shall be studied for each city or municipality. MWSI business units might be important to operate and manage their organization.

## 6.2 Sewerage Service Development Project

### 6.2.1 Central Manila

Population of Manila is 1,497,440 in 2007 and projected 1,499,626 in 2021. Sewerage system of Tondo Ocean Outfall is covering 70% with sewer lines, but service population in 2007 is 486,393 (9%). The business plan targets the service population in 2021 for 776,284 (53%) by sewerage system, and 756,651 (51%) by sanitation service. Sanitation service population is now only 2,094 (0.14%) at the year of 2007.

Tondo effluent was reducing every year from 2000 because of pipe damage and deterioration, then rehabilitation program started in 2002 and completed in 2004. Then effluent is now increasing every year.

If the sewer line is completed, sewage water per capita would be 150 l/cap.d including groundwater infiltration 15%. In that case, Tondo discharging flow rate must be 72,950 $m^3$/d, against actual flow rate of 14,716 $m^3$/d, almost double rate.

Discharge Record of Effluent at Tondo Pumping Station

(Unit: $m^3$)

| Year / Month | 2000 | 2001 | 2002 | 2003 | 2004 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|
| | Monthly | Monthly | Monthly | Monthly | Monthly | Monthly | Monthly | Monthly |
| January | 4,868,676.00 | 4,958,388.00 | 3,807,468.00 | (No data) | 2,779,567.20 | 4,029,628.00 | 3,401,530.00 | 3,966,160.00 |
| February | 4,531,068.00 | 4,299,300.00 | 3,141,540.00 | (No data) | 1,717,758.00 | 3,589,634.00 | 3,126,650.00 | 3,721,080.00 |
| March | 4,825,005.00 | 3,658,968.00 | 3,189,276.00 | (No data) | 1,763,672.40 | 4,011,270.00 | 3,983,240.00 | 3,542,690.00 |
| April | 4,739,328.00 | 3,517,308.00 | 3,290,436.00 | (No data) | 2,520,424.80 | 2,598,180.00 | 3,352,600.00 | 3,694,040.00 |
| May | 5,044,500.00 | 3,516,804.00 | 3,114,576.00 | (No data) | 2,982,729.60 | 3,098,220.00 | 3,716,750.00 | 4,508,000.00 |
| June | 4,521,888.00 | 3,116,808.00 | 2,988,158.00 | (No data) | 2,909,613.60 | 3,098,220.00 | 3,678,530.00 | 4,263,490.00 |
| July | 5,324,148.00 | 3,696,300.00 | 3,069,522.00 | (No data) | 1,741,712.40 | 2,786,630.00 | 3,580,980.00 | 4,467,660.00 |
| August | 5,144,256.00 | 3,453,444.00 | 3,187,519.00 | (No data) | 3,084,426.00 | 3,375,090.00 | 4,184,250.00 | 4,117,460.00 |
| September | 4,786,164.00 | 3,450,528.00 | 3,311,568.00 | (No data) | 3,083,454.00 | 3,141,380.00 | 4,121,370.00 | 3,717,180.00 |
| (Sum to Sept.) | 43,785,033.00 | 33,667,848.00 | 29,100,063.00 | 0.00 | 22,583,358.00 | 29,728,252.00 | 33,145,900.00 | 35,997,760.00 |
| Rate to 2000 (%) | ------ | 76.89 | 66.46 | ------ | 51.58 | 67.90 | 75.70 | 82.21 |
| October | 4,818,412.00 | 3,481,092.00 | (No data) | (No data) | 2,412,619.20 | 3,574,440.00 | 4,069,710.00 | 3,884,570.00 |
| Nobember | 4,582,872.00 | 3,237,192.00 | (No data) | (No data) | 3,327,980.40 | 3,793,050.00 | 4,076,550.00 | (No data) |
| December | 4,561,200.00 | 3,491,172.00 | (No data) | (No data) | 2,814,102.00 | 3,374,740.00 | 4,181,140.00 | (No data) |
| Total | 57,747,517.00 | 43,877,304.00 | 38,379,698.90 | ------ | 31,138,059.60 | 40,470,482.00 | 45,473,300.00 | 51,361,552.78 |
| Rate to 2000 (%) | ------ | 75.98 | 66.46 | ------ | 53.92 | 70.08 | 78.75 | 88.94 |
| Daily Average | 158,212.38 | 120,211.79 | 105,149.86 | ------ | 85,309.75 | 110,878.03 | 124,584.38 | 140,716.58 |

Notes: 1. Red letters show monthly maximum in the year

2. Blue letters show assumption volumes

Rehabilitation Project completed (Pumps & Sewerpipes)

Table. 6-7 Discharge Record of Tondo Pumping Station

If the sewer line is well rehabilitated and recovers tight connection to avoid much water infiltration, the sewage water per capita in CMSS would be reduced, however, at this moment per capita in this system shall be assumed as 300 l/cap.d.

The service coverage population in 2021 is projected 776,284, so over all influent flow rate into the system will be 232,885 $m^3$/d (substantial). The Tondo Sea Outfall system has the maximum capacity of 351,014 $m^3$/d, therefore the system has more acceptance capacity of 118,129 $m^3$/d, which means this system could accept wastewater generated by the population of 900,000 from the other neighboring area, such as Quezon City, Makati City and Pasay City by connecting combined sewer lines from the areas (in this case, sewage water per capita is assumed 130 l/cap.d, however, referring actual flow rate, the maximum population would be **300,000**).

Sewerage Service Development Project for Manila is as follows.

(1) Sewer Line Connections

Tondo Sea Outfall System has an enough capacity and 70% sewer line coverage, which means that MWSI should promote and encourage the people to connect the households to the lines to accomplish the service coverage development program described in the business plan. Reduction of the connection fee may be required.

(2) Improve Discharge Water Quality at Tondo Terminal Pumping Station

CMSS is applying sea outfall of sewage water directly into Manila Bay through Tondo Terminal Pumping Station. The water quality level discharging into Manila Bay is regulated under 100 mg/l of BOD or less. **Table. 6-8** shows sampling data of wastewater analysis at the lift up pumping stations after completion of rehabilitation program in 2005.

**Table. 6-8 Sampling Water Analysis in Tondo Sewerage System**

| | Paco L.S | | Malate L.S | | Legarda L.S | | Tondo P.S | |
|---|---|---|---|---|---|---|---|---|
| | 10/26/07 | 11/26/07 | 10/26/07 | 11/26/07 | 10/26/07 | 11/26/07 | 10/26/07 | 11/26/07 |
| Dissolved Oxygen | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Suspended Solids | 1,010 | 240 | 30 | 72 | 270 | 95 | 38 | 58 |
| BOD5 | 140 | 40 | 62 | 40 | 72 | 61 | 59 | 61 |
| COD | 3,523 | 156 | 330 | 312 | 222 | 257 | 157 | 162 |
| Oil & grease | 509 | 84 | 5.8 | 18 | 55 | 16 | 7.1 | 16 |

These sampling was conducted during the rainy season, and only small and short term data were taken. Regarding $BOD_5$, only the number in Paco on 26 of October, 2007 is over 100mg/l (140mg/l) and the other data are less than 100 mg/l. Even though many points of

sewer line network have been repaired under MSSP-2 rehabilitation program, many piping connection parts are remained insufficient sealing; so much groundwater and rainwater are coming into the network and diluting the sewage water. And in low ground level area, sometimes people open the covers of manholes to discharge the rainwater pooling on the street into the network. However, during dry seasons or as rehabilitation is promoted, sewage water quality discharging into Manila Bay must be aggravated.

It is ideal that a sewage treatment plant is installed between the discharging point and Tondo pumping station, but because of many problems anticipated to prepare an enough space for a sewage treatment plant to construct in the area and financial reason; this option would be selected at the last. If available space for setting the treatment process in the CMSS is found in the 7 lift-up pumping station sites, it is realistic idea to install the wastewater treatment facilities in the spaces, however, too much small to install the conventional sewage treatment system in the sites. Therefore minimum sewage process, that might be possible to reduce overall water quality at the final discharge point down to 100mg/l of $BOD_5$, shall be studied, that is, partial treatment system might be adopted.

The point lies in how to efficiently carry out treatment within the limited space of the pump stations. A similar approach to the combined flow improvement countermeasures are taken with applications of sedimentation tanks, swirl distribution tanks, or the fiber media rapid filtration method. However, due to the limited space available in this case, any economical and smaller sized system in these counter measures could not satisfy the minimum objective. Thus, it is not possible to avoid applying the fiber media rapid filtration method at selected pumping stations comparably having larger space to contain the system inside, and grade-up level of water quality shall be 100mg/l in total. Influent sewage water quality into the system shall be assumed finally to rise up to as much as 120mg/l in total average during dry seasons. The possible sites to install the treatment facility to cater for their own influent wastewater volume to be treated at each station are not found except Leagrda, Sta Cruz and Luneta. The calculation results to realize the final effluent water quality kept less than 100mg/l on $BOD_5$ base by installing two rapid filters with 60,000$m^3$/d at Luneta and Sta. Cruz are shown in Table 6-9.

**Table. 6-9 Effluent Water Quality after Installation of Rapid Filters**

| Lift Pumping Station (LS) | Design sanitary sewage flow discharged ($m^3$/day) | Installation of Sewage Treatment Process | Sewage Water Volume treated ( ($m^3$/day) | Influent Water Quality (mg/l) | Effluent Water Quality (mg/l) |
|---|---|---|---|---|---|
| Legarda LS | 108,691 | × | — | 120 | 120 |
| Sta Cruz LS | 132,480 | o | 66,000 | 120 | 90.1 |
| Port Area L.S | 1,382 | × | — | 120 | 120 |
| Sta Ana LS | 23,328 | × | — | 120 | 120 |
| Paco LS | 76,090 | × | — | 120 | 120 |
| Malate LS | 97,805 | × | — | 120 | 120 |
| Luneta LS | 129,312 | o | 66,000 | 120 | 89.4 |
| Tondo & Dagupan Sys. | 156,153 | × | — | 120 | 120 |
| Tondo Outfall | 351,014 | — | 120,000 | 97.4 | 97.4 |

(Note)

1. Total flow rate refers the central manila sewerage system flow rate in NWDCN-SW (Improvement of National Water Data Collection Network-Stream flow Monitoring) report issued 23 March 2001 by MWSI.
2. Average sewage water quality is assumed less than 120mg/l, and consequently total outfall water quality shall be less than 97.4mg/l.

As shown in Table 6-9, it is possible to clear the total effluent quality less than 100mg/l in total average (96.5mg/l) at the year of 2021.

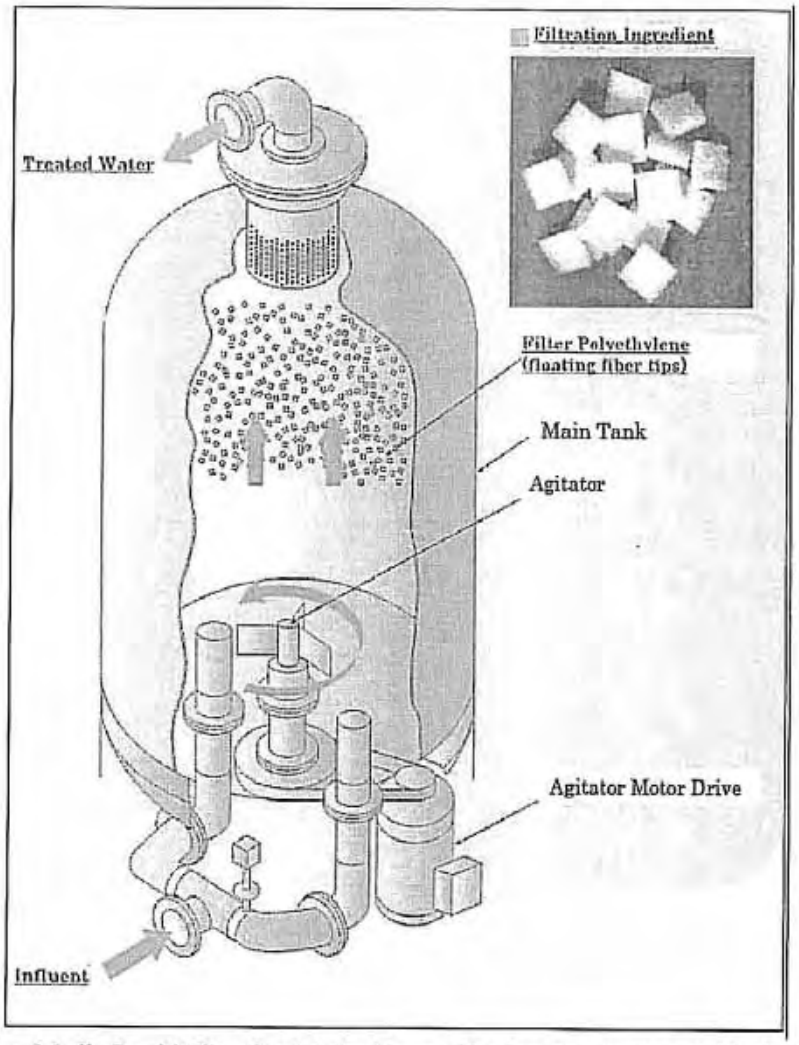
The assumption of the raw sewage water quality is less than 120mg/l, however, if 66,000m3/d equipment is added to Legarda, total effect of the filtration process could cater for raw wastewater quality of 137mg/l, however the total efficiency is getting down. In this calculation, the design flow rate (the maximum system capacity) is used; however, actual flow rate projected in 2021 is only 232,885 $m^3$/d in total against 351,014 $m^3$/d which is used in the calculation.

Table. 6-10 shows actual flow rates in Luneta and Sta. Cruz. In the year of 2001, sewage water flow rates in average of Luneta and Sta. Cruz are 43,115 $m^3$/d and 41,392 $m^3$/d respectively, while design values shown in Table. 6-9 are 129,312 $m^3$/d and 132,480 $m^3$/d respectively

As described later section, this CMSS could receive wastewater generated in Quezon City and Pasay City up to additional 90,000$m^3$/d.

Fig. 6-7 shows Fiber Media Rapid Filtration Facility.

**Fig. 6-7 Fiber Media Rapid Filtration Method**




Fiber Media Rapid Filtration Method is an effective measure to get rid of the Suspended Solid in the wastewater together with undissolved organic matters rapidly in large quantity. Figure 1 shows the process structure. The wastewater is entering from the bottom side of the filtration tank and in the process to the reaching upper side filtration layer; solids with faster thinking velocity of gravity than upstream speed are settling out and removed. The remaining solids with undissolved organic matters are caught out by the filtration polyethylene fiber while upstream wastewater is passing through floating ingredient. Therefore the following merits are realized;

a) High velocity stream require smaller size against large volume of wastewater,
b) No chemical dosing is required, so easy maintenance is realized,

Table. 6-10Effluent Value ay Luneta and Sta. Cruz

| | 2000 | | | | 2001 | | | | 2002 | | | | 2004 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Luneta | | Sta.Cruz | | Luneta | | Sta.Cruz | | Luneta | | Sta.Cruz | | Luneta | | Sta.Cruz | |
| | Running Hours | Effluent $m^3$ | Running Hours | Effluent $m^3$ | Running Hours | Effluent Vol Liter | Running Hours | Effluent $m^3$ | Running Hours | Effluent $m^3$ | Running Hours | Effluent $m^3$ | Running Hours | Effluent $m^3$ | Running Hours | Effluent $m^3$ |
| Jan | 1,282 | 1,892,232 | 723 | 1,074,956 | 1,285 | 1,896,660 | 1,052 | 1,564,113 | 974 | 1,437,624 | 612 | 909,921 | 0 | 0 | 0 | 0 |
| Feb | 1,241 | 1,831,716 | 658 | 978,314 | 1,248 | 1,842,048 | 996 | 1,480,852 | 717 | 1,058,292 | 370 | 550,116 | 0 | 0 | 0 | 0 |
| Mar | 1,295 | 1,911,420 | 724 | 1,076,443 | 902 | 1,331,352 | 849 | 1,262,293 | 549 | 810,324 | 431 | 640,810 | 0 | 0 | 0 | 0 |
| Apr | 1,274 | 1,880,424 | 679 | 1,009,537 | 505 | 745,380 | 612 | 909,921 | 194 | 286,344 | 461 | 685,414 | 0 | 0 | 81 | 127,148 |
| May | 1,461 | 2,156,436 | 592 | 880,185 | 644 | 950,544 | 857 | 1,274,187 | 107 | 157,932 | 375 | 557,550 | 4 | 5,644 | 140 | 219,048 |
| Jun | 1,377 | 2,032,452 | 650 | 966,420 | 882 | 1,301,832 | 864 | 1,284,595 | 74 | 109,224 | 241 | 358,318 | 7 | 9,185 | 1 | 1,484 |
| Jul | 1,129 | 1,666,404 | 401 | 596,206 | 934 | 1,378,584 | 879 | 1,306,897 | 274 | 404,424 | 212 | 315,201 | 0 | 0 | 36 | 55,996 |
| Aug | 1,338 | 1,974,888 | 564 | 838,555 | 744 | 1,098,144 | 870 | 1,293,516 | 825 | 1,217,700 | 422 | 627,429 | 04 | 529 | 0 | 421 |
| Sep | 1,158 | 1,709,208 | 548 | 814,766 | 888 | 1,310,688 | 866 | 1,287,568 | 50 | 73,800 | 741 | 1,101,719 | 0 | 0 | 0 | 0 |
| Oct | 861 | 1,270,836 | 608 | 903,974 | 927 | 1,368,252 | 589 | 875,725 | ---- | ---- | ---- | ---- | 11 | 14,364 | 30 | 47,637 |
| Nov | 1,311 | 1,935,036 | 627 | 932,223 | 790 | 1,166,040 | 803 | 1,193,900 | ---- | ---- | ---- | ---- | 0 | 0 | 0 | 0 |
| Dec | 1,428 | 2,107,728 | 642 | 954,525 | 913 | 1,347,588 | 928 | 1,374,750 | ---- | ---- | ---- | ---- | 0 | 0 | 0 | 0 |
| Tot | 15,155 | 22,368,780 | 7,416 | 11,026,104 | 10,662 | 15,737,112 | 10,165 | 15,108,317 | 3,764 | 5,555,664 | 3,865 | 5,746,478 | 22 | 29,722 | 289 | 451,734 |

Note: Each LS has no flow-measurement, the effluent values are computated by the pump capacity and running hours.
Therefore, each effluent value is larger than actual flow rate.

Luneta Lift Station is adjacent to the big park, so 100 $m^3$/day of treated water there shall be distributed to the park for planting purpose during dry seasons. The supply water shall be made by the fiber media filtration and disinfected by the solid chlorine. Remaining chlorine shall be reduced to 0.1mg/l 15 minutes after chlorine dosing, which is enough to eliminate coliform.

(3) Expansion of Tondo Sea Outfall System

As described in the former section, Tondo Sea Outfall System has tolerance capacity of 90,000$m^3$/d. Thus this system should expand its service sewer line not only in Manila but also neighboring area like Quezon City, Pasay City and Makati City by connecting combined sewer pipes to be installed (refer Fig. 11).

Additional service population would be 300,000 in total, such as 100,000 in Manila, 50,000 in Quezon City (out of far south San Juan Basin), and 150,000 in Pasay City,

Fig. 6-8 shows Station Fiber Media Filtration System of Luneta Lift Station,

Fig. 6-9 shows layout of Luneta Lift Station with Rapid Filter Installed.

Fig. 6-10 shows layout of Sta Cruz Lift Station with Rapid Filter Installed.

**Fig. 6-8Filtration Flow in Luneta**

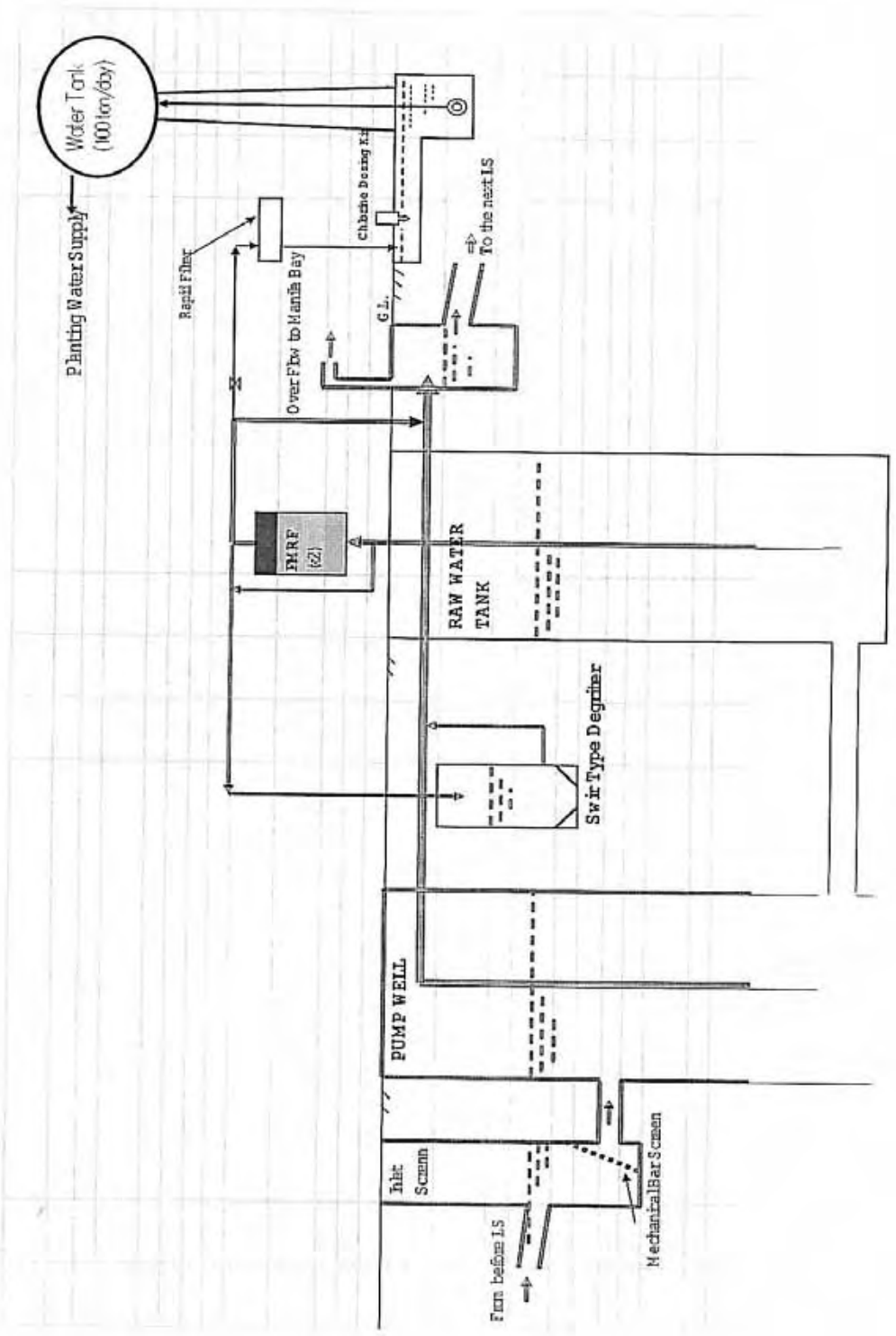


**Fig. 6-9 Luneta Layout**

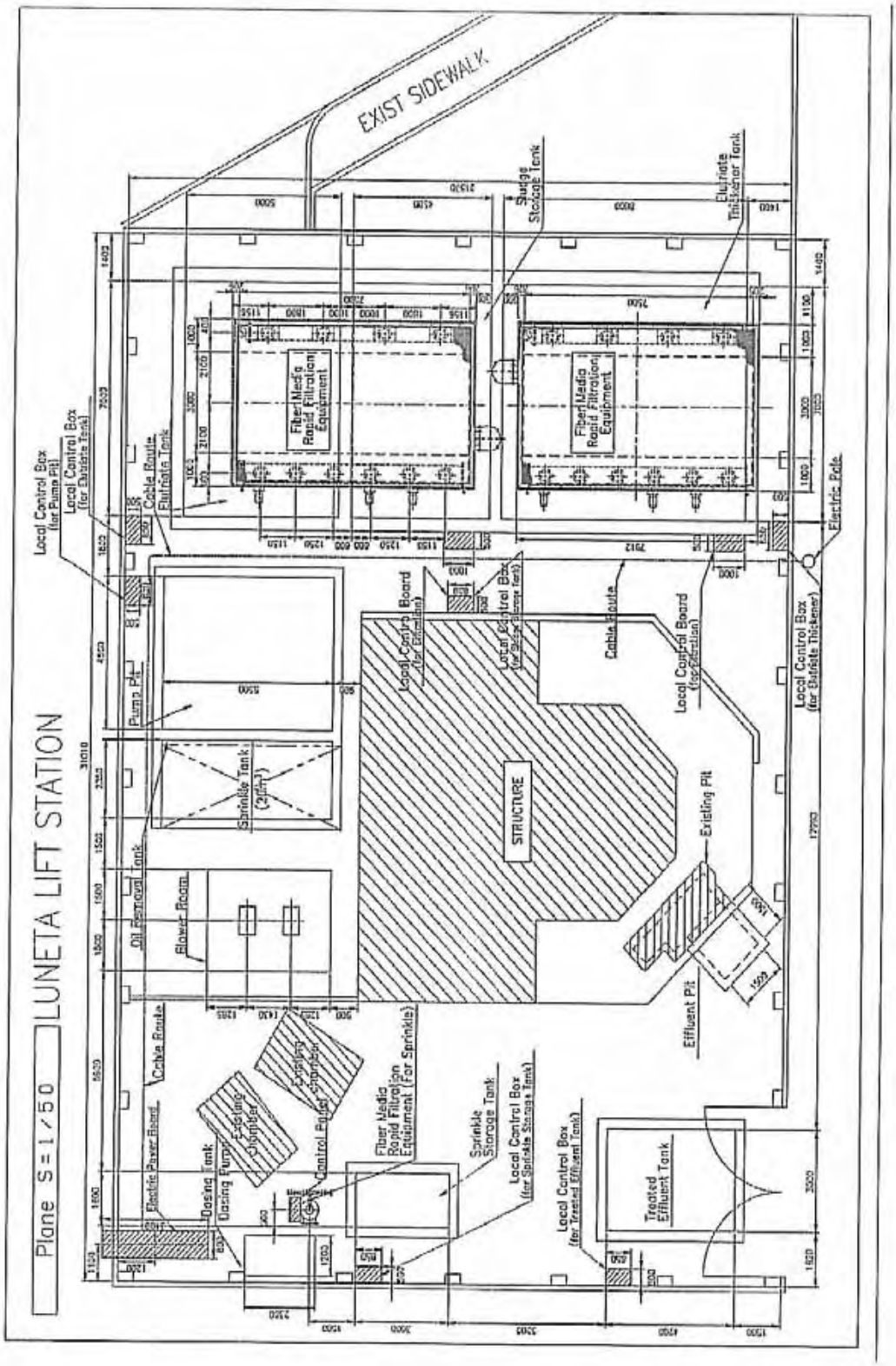
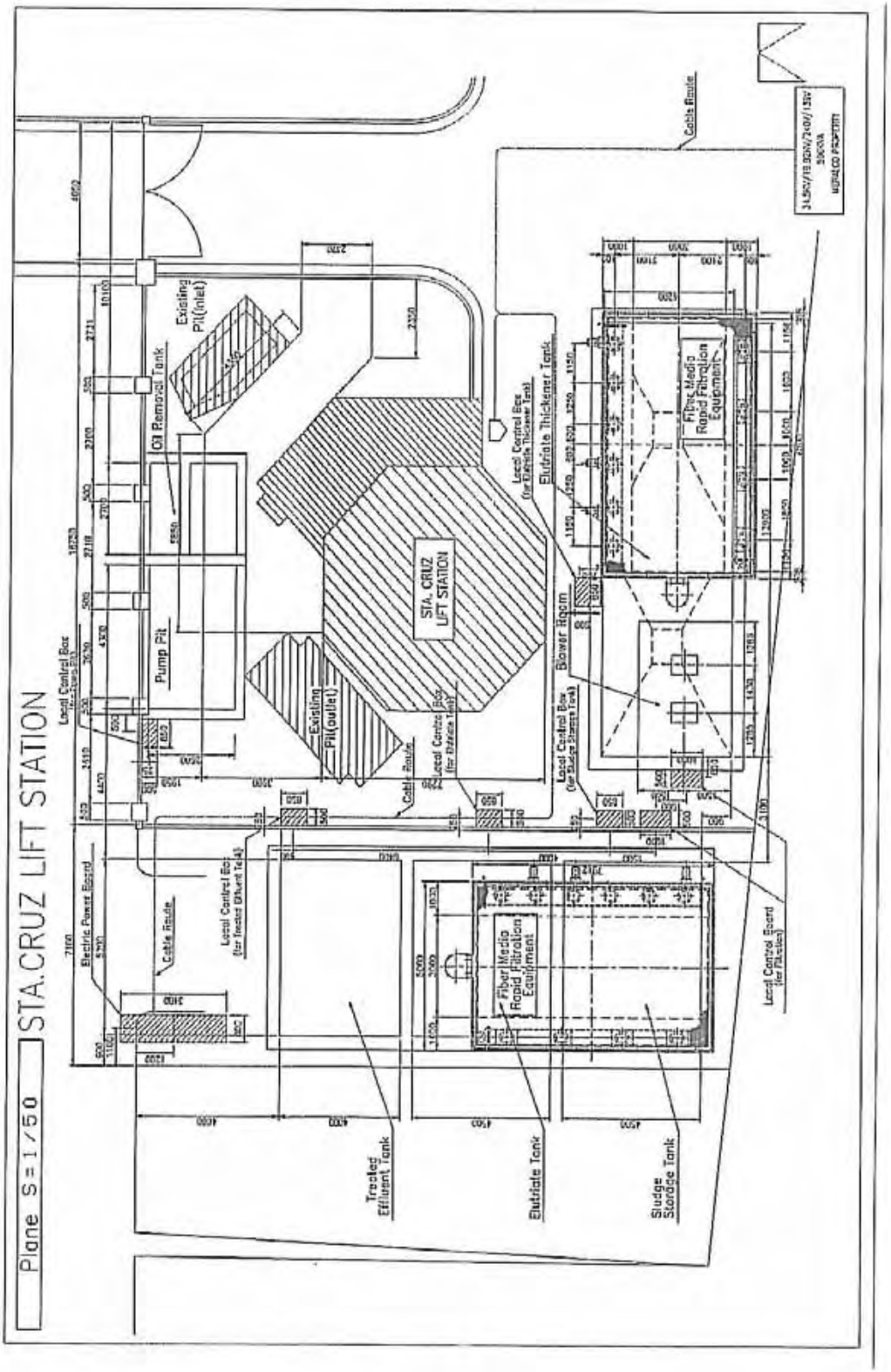


**Fig. 6-10 Sta. Cruz Layout**



### 6.2.2 Quezon City

Population of Quezon City is 1,825,394 in 2007 and projected 2,200,191 in 2021. The business plan targets the service population in 2021 for 1,192,997 (58%) by sewerage system, and 960,886 (46%) by sanitation service. Sanitation service population is now only 1,483 (1%) at the year of 2007. San Juan Basin is one of most polluted area and locating upstream of Pasig river. San Juan River and its tributaries must be one of major reasons of pollution of Pasig River, and consequently Manila Bay area. Almost residential area of San Juan River basin are congestion area and inaccessible for septic collection. There are appropriate creeks as San Juan River tributaries which could be used as sewage trunk sewer. The study results and proposals are shown in **Addendum 1**. According to this study, there are 19 sewage treatment plants to be constructed in this area, and 558,181 people living in the area will be provided sewerage service. Fig. 11 shows this project areas and gravity wastewater flow directions in the San Juan River basin and the North and Central Metro Manila area. Wastewater gravity flow direction in the outside area at the bottom of this project area, around **50,000** people living in this area, is forwarding Legarda Lift Station; therefore combined connection sewer line shall install to connect Legarda pipe line (refer section 5.2.1.1).

Most of the North East Area of Quezon City is belonging to Tuliahan River Basin. Judging from the gravity flow directions in Fig. 11, the gravity flow is going down to Tuliahan River and then to the downstream of the river. The sewage treatment plants of 26,000$m^3$/d and 39,000 $m^3$/d shall establish on the right side and left side of the river respectively near San Bartolome, which provide sewerage service for 500,000 people. Total length of 20 km combined type sewer lines shall install in both of the river side.

10 communal plants with the capacity of 650 m3/d are installed in the other areas to serve sewerage service to the population of 50,000.

### 6.2.3 Valenzuera City

Population of Valenzuera City is 573,047 in 2007 and projected 676,000 in 2021. The business plan targets the service population in 2021 for 351,161 (53%) by sewerage system, and 329,701 (50%) by sanitation service.

Taking consideration of gravity flow directions of wastewater, sewage treatment plants of 26,000 m3/d and 13,000 m3/d shall be installed on the Right side of Tulahan River with combined sewers of 8 km long in total, which provide sewerage service to population of 300,000. 10 communal plants with capacity of 650 $m^3$/d are installed in the other areas to serve sewerage service to the population of 50,000.

**Fig. 6-11 Gravity Flow Direction San Juan Basin and Vicinity Area**

### 6.2.4 Malabon

Population of Malabon City is 361,351 in 2007 and projected 410,162 in 2021. The business plan targets the service population in 2021 for 208,122 (51%) by sewerage system, and 208,963 (52%) by sanitation service.

Taking consideration of gravity flow directions of wastewater, sewage treatment plants of 13,000 $m^3/d$ and 13,000 $m^3/d$ shall be installed on the left side of Tulahan River with combined sewers of 6 km long in total, which provide sewerage service to population of 200,000.

2 communal plants with the capacity of 659 $m^3/d$ are installed in the other areas to serve sewerage service to the population of 10,000 in total.

### 6.2.5 Caloocan (North)

Because of the residents' locations, only 10 communal plants with capacity of 650 $m^3/d$, which provide sewerage service to population of 50,000 in total.

### 6.2.6 Navotas

Population of Navotas City is 246,046 in 2007 and projected 281,079 in 2021. The business plan targets the service population in 2021 for 265,641 (77%) by sewerage system, and 72,525 (26%) by sanitation service.

Taking consideration of gravity flow directions of wastewater, sewage treatment plants of 26,000 $m^3/d$ shall be installed at the Navotas West with combined sewers of 2 km long installed in Gov. A. Pascual, which provide sewerage service to population of 200,000.

2 communal plants with the capacity of 650 m3/d are installed in the other areas to serve sewerage service to the population of 10,000 in total.

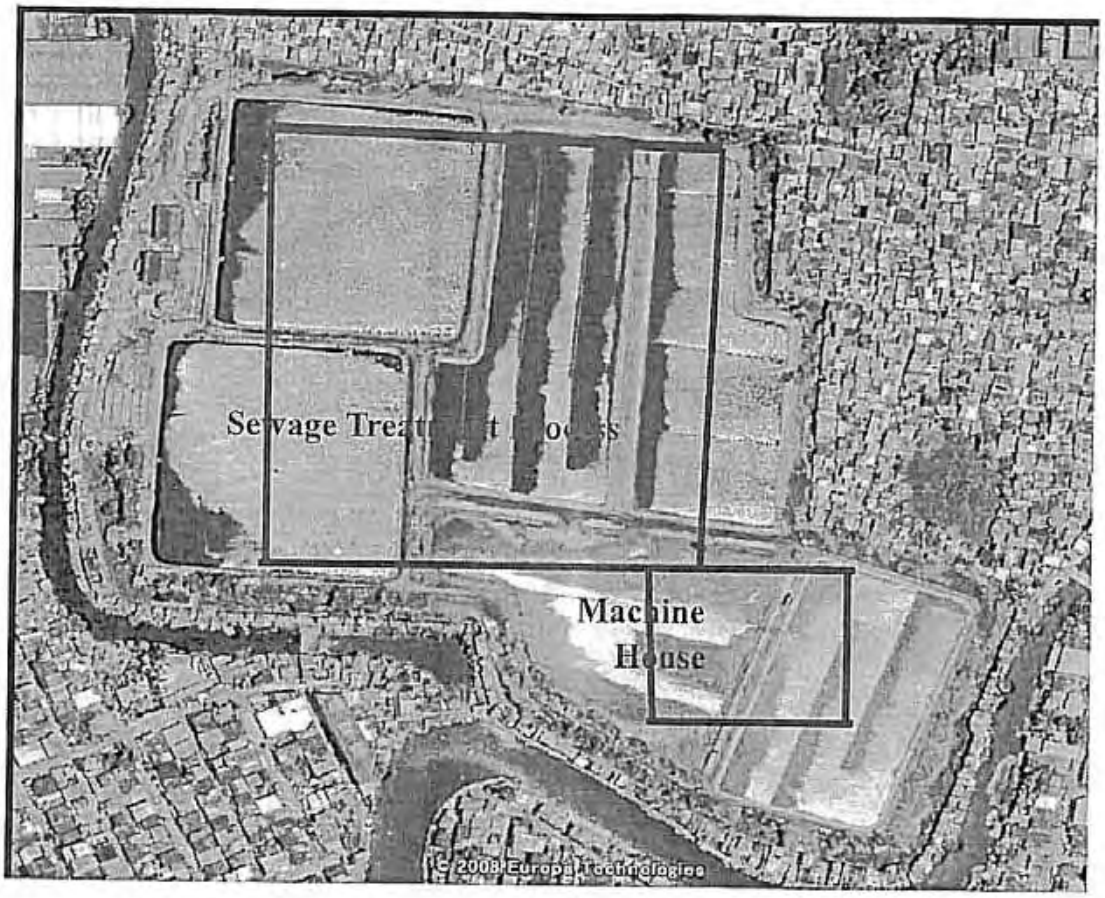
### 6.2.7 Caloocan

Population of Caloocan City is 1,388,780 in 2007 and projected 1,707,362 in 2021. The business plan targets the service population in 2021 for 933,690 (63%) by sewerage system, and 615,315 (41%) by sanitation service.

The existing Dagat-dagatan sewage treatment plant is of capacity of 13,000 $m^3/d$ with 67 km sewer network, but average load is only 4,000 $m^3/d$.

In order to develop the treatment capacity, SBR treatment process shall be applied to have a treatment capacity of 130,000 $m^3/d$. Total length of (1.2km + 5.0km) connection pipe with Φ800 mm and 3km with Φ400 mm forth main would be necessary.

Fig. 6-12 Dagat-dagatan Sewage Treatment Plant Renovation




Sludge volume generated in this plant is about 2,800m$^3$/d. The sludge produces methane gas through sludge digestion process. The methane gas generation rate is assumed 10,400m$^3$/d and the electric power rate generated by gas generation would be 800kwh, which could supply full electrical power demand by the plant.

### 6.2.8 Pasay and Makati City

Population of Makati City (part) is 88,789 in 2007 and projected 95,400 in 2021. The business plan targets the service population in 2021 for 7,122 (19%) by sewerage system, and 86,459 (84%) by sanitation service.

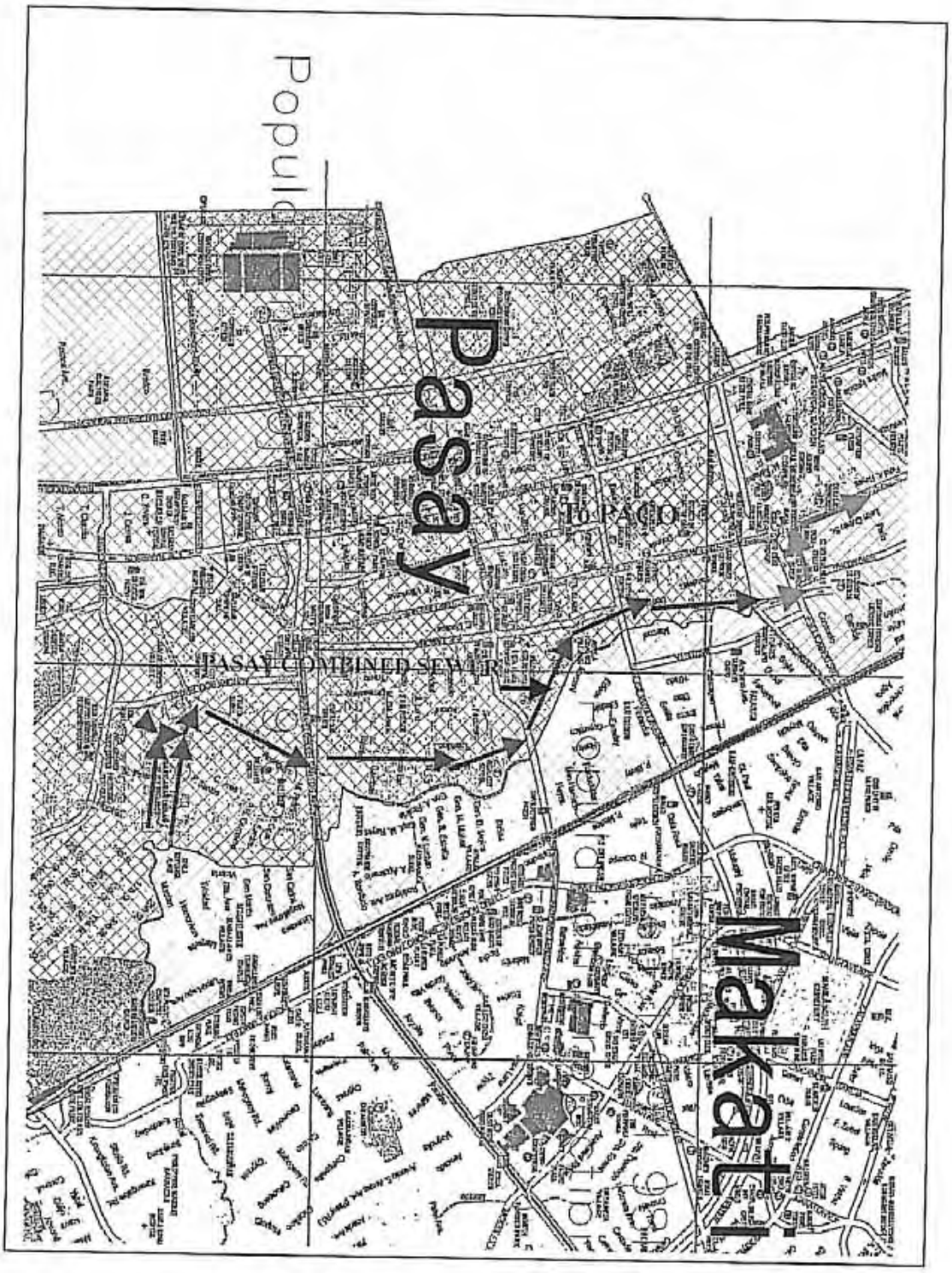
Population of Pasay City is 405,970 in 2007 and projected 455,101 in 2021. The business plan targets the service population in 2021 for 84,494 (8%) by sewerage system, and 376,921 (92%) by sanitation service.

There shall not be provided any sewerage service in Makati (part) area.

Total length of 6 km combined sewer lines shall be provided alongside Paranaque River upstream to collect 20,000 m3/d sewage generated in the basin

There shall be provided 3 communal plants with capacity of 650 m3/d for the congestion areas in Pasay City,.

**Fig. 6-13 Combined Sewer Lines jointing Paco LS**



### 6.2.9 Paranaque City

Population of Paranaque City is 557,857 in 2007 and projected 669,860 in 2021. The business plan targets the service population in 2021 for 450,589 (67%) by sanitation service, and no plan up to 2021 by sewerage service.

Mostly there is seemed to have less congestion area than Pasay City, Basically to say, MWSI is planning to provide Paranaque City as much as possible by sanitation service, but at this moment it has still some congestion area such as the area near SCAT Road cor. DONA NINAI SANTOS ROAD with population of around 6,000 and the both side 0f TRANO ROAD between QUIRINO AV. and VILLA REAL with population of about 12,000. These areas would be supplied communal plants like JOKASOU system or underground STPs.

### 6.2.10 Las Pinas City

Population of Paranaque City is 535,208 in 2007 and projected 615,070 in 2021. The business plan targets the service population in 2021 for 431,400 (70%) by sanitation service, and no plan up to 2021 by sewerage service. MWSI is planning to provide Las Pinas City as much as possible by sanitation service, but at this moment it has some congestion area such as the area surrounded by J. AGLIAR AV., TROPICA AV., OARANAQUE Boarder and DAHLIA DALANDAN with population of about 10,000. These kinds of areas would be supplied communal plants like JOKASOU system or underground STPs in future like Paranaque City.

### 6.2.11 Muntinlupa City

Population of Muntinlupa City is 456,610 in 2007 and projected 531,969 in 2021. The business plan targets the service population in 2021 for 262,714 (65%) by sewerage system, and 148,831 (84%) by sanitation service.

Muntinlupa locates alongside Lagna de Bay, and lots of congestion areas are locating the lake side. Because of the households allocation, one main combined trunk sewer setting out in the lakefront would be preferable and gravity flow direction of most of wastewater is from inland to the lake. Therefore one combined sewer line shall be installed the lakeside road "PRE. MANUEL L. QUIRINO-IRAYA-SAN GUILLERMO", total length of 7 km, and at the far South end of the load, just before Poblacion River, one sewage treatment plant with capacity of 30,000 $m^3/d$ shall be established. In the course, all creeks shall be

Fig. 6-14-1 Muntinlupa City Sewerage Plan

Fig.6-14-2 Muntinlupa City Sewerage Plan

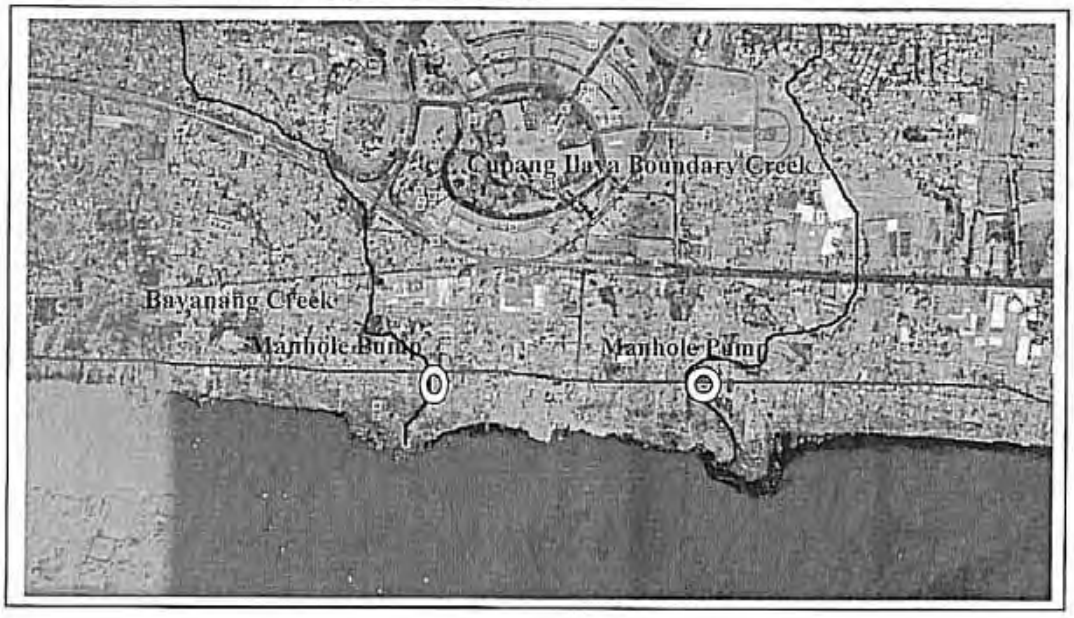


Fig. 6-14-3 Muntinlupa City Sewerage Plan

used as combined sewer lines and Poblacion River side one interceptor should be installed. Minimum 5 manhole pumps would be required. This STP (Muntinlupa STP) could cater for servicing to 230,000 people and more.

The other three communal plants with capacity of 2,000 m3/d should be installed at appropriate positions, which provide sewerage services to the people of 46,000.

### 6.2.12 Other South Residential Areas

In the south, there 6 municipalities including Cavite City are under MWSI concession. Except Bacor, the sizes of residential areas are rather small in the large territory lands. Therefore, MWSI business plan would provide sanitation service only in these areas. However, Cavite City includes several congestion areas, so 3 communal plants (Jokasou) with capacity of 650 $m^3/d$ would be preferable as a supplement to the sanitation service.

The population projection and MWSI service plan are shown in Table.

Table. 6-10 The Municipalities in The South

| Municipality | Population | | MWSI Service Plan in 2021 | |
|---|---|---|---|---|
| | In 2007 | In2021 | Sanitation | Sewerage |
| Bacor | 448,616 | 670,020 | 581,450 (84%) | 0 ( 0%) |
| Cavite City | 104,824 | 128,211 | 103,511 (81%) | 0 ( 0%) |
| Imus | 256,156 | 325,000 | 210,405 (65%) | 0 ( 0%) |
| Kawit | 77,092 | 104,750 | 100,475 (96%) | 0 ( 0%) |
| Noveleta | 39,665 | 56,424 | 56,198 (100%) | 0 ( 0%) |
| Rossario | 95,288 | 135.059 | 121,288 (90%) | 0 ( 0%) |

## 6.3 Development Plan of Sewage Treatment Plants

The business plan targets their sewerage development plan in percentage at three highlighted years in 2011, 2016 and 2021 of final year. Table 6-11 shows the project development plans to achieve the target service coverage in the business plan.

Table 6-11 Sewerage Service Facility Development Plan

| Year of | | 2008 | 2011 | 2016 | 2021 |
|---|---|---|---|---|---|
| Business | Coverage Targeted | 8.6% | 11.0% | 31.0% | 43.0% |
| Plan | Service Population | 544,639 | 849,507 | 2,704,072 | 4,032,225 |
| Master | Service Coverage | - | 16.2% | 33.7% | 45.3% |
| Plan | Service Population | - | 1,250,787 | 2,936,556 | 4,243,556 |
| | Treatment Capacity in Total ($m^3$/d) | - | 292,867 | 462,017 | 631,927 |
| 1st Stage Plant Construction by 2011 | | | ($m^3$/d) | ($m^3$/d) | ($m^3$/d) |
| Sewer Line Full Connection (CMS & Dagat-dagatagatan) | | | 245,885 | | |
| Five Communal Plants Renovation (1 of 5 by WB P) | | | 1,690 | | |
| Bagbag STP construction (San Juan) | | | 10,400 | | |
| Talayan STP construction (San Juan) | | | 15,600 | | |
| 20 Module STPs construction | | | 12,792 | | |
| Quezon South Combined Sewer Connection | | | 6,500 | | |
| 2nd Stage Construcion by 2016 | | | | | |
| Pasay Combined Sewer Connection | | | | 19,500 | |
| Central Sewer Line Expansion | | | | 13,000 | |
| Muntinlupa STP | | | | 30,000 | |
| Navotas West STP | | | | 26,000 | |
| 15 Module STPs | | | | 9,750 | |
| San Juan South STPs (3 in total) | | | | 16,900 | |
| (Tullahan River STPs (Quezon, Valenzuela) | | | | 104,000 | |
| 3rd Stage Construction by 2021 | | | | | |
| San Juan, Cabocan, Paranaque STPs | | | | | 169,910 |
| Note: Service Target Population; 2011-7,613,821 | | 2016-8,804,422 | | 2021-9,377,010 | |

## 6.4 Cost Estimation

The construction costs are estimated in Table 6-12.

Table 6-12 Construction Cost Estimate

| Districts | Sewerage System | | | | |
|---|---|---|---|---|---|
| | Facilities | Treatment Capacity | Cost in million PhP | | |
| | | | Equipment | Civil | Total |
| Caboocan | Dagat-dagatan STP | 130,000m³/d | 3,666 | 2,873 | 6,539 |
| | Jokasou | 650m³/d x 10 | 294 | 126 | 420 |
| | Combined Sewer | Φ 800 x 62km | | 6 | 6 |
| (Include North) | Force Main | Φ 400 x 3km | 24 | 3 | 27 |
| Quezon | Tondo connection | 13,000m³/d | | 2 | 2 |
| | San Juan Project*1 | 71,864m³/d | 2,863 | 1,308 | 4,171 |
| | Tullahan River right | 26,000m³/d | 733 | 575 | 1,308 |
| | Tullahan River left | 39,000m³/d | 1,100 | 862 | 1,962 |
| | Jokasou | 650m³/d x 10 | 294 | 126 | 420 |
| | Combined Sewer | Φ 600 x 20km | | 20 | 20 |
| Valenzuela | Tullahan River right | 26,000m³/d | 733 | 575 | 1,308 |
| | Do | 13,000m³/d | 367 | 287 | 654 |
| | Combined Sewer | Φ 600 x 8km | | 8 | 8 |
| | Jokasou | 650m³/d x 10 | 294 | 126 | 420 |
| Malabon | Tullahan River left | 13,000m³/d x 2 | 733 | 575 | 1,308 |
| | Jokasou | 650m³/d x 2 | 78 | 34 | 112 |
| | Combined Sewer | Φ 600 x 6km | | 6 | 6 |
| Navotas | Navotas West | 26,000m³/d | 733 | 575 | 1,308 |
| | Combined Sewer | Φ 600 x 2km | | 2 | 2 |
| | Jokasou | 650m³/d x 2 | 78 | 34 | 112 |
| Manila | Tondo Sea Outfall | 232,885m³/d | 16 | 4 | 20 |
| | Rapid Filter | 66,000m³/d x 2 | 304 | 130 | 435 |
| Makati | - | - | | | |
| Pasay | Combined Sewer | Φ 600 x 6km | | 6 | 6 |
| | Jokasou | 650m³/d x 3 | 105 | 45 | 150 |
| Paranaque | Jokasou | 780m³/d x 1 | 57 | 24 | 81 |
| | STP | 1,560m³/d | 44 | 34 | 78 |
| Muntinlupa | STP | 30,000m³/d | 846 | 663 | 1,509 |
| | STP | 2000m³/d x 3 | 169 | 133 | 302 |
| Las Pinas | Jokasou | 650m³/d x 2 | 105 | 45 | 150 |
| Bacoor | - | - | - | | |
| Imus | - | - | - | | |
| Kawit | - | - | - | | |
| Cavite City | Jokasou | 650m³/d x 3 | 105 | 45 | 150 |
| Noveleta | - | - | - | | |
| Rosario | - | - | - | | |
| Total | | 794,889 | 13,742 | 9,251 | 22,993 |

# 7. SANITATION SERVICES DEVELOPMENT PROJECT

Sanitation management is mainly conducted by the combination of septage collection and treatment. Generally 10 tones vacuum vehicles are used for septage collection with interval 5 to 7 years. Collected septage is treated at the septage treatment plant. The per capita for septage generation is assumed as 1litter/cap.year (Refer Chapter 5).

At this moment, MWSI is operating only Dagat-dagatan Septage treatment plant with capacity of 450m$^3$/d. Therefore MWSI should construct more septage treatment plants at proper place to achieve their business plan.

## 7.1 Septage Volume Prediction treated by MWSI at the year of 2021

### 7.1.1 Total Sewage Treatment Capacity in 2021

MWSI business plan shows the service coverage plans as follows.

Table 7-1 Sewerage and Sanitation Service Coverage Target Plan (in %)

| | | Year of | | | |
|---|---|---|---|---|---|
| | | 2007 | 2011 | 2016 | 2021 |
| Total Population | | 8,961,630 | 9,459,996 | 10,042,103 | 10,562,022 |
| Sewerage | Coverage | 8.93 | 11.00 | 31.00 | 43.00 |
| | Population | 544,639 | 849,507 | 2,704,072 | 4,032,225 |
| Sanitation | Coverage | 29.00 | 45.00 | 52.00 | 60.00 |
| | Population | 484,687 | 3,446,428 | 4,555,340 | 5,611,565 |

Sewerage service development plan shown in Chapter 5 in 2021 is as follows.

Table 7-2 Sewerage Development Plan achieved in 2021

| | Manila | Quezon | Caloocan | The Others |
|---|---|---|---|---|
| Total Capacity (m$^3$/d) | 258,885 | 143,271 | 130,000 | 167,558 |
| Service Population | 876,284 | 1,117,340 | 1,000,000 | 1,288,908 |
| Total Service Population | 4,282,532 | | | |
| Overall Coverage for Targeted People | 106.2% (per people of 4,032,225) | | | |

As far as the sewerage service plan is concerned, the target service population in the year of 2021 would be achieved if the master plan is implemented as the schedule.

### 7.1.2 Total Septage Treatment Capacity to be Required in 2021

### 7.2.1 Total Septage Treatment Capacity in the Year of 2021

According to Chapter 5, the septage generation rate is 100 litter/cap.year. Therefore total septage treatment capacity should be 536,125.8 $m^3$/year (5,361,258 x 1 litter).

Therefore daily treatment capacity shall be 1490$m^3$/d (assuming 360 days operation per year).

At this moment, MWSI operates Dagat-dagatan septage treatment plant with capacity of 450 $m^3$/d. It means that MWSI should construct another septage treatment plants with total capacity of 1,040 $m^3$/d and more. Septage Treatment Plant Operation is planed on the premises of 16 hours/d

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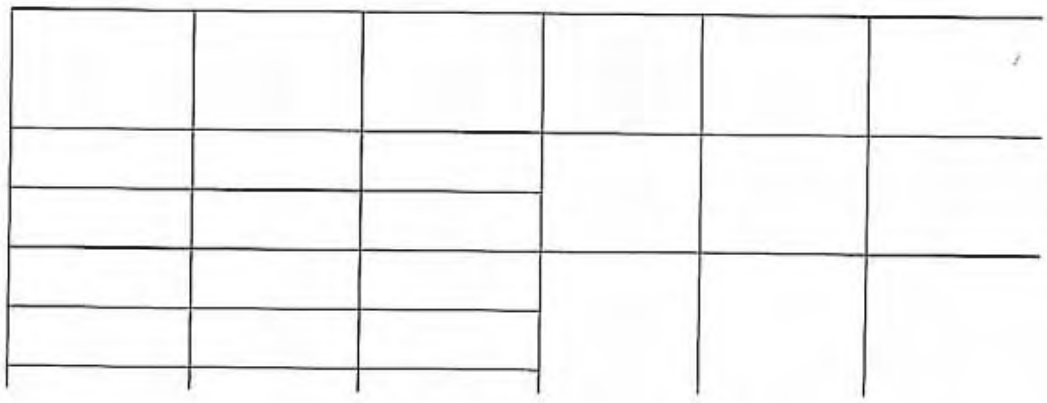


### 7.1.2 Total Septage Treatment Capacity to be Required in 2021

The service population of septage treatment plan in 2021 is 5,611,565 (Table. 7-2).

If the sewerage develop plan is successful, people of 250,307 in 5,611,565 would be getting sewerage service instead of the sanitation services at that time. Thus, the minimum requirement of the service population in 2021 will be 5,361,258.

Table 7-3 shows the sewerage and sanitation service distribution in year of 2001.

Table 7-3 Sewerage and Sanitation Service Distribution in 2021

| Districts | Population to be serviced in 2021 | Sewerage System | | | Sanitation System | |
|---|---|---|---|---|---|---|
| | | Facilities | Treatment Capacity | Service Population | Population to be Served | Septage Generated ($m^3$/year) |
| Caloocan (Include North) | 1,549,005 | Dagat-dagatan STP | 130,000$m^3$/d | 1,000,000 | 499,005 | 49,901 |
| | | Combined Sewer | Φ 800 x 62km | | | |
| | | Force Main | Φ 400 x 3km | | | |
| | | Jokasou | 650$m^3$/d x 10 | 50,000 | | |
| Quezon | 2,153,883 | Tondo connection | 13,000$m^3$/d | 50,000 | 995,702 | 99,570 |
| | | San Juan Project*1 | 71,864$m^3$/d | 558,181 | | |
| | | Tullahan River right | 26,000$m^3$/d | 200,000 | | |
| | | Tullahan River left | 39,000$m^3$/d | 300,000 | | |
| | | Jokasou | 650$m^3$/d x 10 | 50,000 | | |
| | | Combined Sewer | Φ 600 x 20km | | | |
| Valenzuela | 680,862 | Tullahan River right | 26,000$m^3$/d | 200,000 | 380,862 | 38,086 |
| | | Do | 13,000$m^3$/d | 100,000 | | |
| | | Combined Sewer | Φ 600 x 8km | | | |
| | | Jokasou | 650$m^3$/d x 10 | 50,000 | | |
| Malabon | 417,085 | Tullahan River left | 13,000$m^3$/d x 2 | 200,000 | 207,085 | 20,709 |
| | | Jokasou | 650$m^3$/d x 2 | 10,000 | | |
| | | Combined Sewer | Φ 600 x 6km | | | |
| Navotas | 288,166 | Navotas West | 26,000$m^3$/d | 200,000 | 88,166 | 8,817 |
| | | Combined Sewer | Φ 600 x 2km | | | |
| | | Jokasou | 650$m^3$/d x 2 | 10,000 | | |
| Manila | 1,532,935 | Tondo Sea Outfall | 232,885$m^3$/d | 776,284 | 656,651 | 65,665 |
| | | Rapid Filter | 66,000$m^3$/d x 2 | 100,000 | | |
| Makati | 93,579 | - | - | 0 | 93,579 | 9,358 |
| Pasay | 461,415 | Combined Sewer | Φ 600 x 6km | 153,846 | 292,569 | 29,257 |
| | | Jokasou | 650$m^3$/d x 3 | 15,000 | | |
| Pamanaque | 450,589 | Jokasou | 780$m^3$/d x 1 | 6,000 | 432,589 | 43,259 |
| | | STP | 1,560$m^3$/d | 12,000 | | |
| Muntinlupa | 411,545 | STP | 30,000m 3/d | 230,000 | 135,395 | 13,540 |
| | | STP | 2000m 3/d x 3 | 46,150 | | |
| Las Piñas | 431,400 | Jokasou | 650$m^3$/d x 2 | 10,000 | 421,400 | 42,140 |
| Bacoor | 581,450 | - | - | 0 | 581,450 | 58,145 |
| Imus | 210,405 | - | - | 0 | 210,405 | 21,041 |
| Kawit | 100,475 | - | - | 0 | 100,475 | 10,048 |
| Cavite City | 103,511 | Jokasou | 650$m^3$/d x 3 | 15,000 | 88,511 | 8,851 |
| Noveleta | 56,196 | - | - | 0 | 56,196 | 5,620 |
| Rosario | 121,288 | - | - | 0 | 121,288 | 12,129 |
| Total | 9,643,789 | | 794,889 | 4,342,461 | 5,361,328 | 536,133 |

*1 Refer the Master Plan Volume 2 (addendum 1)

## 7.2 Septage Service Plan

### 7.2.1 Total Septage Treatment Capacity in the Year of 2021

According to Chapter 5, the septage generation rate is 100 litter/cap.year. Therefore□total septage treatment capacity should be 536,125.8 $m^3$/year (5,361,258 x 1 litter).

Therefore daily treatment capacity shall be 1490$m^3$/d (assuming 360 days operation per year).

At this moment, MWSI operates Dagat-dagatan septage treatment plant with capacity of 450 $m^3$/d. It means that MWSI should construct another septage treatment plants with total capacity of 1,040 $m^3$/d and more. Septage Treatment Plant Operation is planed on the premises of 16 hours/d operation, so extension of operation time could not be taken.

### 7.2.2 Distribution of Population to be provided Sanitation Services

Table 7-3 shows sanitation service population by each district. Regarding Caloocan City, almost all of sanitation service assume to be provided in Caloocan North, because Caloocan south would be serviced by Dagat-dagatan STP to be renovated to the capacity of 130,000 $m^3$/d at the last development stage.

### 7.2.3 Septage Plant Categorization

Sanitation service is performed with septage treatment process and septage collection vehicles. Taking consideration the commuting efficiency of the collection vehicle between the plant and residential area, the direct distance between two points is preferable within 10km, that is, the commuting distance would be around 14km one way. And vehicle visiting times in the plant shall be less than 6 per hour during working hour, to avoid traffic congestion and to mitigate noise problem to the neighboring residents. Therefore the maximum capacity of septage treatment plant is preferable less than 500$m^3$/d. Taking consideration these two points, travel distance of vehicles and the maximum septage treatment plant size, the septage treatment plant shall be divided as four sites, such as, North, Central, South and Cavite.

The septage plant category and the treatment capacity sizes are shown in Table 7-4.

Table 7-4 Septage Treatment Plant Capacities and Categorization

| Districts | Septage Generated ($m^3$/year) | Septage to be treated (*3) ($m^3$/day) | Treatment Capacity Localized ($m^3$/day) | Treatment Plant Size in Local Unit ($m^3$/day) | Categorization (*2 |
|---|---|---|---|---|---|
| Cabocan North | 54,900 (*1) | 153 | 429 | 400 | North |
| Quezon | 99,570 | 277 | | | |
| Cabocan | 0 (*1) | 0 | 396 | 450 | Central Dagat-dagatan (Existing) |
| Valenzuela | 38,086 | 106 | | | |
| Malabon | 20,709 | 58 | | | |
| Naovotas | 8,817 | 24 | | | |
| Manila | 65,665 | 182 | | | |
| Makati | 9,358 | 26 | | | |
| Pasay | 29,257 | 81 | 356 | 350 | South |
| Parnanaque | 43,259 | 120 | | | |
| Muntinlupa | 13,540 | 38 | | | |
| Las Pinas | 42,140 | 117 | | | |
| Bacoor | 58,145 | 162 | 322 | 350 | Cavite |
| Imus | 21,041 | 58 | | | |
| Kawit | 10,048 | 28 | | | |
| Cavite City | 8,851 | 25 | | | |
| Noveleta | 5,620 | 16 | | | |
| Rosario | 12,129 | 34 | | | |
| Total | 541,132 | 1,503 | 1,503 | 1,550 | |

Notes: *1 Assuming septage generation only for Cabocan North.

*2 Basically the septage collecting vehecle field activity is less than in 10km distance.

*3 Plant operation dates per year is assumed 360 days.

## 7.3 Development Plan of Septage Treatment Plants

The business plan targets their sanitation development plan in percentage at three highlighted years in 2011, 2016 and 2021 of final year. Table 7-5 shows the project development plans to achieve the target service coverage in the business plan.

Table 7-5 Sanitation Facility Development Plan

Sanitation Service Facility Development Plan

| Year of | 2011 | 2016 | 2021 |
|---|---|---|---|
| Coverage Targeted | 45% | 52% | 60% |
| Population | 3,446,428 | 4,555,340 | 5,611,565 |
| Sepatage Generated ($m^3$/year) | 344,643 | 455,534 | 561,157 |
| Plant Capacity ($m^3$/day) | 957 | 1,265 | 1,559 |
| Plant Expansion ($m^3$/day) *1 | 507 | 815 | 1,109 |
| Plant Constructed ($m^3$/day) | 550 | 850 | 1,100 |
| Coverage by the plants | 47% | 53% | 60% |
| (Construction Schedule) $m^3$/d | | | |
| 1st. Plant Construction by 2011 | | | |
| North | 400 | | |
| South No1 | 150 | | |
| 2nd Plant Construction by 2016 | | | |
| South No2 | | 200 | |
| Cavite No1 | | 100 | |
| 3rd Plant Construction by 2021 | | | |
| Cavite No2 | | | 250 |

*1 Expansion to be required, except Existing facility, Dagat-dagatan septage treatment plant, of 450$m^3$/d

## 7.4 Location of New Septic Treatment Plants

### 7.4.1 Vehicle Commuting Numbers between Septage treatment Plants and Houses

Taking consideration the commuting efficiency of the collection vehicle between the plant and residential area, the direct distance between two points is preferable within 10km, that is, the commuting distance would be around 14km one way.

Vehicle septage tank capacity is 10 $m^3$/d. Therefore visiting house numbers are assumed 10 household one time in average and collecting time would be 1 hour (6 minutes per household).

If vehicle speed is 20km/h, the necessary round travel time is around 1 hour and half. Therefore, one cycling time of the collecting vehicle is 2 hours and half. In case that working hour is 7 hours per day, the vehicle commuting numbers are around 3 times a day.

### 7.4.2 Working Schedule and Vehicle Numbers to be Required

Working schedule is set as follows.

| | |
|---|---|
| Plant Operation Hour | 16 hours (2 shifts) |
| Plant Open | 8 am to 5 pm |
| Vehicle Access Time | 8:30 am to 4 pm (7:30 hours) |
| Vehicle Cycling Times | 3 times a day in average |
| Working Date | Monday to Friday (5days a week) |

Therefore, one vehicle conveys 30 tones septic a day. However, the vehicle works 5 days a week, so septage transportation efficiency of one vehicle is 21.47 tones.

Daily septage treatment capacity is 1550 $m^3/d$ in total, so necessary vehicle numbers are 73.

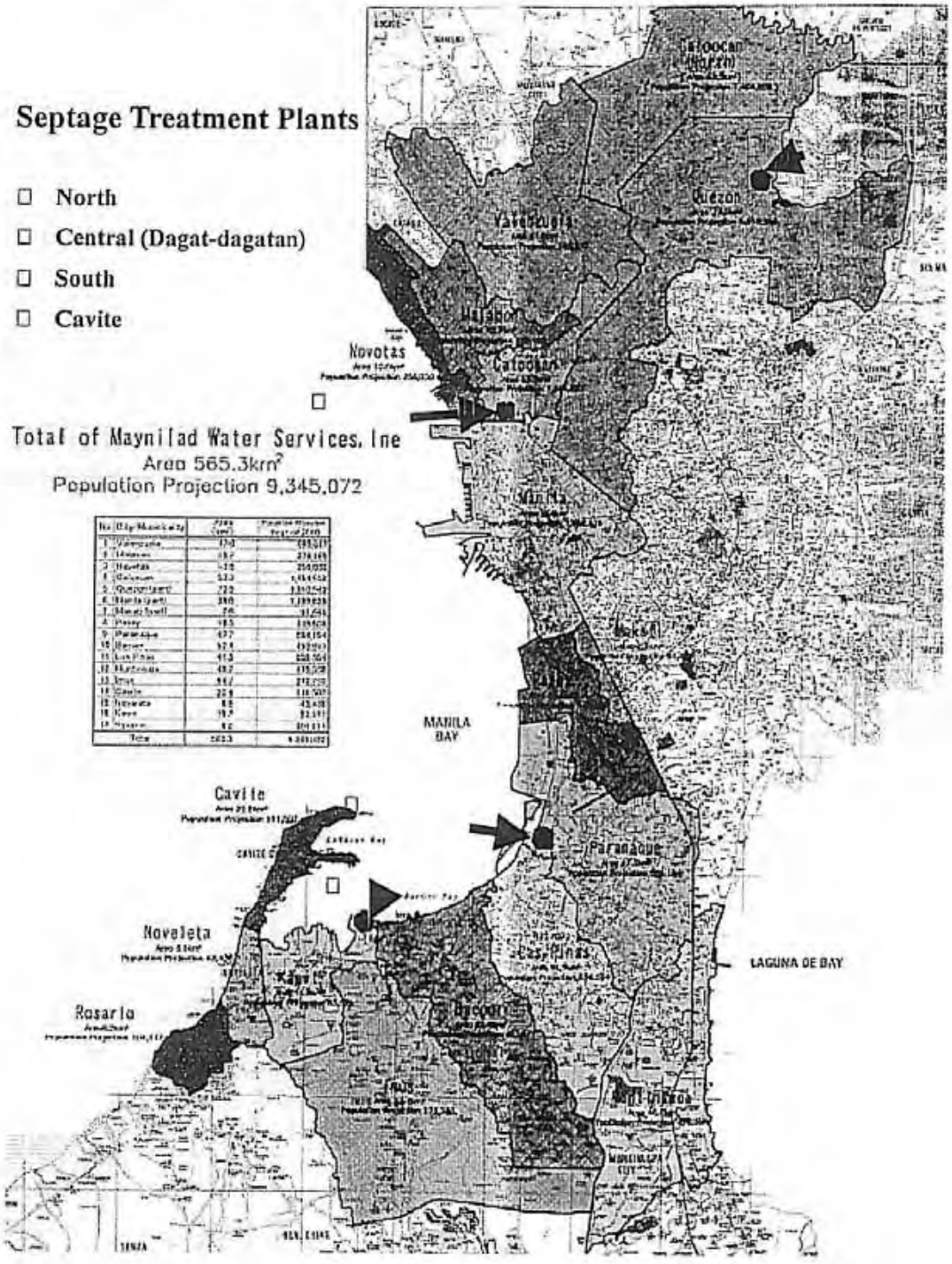
### 7.4.3 Plant Locations and Treatment Capacities to be Required

As shown in Table 7-4, Treatment Capacities to be required are as follows.

| | |
|---|---|
| North | 400$m^3/d$ |
| Central | 450$m^3/d$ |
| South | 350$m^3/d$ |
| Cavite | 350$m^3/d$ |

The plant locations are shown in Fig. 7.1.

**Fig 7-1 Septage Treatment Plant Location Plan**



## 7.5 Cost Estimation

Table 7-6 Cost Estimation of Septage Treatment Plant

| Septage Treatment Plant | | Cost Estimation (in x 1,000 PhP) | | |
|---|---|---|---|---|
| | | Equipment | Civil Work | Total |
| North | 400m3/d | 225,000 | 43,000 | 268,000 |
| Central | 450m3/d | Existing (Dagat-dagatan Septage Treatment) | | |
| South | 350m3/d | 197,000 | 38,000 | 235,000 |
| Cavite | 350m3/d | 197,000 | 38,000 | 235,000 |
| Total | 1,550m3/d | 619,000 | 119,000 | 738,000 |

# 8 Project Construction Program and Budgetary Schedule

## 8.1 Sewerage Construction Project

Sewerage construction projects should be implemented to follow the MWSI master plan reviewed in 2007, and the service coverage rating targets at key years of 2011, 2016 and 2021 should be achieved or over by the project construction schedules. According to Table 6-11 "Sewerage Service Facility Development Plan" in Chapter 6 shows the project implementation schedule.

### 8.1.1 1st Plant Construction Projects by 2011

The first plant construction projects by 2011 are; Four Communal Plants Renovation in Quezon City and Rapid Filtration Process integration into Luneta and Sta Cruz Lift Stations in Central Manila Sewerage System. The detail design with cost estimation and bid documentation has been prepared in 2008, and the construction implementation schedule is shown in the "Project Packages" in the design report. According to the plan, the construction of the 6 projects shall be completed within year of 2011

And, in order to catch up to the service coverage in 2011 complying with the business plan, additional projects shall start designs and constructions early in 2009. Those projects are:

Bagbag STP,

Talayan STP,

Dagat-dagatan STP sewer full connection program,

Central Manla sewer full connection program,

Quezon South Combined Sewer Connection, and

20 Module Type STP construction

Caloocan North x 10,

Quezon x 10)

### 8.1.2 2nd Plant Construction Projects by 2016

According Table 6-11, the second plant construction projects are as follows;

Pasay North Combined Sewer Connection,

Central Manila Sewer Expansion,

Muntinlupa STP,

Navotas West STP,

San Juan River Basin South STPs (3 units),

Tullahan River DTPs (Quezon x 2, Valenzuela x 2), and

15 Module Type STPs construction

Valenzuela x 10

Pasay x 2

Cavite x 3

The construction implementation schedule for 1st projects and 2nd projects is shown in Table 8-1

Table 8-1 2nd Plant Construction Schedule by 2016

| Project Steps | Year of | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| **1st Stage Construction Projects** | | | | | | | | |
| Four Communal Plant | | | | | | | | |
| Luneta Sta Cruz Rapid Filtration | | | | | | | | |
| Bagbag STP | | | | | | | | |
| Talayan STP | | | | | | | | |
| Dagat-dagatan Sewer Full Connection Plan | | | | | | | | |
| Central Manila Sewer Full Connection Plan | | | | | | | | |
| Quezon South Combined Sewer Connection | | | | | | | | |
| 20 Module Type STPs | | | | | | | | |
| Caloocan North x 10 | | | | | | | | |
| Quezon x 10 | | | | | | | | |
| | | | | | | | | |
| **2nd Stage Construction Projects** | | | | | | | | |
| Muntinlupa STP | | | | | | | | |
| Navotas West STP | | | | | | | | |
| Pasay North Combined Sewer Connection | | | | | | | | |
| Central Manila Sewer Expansion | | | | | | | | |
| 15 Module Type STPs | | | | | | | | |
| Valenzuera x 10 | | | | | | | | |
| Laspinas x 2 | | | | | | | | |
| Cavite x 3 | | | | | | | | |
| San Juan River Basin South STPs (3 units) | | | | | | | | |
| Tullahan River STPs (Quezon x 2, Valenzuela x 2) | | | | | | | | |
| Note: | Survey, Design, Bid preparation | | | | | | | |
| | Bidding Process | | | | | | | |
| | Construction | | | | | | | |

Priority projects are selected in the order of easier site procurement, or the site is defined at this moment. The project implementation priority of the site that would require wider area geographical survey is lower.

### 8.1.3 3rd Plant Construction Projects by 2021

Table 6-11 shows that all remaining projects should be completed by 2021 to cater for realization of the business plan targets for sewerage service coverage development.

Table 8-2 is just showing the case when the project implementation plan is packaged by each

district. However, when more wide and precise site survey and study are conducted and any local situations and political reasons are taken consideration, the construction implementation order or priority projects would be adjusted.

Table 8-2 3rd Plant Construction Schedule by 2021

| Districts | STP | Capacity | Year of | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | $m^3/d$ | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| Caloocan | Dagat-dagatan | 130,000 | | | | | | |
| Quezon (Diliat-Dario) | (Diliat-Dario) | | | | | | | |
| KTSP, SaSTP | Jokasou | 156 x 2 | | | | | | |
| TsSTP | SBR | 1,560 | | | | | | |
| SSTP | Do | 2,210 | | | | | | |
| BaSTP | Do | 5,200 | | | | | | |
| BtSTP-1 | Jokasou | 780 | | | | | | |
| BtSTP-2 | SBR | 3,900 | | | | | | |
| AsSTP | Jokasou | 1,170 | | | | | | |
| | | | | | | | | |
| (Sanfrancisco -Mambo) | | | | | | | | |
| AsSTP-1 | Jokasou | 286 | | | | | | |
| AsSTP-2 | Do | 546 | | | | | | |
| SaSTP-2 | SBR | 2,860 | | | | | | |
| VSTP | Do | 1,300 | | | | | | |
| P-PSTP | Do | 2,600 | | | | | | |
| SS-STP | Do | 4,550 | | | | | | |
| Malabon | Tullahan river L | 13,000 | | | | | | |
| | Jokasou | 650 x 2 | | | | | | |
| Navotas | Navotas West | 2,600 | | | | | | |
| | Jokasou | 650 x 2 | | | | | | |
| Pasay | Do | 650 x 3 | | | | | | |
| Paranaque | SBR | 1,560 | | | | | | |
| | Jokasou | 780 | | | | | | |
| Munthlupa | SBR | 2,000 | | | | | | |
| Laspinas | Jokasou | 650 x 2 | | | | | | |
| Note: | | Survey, Design, Bid preparation | | | | | | |
| | | Bidding Process, Equipment purchase | | | | | | |
| | | Construction | | | | | | |

Priority projects would be reselected with pre-feasibility study by budgetary conditions or the other practical situations of the districts of local government.

## 8.2 Sanitation Construction Projects

In the Chapter .7, required capacities and appropriate locations of the septage treatment plants are studied and consequently the other 3 septage treatment plant except the existing Dagat-dagatan septage treatment plant with capacity of $450m^3$/dare are proposed to be established in order to the Business Plan. As table 7-4 shows, the following 3 septage treatment plant are recommended.

| | |
|---|---|
| North Septage Treatment Plant | 400m$^3$/d |
| (Central Septage Treatment Plant) | 450m$^3$/d (Existing) |
| South Septage Treatment Plant | 350m$^3$/d |
| Cavite Septage Treatment Plant | 350m$^3$/d |

Table 7-4 shows the development plan of the septage treatment plants as follows.

Completed by the year of;

| | |
|---|---|
| 2011 | North 4oom$^3$/d, full capacity |
| | South 150m$^3$/d, initial construction |
| 2016 | South 200m$^3$/d, final extension |
| | Cavite 100m$^3$/d, initial construction |
| 2021 | Cavite 250m$^3$/d final extension |

According to this program, the plant construction schedule by 2021 would be as follows

8-3 Septage Treatment Plant Construction Schedule

| Septage Treatment Plant | Year of | | | | | | | | | | | | | Capacity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | '09 | '10 | '11 | '12 | '13 | '14 | '15 | '16 | '17 | '18 | '19 | '20 | '21 | m$^3$/d |
| North | | | | | | | | | | | | | | 400 |
| South I'st Stage | | | | | | | | | | | | | | 150 |
| South Final Stage | | | | | | | | | | | | | | 200 |
| Cavite 1'st Stage | | | | | | | | | | | | | | 100 |
| Cavite Fibnal Stage | | | | | | | | | | | | | | 250 |

Note: Design, Bid Preparation
Equipment Procurement
Construction

The project implementation plan just decides the treatment sizes required, appropriate the plant locations, and the development timing. However, the site procurement should be discussed in the client and relevant agencies.

## 8.3 Budgetary Schedule

The project costs are shown in Table 6-4 for Sewage Treatment Systems, Table 7-6 for Septage Treatment Systems and in Addendum 2 for the Urgent Projects of Quezon City Four Communal Plant Renovation and Rapid Filtration Integration Project of Luneta and Sta Curz Lift Stations. The project component costs of the breakdown of Table 6-4 are shown in Addendum 1.

The project implementation proposals are shown in Table 8-1 for the 2'nd plant construction schedule, Table 8-2 for 3'rd plant construction schedule, and Table 8-3 for septage treatment plant construction schedule. The 1'st construction schedule (urgent project implementation schedule) is

shown in Addendum 2, which shows that the detail design and bid preparation has been completed in 2008, and the purchasing order through bidding process will be done in 2009, and the construction would starts in the year of 2009 and complete in the end of 2011.

Taking consideration these schedules, the client budgetary schedule would be shown in Table 8-4 "Budgetary Schedule for Sewerage and Sanitation Projects". Budget distributions shall be divided into three stages, that is, 10% for design and bid preparation period, 20% for bidding process and purchasing period, and balance of 70% for construction period.

Table 8-4 Budgetary Schedule for Sewerage and Sanitation Projects

in MPhP

| Project Category | 5 Year Budget | Budgetary Yaearly Schedule | | | | |
|---|---|---|---|---|---|---|
| "009 - 2011 | | - | - | 2009 | 2010 | 2011 |
| Seweage Project | 3,366 | - | - | 458 | 1,076 | 1,832 |
| Sanitation Project | 30 | - | - | 0 | 0 | 30 |
| Subtotal | 3,396 | - | - | 458 | 1,076 | 1,862 |
| 2012 - 2016 | | 2012 | 20113 | 2014 | 2015 | 2016 |
| Seweage Project | 10,426 | 51 | 466 | 1,518 | 3,996 | 4,395 |
| Sanitation Project | 100 | | | 10 | 30 | 60 |
| Subtotal | 10,526 | 51 | 466 | 1,528 | 4,026 | 4,455 |
| 2017 - 2021 | | 2017 | 2018 | 2019 | 2020 | 2021 |
| Seweage Project | 9,887 | 552 | 1,084 | 1,904 | 3,189 | 3,158 |
| Sanitation Project | 150 | 70 | 30 | | 25 | 25 |
| Subtotal | 10,037 | 622 | 1,114 | 1,904 | 3,214 | 3,183 |
| 2009 - 2021 | | | | | | |
| Grand Total Budget | 23,959 | | | | | |

Detail Budget Schedule for each project is shown in Tables 8-5 (1/2), 8-5 (2/2) and8-6.

## Table 8-5 (1/2) Budgetary Schedule for Each Project Implementation

| Districts | Sewerage System | | | Construction Period (Year of) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Facilities | Treatment Capacity | Cost in MPhP | Budget Requirement (Lower Column in MPhP) | | | | | | | | | | | | | |
| | | | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | |
| Caloocan | Dagat-dagatan STP | 130,000m³/d | 6,539 | | | | | | | | | | 653 | 1,308 | 2,289 | 2,289 | |
| | Combined Sewer | φ 600 :: 62km | 6 | | | | | | | | | | 1 | 1 | 2 | 2 | |
| | Force Main | φ 400 :: 3km | 27 | | | | | | | | | | 2 | 7 | 9 | 9 | |
| | Jokasou | 650m³/d :: 10 | 420 | | 210 | 210 | | | | | | | | | | | |
| | Dagat-dagatan STP | Full connection | | | 2 | 2 | | | | | | | | | | | |
| Quezon | South combined conn. | 6,500m³/d | 2 | | 1 | 1 | | | | | | | | | | | |
| | San Juan Project*1 | 71,864m³/d | 4,171 | 328 | 476 | 798 | 0 | 0 | 200 | 320 | 434 | 340 | 367 | 426 | 284 | 83 | |
| | Tullahan River right | 26,000m³/d | 1,308 | | | | | | 130 | 600 | 578 | | | | | | |
| | Tullahan River left | 39,000m³/d | 1,962 | | | | | | 190 | 800 | 972 | | | | | | |
| | Jokasou | 650m³/d :: 10 | 420 | | 150 | 270 | | | | | | | | | | | |
| | Combined Sewer | φ 600 :: 20km | 20 | | | | | | | 10 | 10 | | | | | | |
| | Four Communal Plant | 1,690m³/d | 296 | 50 | 100 | 146 | | | | | | | | | | | |
| Valenzuela | Tullahan River right | 26,000m³/d | 1,308 | | | | | | 200 | 500 | 608 | | | | | | |
| | Do | 13,000m³/d | 654 | | | | | | 60 | 250 | 344 | | | | | | |
| | Combined Sewer | φ 600 :: 8km | 8 | | | | | | 2 | 3 | 3 | | | | | | |
| | Jokasou | 650m³/d :: 10 | 420 | | | | | | | 100 | 320 | | | | | | |
| Malabon | Tullahan River left | 13,000m³/d :: 2 | 1,308 | | | | | | | | | | | 100 | 500 | 708 | |
| | Jokasou | 650m³/d :: 2 | 112 | | | | | | | | 50 | 62 | | | | | |
| | Combined Sewer | φ 600 :: 6km | 6 | | | | | | | | | | | 2 | 2 | 2 | |
| Navotas | Navotas West | 26,000m³/d | 1,308 | | | | | | 100 | 600 | 608 | | | | | | |
| | Combined Sewer | φ 600 :: 2km | 2 | | | | | | | 1 | 1 | | | | | | |
| | Jokasou | 650m³/d :: 2 | 112 | | | | | | 10 | 20 | 82 | | | | | | |

## Table 8-5 (2/2) Budgetary Schedule for Each Project Implementation

| Districts | Sewerage System | | | Construction Period (Year of) / Budget Requirement (Lower Column in M PhP) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Facilities | Treatment Capacity | Cost in M PhP | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| Manila | Tondo Sea Outfall | 232,885m³/d | 20 | 2 | 10 | 8 | | | | | | | | | | |
| | Rapid Filter | 66,000m³/d x 2 | 435 | 43 | 86 | 306 | | | | | | | | | | |
| | MCS Expansion | 13,000m³/d | 30 | | | | | | 5 | 10 | 15 | | | | | |
| Makati | - | - | | | | | | | | | | | | | | |
| Pasay | Combined Sewer | φ 600 x 6km | 6 | | 1 | 1 | 1 | 2 | 1 | | | | | | | |
| | Jokasou | 650m³/d x 3 | 150 | | | | | | | | 30 | 120 | | | | |
| Parnanaque | Jokasou | 780m³/d x 1 | 81 | | | | | | | | | 30 | 51 | | | |
| | STP | 1,560m³/d | 78 | | | | | | | | | | 10 | 30 | 38 | |
| | South SpSTP | 350m³/d | 235 | 35 | 40 | 60 | | | 10 | 30 | 60 | | | | | |
| Muntinlupa | STP | 30,000m³/d | 1,509 | | | 30 | 50 | 429 | 500 | 500 | | | | | | |
| | STP | 2000m³/d x 3 | 302 | | | | | | 50 | 102 | 150 | | | | | |
| Las Pinas | Jokasou | 650m³/d x 2 | 150 | | | | | | | 80 | 70 | | | | | |
| Bacoor | - | - | - | | | | | | | | | | | | | |
| Imus | - | - | - | | | | | | | | | | | | | |
| Kawit | SpSTP | 350m³/d | 235 | | | | | 35 | 30 | 30 | 30 | | | 30 | 40 | 40 |
| Cavite City | Jokasou | 650m³/d x 3 | 150 | | | | | | 30 | 40 | 30 | | | | 25 | 25 |
| Novelata | - | - | - | | | | | | | | | | | | | |
| Rosario | - | - | - | | | | | | | | | | | | | |
| Total | - | - | - | 458 | 1,076 | 1,832 | 51 | 466 | 1,518 | 3,996 | 4,295 | 552 | 1,084 | 1,904 | 3,189 | 3,158 |

## Table 8-6 Budgetary Schedule for Each Project Implementation San Juan Basin, Quezon City)

| | Sewerage System | | | Construction Period (Year of) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Facilities | Treatment Capacity | Cost in M PhP | Budget Requirment (Lower Column in 1,000PhP) | | | | | | | | | | | | | |
| | | | | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | |
| 1 | BSTP | 10,400m³/d | 531 | 150 | 170 | 211 | | | | | | | | | | | |
| 2 | TSTP | 15,600m³/d | 785 | 150 | 250 | 385 | | | | | | | | | | | |
| 3 | KTSP | 156m³/d | 46 | | | | | | | | 15 | 31 | | | | | |
| | TsSTP | 1,560m³/d | 78 | | | | | | | | | | | 20 | 25 | 33 | |
| | SSTP | 2,210m³/d | 111 | | | | | | | | | 21 | 40 | 50 | | | |
| | BaSTP | 5,200m³/d | 263 | | | | | | | | | | 50 | 100 | 113 | | |
| | BtSTP-1 | 780m³/d | 83 | | | | | | | | 30 | 53 | | | | | |
| | BtSTP-2 | 3,900m³/d | 196 | | | | | | | | | 40 | 80 | 76 | | | |
| | AsSTP | 1,170m³/d | 107 | | | | | | | | 30 | 40 | 37 | | | | |
| | SaSTP-1 | 156m³/d | 46 | | | | | | | | 15 | 31 | | | | | |
| | 4 communal | 1,690m³/d | 287 | 28 | 56 | 203 | | | | | | | | | | | |
| 4 | AsSTP-1 | 286m³/d | 52 | | | | | | | | 20 | 22 | | | | | |
| | AsSTP-2 | 546m³/d | 69 | | | | | | | | 19 | 25 | 25 | | | | |
| | SaSTP-2 | 2,860m³/d | 145 | | | | | | | | | | | 30 | 65 | 50 | |
| | VSTP | 1,300m³/d | 67 | | | | | | | | | | 20 | 20 | 27 | | |
| | P-PSTP | 2,600m³/d | 139 | | | | | | | | | | 35 | 50 | 54 | | |
| | SS-STP | 4,550m³/d | 237 | | | | | | | | | 77 | 80 | 80 | | | |
| 5 | TJSTP | 7,800m³/d | 395 | | | | | | 70 | 150 | 175 | | | | | | |
| | ASn-STP | 3,900m³/d | 198 | | | | | | 60 | 70 | 68 | | | | | | |
| | SEs-STP | 5,200m³/d | 262 | | | | | | 70 | 100 | 92 | | | | | | |
| Total | - | - | - | 328 | 476 | 798 | 0 | 0 | 200 | 320 | 434 | 340 | 367 | 426 | 284 | 83 | |

1 Bagbag-Dario North Basin
2 Talayan-Balingasa Basin
3 Clist-Dario Basin
4 Sanfrancisco-Marabu Basin
5 San Juan Basin

# 9. Preliminary Environmental Impact Evaluation

Maynilad Water Service Incorporation (MWSI) is now operating four sewerage systems and one Septage Treatment Pilot Plant. These are the followings;

- Central Manila Sewerage System (CMSS)
- Dagat-dagatan Sewerage System
- Quezon City Communal System
- Makati Isolated Sewerage System
- Dagat-dagatan Septage Treatment Plant

The service coverage population is 544,639 by Sewerage Service and 1,114,888 by Sanitation Service in 2008, and the total population in the MWSI concession area is 9,088,483 in 2008. That is to say, the consolidated service coverage of Sewerage and Sanitation Services on the total population in 2008 is around 18%, however, the service contents are mainly septage desludging and raw wastewater sea outfall, and sewage treatment system by four Quezon City Communal Plants are also of septic tanks, that is, almost of the treatment process are low efficient septic tank application or sea water dilution of direct discharging wastewater in to Manila Bay,, except Dagat-dagatan sewerage treatment plant.

## 9.1 Evaluation Present Environmental Conditions

Almost all of sewerage and sanitation facilities are aged and deteriorated through long term operation, except Dagat-gagatan septage treatment plant. Quezon City communal plants are now stopping services. Tondo sea outfall systems with seven lift-up pumping stations together with the sewer lines and dagat-dagatan sewerage treatment plant have been rehabilitated by 2004.

Regarding odor control for the seven lit stations, carbon filter deodorizing facilities have incorporated as a part of rehabilitation. The surface aeration facilities have been installed to Dagat-dagatan sewage treatment plant to improve the treatment process. The site area is enough wide to mitigate the noise problem to the neighboring. Main noise generation sources in the sewerage and sanitation plants are treatment process pumps such as, sludge pumps lift up pumps, dosing facilities, etc. However, almost all of the pumps are submergible pumps, so very few noise problems.

The big environmental problems are still water qualities and solid waste contamination. No

treated wastewater are contaminating main rivers like Pasig, San Juan, Tullahan, Tinejeros, Paranaque, Imus River and the tributaries, consequently pollute Manila Bay coastal area.
Poor solid waste management or resident low perception to the garbage management causes worse hygienic problems and much garbage are put into the creeks, esteros or street drainage systems advertently or inadvertently, And garbage left in the streets are born away into drainage lines, This subsequently causes lot of clogs in the drainage lines and many of garbage reach to the sewerage systems through waterways. The seven lift stations have facilitated the mechanical bar screens at the influent pits in the rehabilitation program. The bar screens to be installed at the inlets of sewerage process are essential to the sewerage system establishment. Those screens could be installed in the waterways, such as appropriate positions of rivers, creeks and drainages; however, this point would also be possible to become obstruction against water stream.

There are found squatters' settlements in many places especially in the middle of Metro Manila. In the other districts, many squatters' settlements are seen and mainly locating waterways and they are using the rivers or drainages as wastewater discharging pit and trashes. They are also serious polluters into the environment. Removals of them are almost impossible, because this problem is strongly connected to the political matters.
But Partial resettlement of them to install simple wastewater treatment system, like biological contact aeration or oxidation ditch process, might be realistic. These kinds of projects should be implemented politically as one of welfare services, because environmental improvement by the projects would also contribute to the tax payers who suffer from environmental contamination by squatters.

All situations mentioned above are also one of the main reasons of town over flood problems.
As such, there are many places in the towns holding over flood or inundation issues. These matters are hampering the appropriate program implementation of the sanitation and sewerage projects.
Poor water qualities of wastewater area serious issues to keep or improve the citizens' hygienic conditions. The civil water supply services are covering a wide range in the service territory; however, wastewater contamination would degrade the water supply service effect.
In order to cater for Manila Bay and Laguna de Bay water contamination, improved sewerage process application and sewerage and sanitation service coverage development should be essential.

## 9.2 Evaluation of Planning Schemes' Environmental Impact

In order to develop the sewerage and sanitation services according to the MWSI business plan reviewed in 2007, about 47 sewage treatment plants and 3 septage treatment plants are proposed in this master plan to be established over MWSI concessional area. Wastewater collection to the plants shall be made through combined sewer system which collect wastewater through existing creeks and/or drainage systems. Almost all of the plants shall be located in or near congestion areas, and in case, underground. The plants are basically low buildings, thus there are few occasions to impair scenery or blot the landscape. And the plant locations are inherently positioned in the lowest land, in most cases near rivers or creeks. Some candidate site areas are near or in swamp area, which might be natural regulating pondage. In the case that the plant is located in the area where sometimes suffers from over flood or inundation, provision shall be made for the plant site itself to be protected from such over flood. Therefore how the over flood condition would be changed after the plant constructed is carefully studied.

Concession areas are districts well developed, thus these plants would not damage on any historical areas. Table 9-1 shows an initial environmental assessment on the master plan.

### 9.2.1 Prediction of Environmental Impact during Project Construction

During the plant construction, unusual situation will emerge, such as, noise, odor, dust, construction waste including wastewater, traffic, tentative building and access road, laborers' house , etc.

Construction noises and vibrations are mainly generated by construction machines, pile driving work, excavation, concrete hammer, etc.

Regarding odor during construction, generally few cases occurs.

Tentative access road is necessary for construction machines and transportation trucks, and generally this road would be used for permanent plant access road.

Construction waste shall be well managed.

Regarding traffic, sometimes large vehicle approach is required. Electric power supply to the plant would require a new transmission lines with electric poles.

Table 9- 2 shows environmental impact during the project construction period.

### 9.2.2 Prediction of Environmental Impact after Project Completed site areas

Main impacts generated in the sewerage systems are, pump noise, odor from screen room and sludge storage tank and excess sludge produced in the aeration process. And main impacts generated in the sanitation systems are odor from septage storage tank and frequent access of septage collection vehicles. These impacts should be properly studied and provision shall be

made for the design to mitigate these impacts against environment and neighbors.

### 9.2.3 Mitigation Measures for the Environmental Impact

Mitigation measures for the predicted environmental impacts shall be properly incorporated in the system designs from the beginning. However, neighboring circumstance changes emerged by construction of the sewerage and sanitation facilities should be accepted by the relative beneficiaries through advance discussions with relative parties or individuals and workshops held in advance and during construction to get proper understanding of them to the systems. Septage collection vehicles shall be managed and operated to prevent residents affected from any dangers and truck noises and dust emission. The daily access times and operation hours of the vehicles shall be decided in the figures as neighboring society acceptable. Access road pavement is essential.

Excess sludge shall be treated by the septic treatment plants. Most pumps are submergible, so it is generally not to make any issues, except air blowers. Noise mitigation wall would be necessary in case.

Odor from sludge storage tanks or screen rooms shall be shut-out and odor diffusion facilities are essential, however, in case of septic treatment plant, odor control facility would be required when the location is near to resident areas.

During construction, potential impacts against the circumstances are construction noises, construction solid waste or wastewater, transportation of heavy machines or construction materials, etc. The contractors should not only comply with relative regulations, laws or acts, but get agreement from the neighboring residents or parties affected by the construction activities.

Especially noises generated by driving piles, concrete cutting or breaking hammer shall need acceptance of the neighbors regarding operation time and dates. Transportation of construction heavy machines or construction materials should be agreed with residents or parties to be affected, regarding access route, time date, etc.

Construction waste and wastewater containing oil, paint and other any chemical materials shall be kept in the construction site, otherwise properly treated.

Table 9-3 shows the necessary constructors activities, and Table 9-4 shows the mitigation measures against the impacts.

## 9.3 Effectiveness for the Environmental Improvement by the Project Implementation

The effectiveness for the environmental improvement by the project implementation is evaluated

by the several parameters such as, ecological aspect by monitoring the water livings, reduction rates of water born diseases, residential satisfaction for the water circumstances, the water front sceneries, etc., as an absolute evaluation. The cost effectiveness could be considered with national consensus.

At this moment, the evaluation of project effectiveness is assumed to be in proportion of the sewerage and sanitation service coverage and reduction of organic matters solved in the water bodies, that is, by absolute evaluation.

### 9.3.1 Effect by the Urgent Project

The urgent projects are proposed in the master plan to be completed in 2011. The available sanitation and sewerage management facilities would be as follows when the urgent projects are completed;

- Luneta, St. Cruz LS Rapid filtration (Tondo sea outfall)
  Maximum discharge water quality and quantity
  232,885$m^3$/d; BOD 120mg/l down to 98mg/l
- Four Communal Plants
  Maximum discharge water quality and quantity
  1,690$m^3$/d; BOD 80mg/l down to 20mg/l
- Dagat-dagatan Sewage Treatment Plant
  Maximum discharge water quality and quantity
  13,000$m^3$/d; BOD 200mg/l down to 20mg/l
- Dagat-dagatan Septage Treatment Plant
  450$m^3$/d of septage (213,525$m^3$/d of sewage equivalent)
  BOD 200mg/l down to 80mg/l
- North and South Septage Treatment Plants Extension of
  550$m^3$/d septage treatment in total (260,975$m^3$/d of sewage equivalent):
  BOD 200mg/l down to 80mg/l

When the urgent projects are completed, wastewater volume treated in total and service coverage population by the above systems is as follows in equivalent sewage treatment capacity.

| | |
|---|---|
| Total Treated Water Volume | 722,075$m^3$/d |
| Service Coverage Population | 5,554,423 |

The population in 2011 in MWSI concession area is predicted of 8,324,092; therefore service coverage percentage is 66.72% (potential capacity base). This number will be realized when the household connection and connection sewer lines to the systems are completed.

9.3.2 2'nd Development Projects

In order to accomplish the business plan of the sewerage and sanitation service coverage in the year of 2016, the following projects are proposed in the master plan

- Tarayan-Balingasa Sewage Treatment Plant
  Maximum discharge water quality and quantity
  15,600$m^3$/d; BOD 200mg/l down to 20mg/l
- Bagbag-Dario Sewage Treatment Plant
  Maximum discharge water quality and quantity
  10,400$m^3$/d; BOD 200mg/l down to 20mg/l
- North and South Septage Treatment Plants Extension of
  300$m^3$/d septage treatment in total (142,350$m^3$/d of sewage equivalent):
  BOD 200mg/l down to 80mg/l
- Pasay Combined Sewer Connection
  Maximum discharge water quality and quantity
  19,500$m^3$/d; BOD 120mg/l down to 98mg/l
- Quezon South Combined Sewer Connection
  Maximum discharge water quality and quantity
  6,500$m^3$/d; BOD 120mg/l down to 98mg/l
- Central Sewer Line Extension
  Maximum discharge water quality and quantity
  13,000$m^3$/d; BOD 120mg/l down to 98mg/l
- Muntinlupa Sewage Treatment Plant
  Maximum discharge water quality and quantity
  30,000$m^3$/d; BOD 200mg/l down to 20mg/l
- Novotas West Sewage Treatment Plant
  Maximum discharge water quality and quantity
  26,000$m^3$/d; BOD 200mg/l down to 20mg/l

When the second projects are completed, wastewater volume treated in total and service coverage population by the above systems is as follows in equivalent sewage treatment capacity.

| | |
|---|---|
| Additional Treated Water Volume | 263,350$m^3$/d |
| Added Service Coverage Population | 2,025,769 |
| Total Service Coverage population | 7,580,192 |

The population in 2016 in MWSI concession area is predicted of 8,765,928; therefore service coverage percentage is 86.47% (potential capacity base). This number will be realized when the household connection and connection sewer lines to the systems are completed.

Taking consideration Japan case, sanitation service percentage 66.72% after the urgent project completed, appreciably is effective numbers to realize better environmental situation, and coverage of 86.47% after the second priority projects completed, is sufficiently good for people to feel the environment conditions or pollution significantly improved.

if the project is implemented over 80%, the cost performance of the project effectiveness against construction and budgetary situation would emerge seriously. And if 80% is successfully realized, spontaneous recovery would expect on the remaining pollution.

### 9.3.3 3'rd Development Project

According to the business plan, the third project implementation plan is proposed in the master plan to accomplish their final sewerage and sanitation service coverage in 2021. The project components for the third project implementation, the remaining project components listed in Table 6-12 and Table 7-6 are proposed to be completed in 2021.

The additional sewage treatment plant capacity and septage treatment plant capacity in total by the third implementation project plan are as follows.

- Sewage Treatment Plants
  Maximum discharge water quality and quantity
  413,314$m^3$/d; BOD 200mg/l down to 20mg/l
- Septage Treatment Plant
  250$m^3$/d of septage (118,625$m^3$/d of sewage equivalent)
  BOD 200mg/l down to 80mg/l

When the third projects are completed, wastewater volume treated in total and service coverage population by the above systems is as follows in equivalent sewage treatment capacity.

| | |
|---|---|
| Additional Treated Water Volume | 531,939m$^3$/d |
| Added Service Coverage Population | 4,091,838 |
| Total Service Coverage population | 11,672,030 |

The population in 2021 in MWSI concession area is predicted of 9,142,557; therefore service coverage percentage is 127.67% (potential capacity base). This number will be realized when the household connection and connection sewer lines to the systems are completed. And it would cater for the population growth after 2021.

However, the cost performance would be low at the third stage; the implementation plan in the business plan should better be rebuilt. If the investment cost should be reduced, the percentage of Septage Treatment System should be increased and the sewerage service should be reduced, and if better water quality is expected, the septage treatment coverage should be reduced.

### 9.3.4 Water Pollution Material Reduction Expected By the Project

Water pollution materials to be get rid of through the sewerage and sanitation systems are estimated as follows.

**Table 9-4** Reduction of Water Pollution Materials

Tons on BOD base

| Year | Daily | | Yearly | |
|---|---|---|---|---|
| | Additional | Cumulative | Additional | Cumulative |
| 2011 | 64.5 | 64.5 | 23,542.5 | 23,542.5 |
| 2016 | 32.7 | 97.2 | 11,935.5 | 35478.0 |
| 2021 | 88.6 | 185.8 | 32,350.3 | 67,828.3 |

Reduction of water pollution materials will be 23,542 tons/year after urgent project (1'st Project) is completed and at the final stage, will reach at as much as 67,828 tons/year (BOD base).

Table 9-1 Initial Environmental Evaluation on the Proposed Projects

| Will the development (either directly or indirectly) | Yes | No | If yes, is it significant? | Comments |
|---|---|---|---|---|
| **General** | | | | |
| 1. Breach any section of Environmental Act or Regulations. | | No | | |
| 2. Be contrary to any environment initiatives or projects endorsed by the Government? | | No | | |
| 3. Be contrary to policies on Sustainable Development in Philippine? | | No | | |
| 4. Be contrary to any provisions of a conservation agreement, management plan, conservation area or reserve? | | No | | |
| 5. Result in the depletion of any non-renewable resource? | | No | | |
| 6. Adversely change the natural features of the topography or ground surface, including the river lines and lakes? | | No | | |
| 7. Destroy, disturb, cover, modify or threaten any unique geologic or physical features? | | No | | |
| 8. Result in unstable land surfaces (subsidence, slip or collapse) or increase the exposure of people or places to such hazards? | | No | | |
| 9. Result in soil erosion, depletion or cause siltation? | | No | | |
| 10. Adversely affect the status of flooding, inundation, cyclonic wave and wind damage, fire or other risk? | | No | | In case of swamp land, reduction of flood receiving capacity shall be kept. |
| 11. Result in an adverse increase in use of any physical resource? | | No | | |
| **Water** | | | | |
| 12. Modify the flow of any channel, or the bed of the river? | | No | | |
| 13. Encroach upon areas affected by floodwaters or tidal waves? | | No | | |
| 30. Use excavation techniques, unacceptable/banned for use in Philippine? | | No | | |
| **Heritage** | | | | |
| 31. After any scenic resources, landscape amenity or result in the obstruction of any scenic vista as viewed from a public area? | | No | | |

| | | | | |
|---|---|---|---|---|
| 32. Adversely affect item, sites or places of archaeological or cultural heritage value? | | No | | EMMP contains provisions on actions to be taken if archaeological sites/materials are found |
| 33. Adversely affect or encroach upon traditional use areas or areas of significant indigenous knowledge, folklore, religious or customary importance? | | No | | Any such issues would be raised in the lease agreement negotiations |
| 34. Adversely affect the tourism potential of areas acknowledged as culturally valuable? | | No | | |
| 35. Adversely affect the customary use of bush areas for plantation, building or fielding materials? | Yes | | Not significant | Compensation and lease payments may be made to affected residents. |
| **Social & Economic.** | | | | |
| 36. Create an aesthetically offensive site open to view from neighbouring land or from public areas? | | No | | |
| 37. Cause or pose a serious detrimental effect? | | No | | It is noted that some residents may perceive the sewage treatment plant would negatively impact the living circumstances. |
| 38. Cause disruption of any existing development in terms of character, location, siting, bulk, scale, shape, size, height, density, design or external objectives? | | No | | |
| 39. Be inconsistent with any elements of integrated local area or community plans, policies or objectives? | | No | | Any such issues would be raised in the lease agreement negotiations |
| 40. Affect areas of recreation, social or cultural activity? | | No | | Any such issues would be raised in the lease agreement negotiations |
| 41. Affect lifestyles, neighbourhood or residential area character? | | No | | Any such issues would be raised in the lease agreement negotiations |
| 42. Affect minority, elderly handicapped, transit-dependant, or other specific interest group? | | No | | |
| 43. Divide or disrupt an established community? | | No | | |
| 44. Adversely affect any community facilities (including medical, educational, scientific, recreational or religious intuitions, ceremonial sites or sacred areas? | | No | | Any such issues would be raised in the lease agreement negotiations |
| 57. Involve more than the minimum extent of cleaning of trees shrubs and groundcovers? | | No | | Project designed to minimize impact and unavoidable impacts will be mitigated by compensation and lease payments |
| **Economic** | | | | |
| 58. Causer or pose a detrimental economic effect? | | No | | Any such issues would be raised in the lease agreement |

| | | | | |
|---|---|---|---|---|
| 59. Cause the reduction of employment, industry or commercial levels? | | No | | negotiations |
| 60. Require the displacement of businesses or activities? | | No | | |
| 61. Adversely affect the economic value of the proposed site for development? | Yes | | Not significant | Land for the treatment plant not under any short or medium development pressure |
| 62. Result in demands to city traffic or river traffic and associated facilities? | | No | | |
| 63. Support commercial, residential, infrastructure or tourism development? | | No | | |
| 64. Increase demands for commercial, industrial, office or services or site areas? | | No | | |
| 65. Result in an oversupply of commercial industrial, office or service trades beyond the threshold of the national or local community to service such use? | | No | | |
| **Other** | | | | |
| 66. Fail to address issues or matters raised as a result of public consultation, pubic notification, consideration proposed from relevant pubic agencies? | | No | | |
| 67. Fail to address the regal and administrative rights and powers of relevant public agencies? | | No | | |

Notes: The Environmental Checklist prepared by Consultant has been used by the Project Implementation Group as a checklist for screening these projects proposed. The checklist has been provided to give a systematic procedure to the appraisal to Environment Impact Assessments (EI□'s). It is used to identify physical, biological, social, cultural and economic factors, which should be considered before giving Development Consent.

## Table 9-2 General Environmental Impacts by STP Construction

| Stage | Environmental factors \ Environmental elements | | Air pollution | Water contamination | Noise | Vibration | Odor | Topography, Geography | Animal, Plant | Landscape | Outdoor recreation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Construction | Transportation of construction materials & machinery | | ■ | | ■ | ■ | | | | | |
| | Leveling of ground (banking) | | ■ | ■ | ■ | ■ | | | | | |
| | Leveling of ground (leveling of land) | | ■ | ■ | ■ | ■ | | | | | |
| | Leveling of ground (tree felling) | | | ■ | ■ | | | | | | |
| | Excavation for foundation work | | ■ | | ■ | ■ | | | | | |
| | Piling | | | | ■ | ■ | | | | | |
| | Access road (inside yard, outside yard) | | | | | | | | | ■ | |
| | Plant building (administration building, others) | | | | | | | | | ■ | |
| | Site (change of groung shape, occupation of surface | | | | | | | ■ | ■ | ■ | ■ |
| Land reclamation | Carrying of waste (transportation) | | ■ | | ■ | ■ | ■ | | | | |
| | Land reclamation work | | ■ | | ■ | ■ | | | | | |
| | Existence of waste Decomp. Of waste | Water solubility | | ■ | | | | | | | |
| | | Volatility | | | | | ■ | | | | |
| | | Rotting characteristics | | ■ | | | ■ | | | | |
| | | Flotation. Scattering | ■ | | | | | | | ■ | |
| | | Feedability | | | | | | | ■ | ■ | ■ |
| Existence | Decomp. of Waste, etc. | Water solubility | | ■ | | | | | | | |
| | | Volatility | | | | | ■ | | | | |
| | | Rotting characteristics | | ■ | | | ■ | | | | |

■ affects projects

Table 9-3 Necessary Contractors Activity

| Impact | Location of impact and severity | Mitigation measures | Responsibility |
|---|---|---|---|
| Siting issues | All compounds | • For noise, dust or fume producing activities such as rock crushing and cement-batching plant, locate at least 50 m away from habitation settlements wherever practicable | Contractor |
| Contamination of areas outside compounds (especially groundwater) by storm water runoff and seepage containing sediment, fuel and oil | All compounds. Impact low unless poorly managed | • All compounds should be fenced<br>• Sites where potentially hazardous chemicals, including fuel or oils, will be stored should be fenced and, if warranted, surrounded by a bund and with a lined floor (heavy duty plastic/HDPE) to prevent groundwater contamination.<br>• Any large quantities of spilled oil or other contaminants should be cleaned-up immediately<br>• Stormwater runoff from compounds should pass through a gross pollutant trap (to filter plastics, cans and other solid wastes) and a lined settlement basin or drain (to trap/absorb oils and other organic substances) before discharge into the soil. At sites where sediment slurry will be produced, the drain should also contain a silt trap (sediment settling basin) | Contractor<br><br>Contractor |
| Mosquito nuisance | All compounds. Minor impact if properly managed | • Avoid creating suitable mosquito breeding habitat by disposing of all or storing under cover small containers such as tins, buckets and tyres which could collect rainwater<br>• Cover all long-term water storage containers so that mosquitoes cannot enter them to breed. | Contractor |
| Dust nuisance | Rock crushing and concrete-batching plants especially. Potentially moderate to high impacts | • Cover or store in sheds construction materials particularly prone to dust production<br>• Provide workers working on dust-prone tasks with masks and goggles.<br>• Screen the compound with a mesh fence or vegetation to prevent dust contamination of surrounding areas | Contractor |
| Noise and emissions from vehicles and plant | Rock crushing, bitumen and concrete-batching plants especially. Potentially moderate to high impacts | • Use well-maintained registered vehicles and equipment which meet Vietnam emission and noise standards.<br>• Operators of noisy equipment should wear ear muffs of ear plugs<br>• Near settlements carry out noisy construction activities during normal working hours and advise local residents of any proposed unusual unavoidable noise | Contractor |

| Impact | Location of impact | Mitigation measures | Responsibility |
|---|---|---|---|

| | | | |
|---|---|---|---|
| | **and severity** | | |
| | | | |
| Wastes disposal | All compounds | • Sewage. Where possible, provide toilets connected to the sewerage system. Elsewhere use portable toilets should be installed and operated to the manufacturer's requirements, with wastes being disposed of into the sewerage system.<br>• Non-hazardous solid waste should be disposed of in an approved sanitary landfill, after recyclable and compostable components have been removed<br>• Take all waste oil for recycling | Contractor |
| Safety of project staff | All compounds | • Ensure all occupational health and safety requirements adopted by the Project for the workforce are in place | Contractor, Ministry of Labour |
| Site de-commissioning | All compounds | • Flatten and smooth out all piles of soils on and around the construction area<br>• Where disturbed soils are prone to wind or water erosion or dust formation, cover with a layer of coarse sand or gravel | Contractor, local community groups |

## 9-4 Mitigation Measures against Project Environmental Impacts

| Impact | Location of impact and severity | Mitigation measures | Responsibility |
|---|---|---|---|
| **Terrestrial Construction Works Management** | | | |
| Loss of trees | Widespread impact, but generally slight | • Design construction works to avoid or minimize impacts<br>• Pay cash compensation for economic trees cut down. | Detailed field design consultations<br>Contractor and local landowners or communities |
| Erosion of and sediment mobilization from construction areas | All areas. Minor impacts, except on disturbed fine textured soils during heavy rain | • Ground disturbance should be phased to that it is limited to areas of a workable size<br>• The creation of piles of potentially erodible soil should be minimized<br>• Encourage stabilization as soon as possible after construction finishes | Contractor |
| Mosquito nuisance | Limited localities. Minor impacts, except in wet periods | • Avoid creating suitable mosquito breeding habitat in stagnant water bodies such as unfilled or poorly rehabilitated trenches and pits | Contractor |
| Dust nuisance | All areas. Mainly minor except where loose or disturbed fine textured soil | • In sensitive areas spray water on exposed construction surfaces and stockpiles during dry/windy periods where dust nuisance is created<br>• Provide workers working on dust-prone tasks with masks and goggles. | Contractor |
| Noise and emissions from vehicles and plant, and construction activities | All areas. Potentially moderate to serious impacts locally | • Use well-maintained registered vehicles and equipment which meets Vietnam emission and noise standards<br>• Operators of noisy equipment should wear ear muffs of ear plugs<br>• Near or in settlements, carry out noisy construction activities during normal working hours and advise local residents of any proposed unusual unavoidable noise | Contractor |
| Rubbish disposal | All areas. Minor impacts | • The recyclable non-biodegradables and compostable organic material should be separated out and the remainder disposed of in an approved landfill. | Contractor |
| Safety of project staff and public | All areas, especially along roads. Minor impacts | • Ensure all occupational health and safety requirements adopted by the Project for workforce are in place<br>• Establish a project hazard reduction plan which will allow safe passage of road users by ensuring separation of motor vehicle traffic from non-motorized and pedestrian traffic<br>• Fence off open trenches and pits.<br>• Install lights and cautionary signs in hazardous areas | Contractor |

| Impact | Location of impact and severity | Mitigation measures | Responsibility |
|---|---|---|---|
| Archaeological, cultural and historic places | Rare occurrence and negligible impact | • For archaeological sites, stop work immediately and report finds to Cultural Division<br>• Avoid all known historic places<br>• Consult with communities where culturally important places may be encroached upon | Contractor |
| Unexploded ordinance | Rare occurrence. Serious risk where located | • Stop work immediately and report finds to Police | Contractor and Police |
| Site de-commissioning | All areas | • Flatten and smooth out all piles of soil on and around construction areas<br>• Where undisturbed soils that are not to be revegetated are prone to wind or wash erosion or dust formation, cover with a layer of coarse sand or gravel<br>• Once the fill of trenches has settled over a period of weeks, cover with top up fill where warranted<br>• Establish a site revegetation plan for areas where revegetation is feasible<br>*The revegetation plan should include:*<br>  • Name(s) of group contracted to carry out the work,<br>  • Summarised outcome of discussions, and decision on what will be planted;<br>  • List of seedlings/stock to be provided; by whom (people or group); agreed price; agreement for planting and tending | Contractor, community organizations |
| Imported materials – quarantine and import requirements | Mainly negligible, potentially high | • Ensure that all imported materials to be transported from the air/sea port have the appropriate import approval documentation (including quarantine) before it is removed from the wharf area. | The Project, Contractor, Customs and Agriculture Division (Quarantine staff) |
| Damage to river ecosystems, fringe vegetation | Low if designed routes and excavation methods are adhered to | • Avoid to settle effluent near the other exit of stream to Hong River | The Project for design and monitoring.<br>Contractor to implement |
| Sediment mobilization onto river or nearshore waters | Low if design routes are adhered to | | Contractor |

| Impact | Location of impact and severity | Mitigation measures | Responsibility |
|---|---|---|---|
| Noise and emissions from vehicles. | All roads used by the project, Potentially moderate to serious impacts | • Use well-maintained vehicles and other road-using machinery which is registered for use on the roads and which meet Vietnam emission and noise standards<br>• Operators of noisy vehicles and machinery should wear ear muffs of ear plugs | Contractor |
| Safety of project staff and public | All roads along which materials are transported. Potentially moderate impacts | • Ensure all occupational health and safety requirements adopted by the Project for truck and machinery drivers are in place<br>• Ensure all transport trucks and machinery obey the traffic laws with respect to permissible loads, speed of travel, distance maintained between vehicles and overtaking. | Contractor, Ministry of Labour |

# 10. Expansion of Sewer Collection Service Coverage (Alternative 1)

The Business Plan of the sewer collection service coverage in 20021 shall be targeted to satisfy 43% and more, and the master plan is proposing how to achieve the final target coverage. In the proposal, the final sewer collection services would reach at 45.3% in the service coverage population rate. The remaining parts shall be serviced by the septage collection and treatment system.

If the sewer collection service coverage is expanded up to 66% and more, the wastewater quality discharged into Manila Bay will be more improved to enhance the environmental condition upgrading, because the effluent water quality of the sewage treatment system to be adopted shall be defined at 20mg/l and less in $BOD_5$ rate.

This chapter shows how to achieve 66% sewer collection service coverage.

## 10.1 Service Coverage of Sewer Line Collection Service in the Master Plan

According to Chapter 7, Table 7-3, the final service coverage rate shall be 45.6%, and remaining part is planned to be covered by the septage collection and treatment system. Table 10-1 shows the sewer and septage collection service coverage in 2021.

Table 10-1 Sewer and Septage Collection Service Coverage Rate

| Districts | Population to be serviced in 2021 | Service Population | | Notes |
|---|---|---|---|---|
| | | Sewage Collection | Septage Collection | |
| Caloocan | 1,549,005 | 1,050,000 | 499,005 | Including the North |
| Quezon | 2,153,883 | 1,158,181 | 995,702 | |
| Valenzuela | 680,862 | 350,000 | 330,862 | |
| Malabon | 417,085 | 210,000 | 207,085 | |
| Navotas | 288,166 | 210,000 | 78,166 | |
| Manila | 1,532,935 | 876,284 | 656,651 | |
| Makati | 93,579 | 0 | 93,579 | |
| Pasay | 461,415 | 168,846 | 292,569 | |
| Paranaque | 450,589 | 18,000 | 432,589 | |
| Muntinlupa | 411,545 | 276,150 | 135,395 | |
| Las Pinas | 431,400 | 10,000 | 421,400 | |
| Bacoor | 581,450 | 0 | 581,450 | |
| Imus | 210,405 | 0 | 210,405 | |
| Kawit | 100,475 | 0 | 100,475 | |
| Cavite City | 103,511 | 15,000 | 88,511 | |
| Noveleta | 56,196 | 0 | 56,196 | |
| Rosario | 121,288 | 0 | 121,288 | |
| Total | 9,522,501 | 4,342,461 | 5,180,040 | Population covered |
| | 100% | 45.6% | 54.4% | Coverage percentage |

The difference of the sewer collection service rates between the Master Plan and the Alternative

target of 66% is 20.4%, which should cover population of **1,942,590.**

In order to satisfy this target coverage, more than 252,536$m^3$/d and more sewage treatment capacity shall be realized with additional sewage treatment systems to the original plan in the Master Plan.

## 10.2 Expansion Plan of Sewage Collection Service Coverage

Enhancing and upgrading the effluent wastewater quality discharging into Manila bay, the water qualities of the main rivers terminating at the Manila Bay and of the main tributaries of the rivers should be improved. That is, the sewerage treatment systems shall be installed near the rivers. Alternative plans for the expansion of the sewage collection service coverage are shown herein under by each municipality.

### 10.2.1 Expansion with Installation of Combined Interceptors alongside Main Rivers or by Utilizing Existing Sewer Collection Systems

**(1) Manila**

The population out of the Central Manila Sewerage System(CMSS) which will be 656,651 in year of 2022. The maximum capacity of the system is more than 350,000$m^3$/d against actual load of less than 240,00$m^3$/d in 2021. Thus another 110,000$m^3$/d of the system coverage would be applicable, if the sewer line extension is made. In the case, additional population of **423,000** (80,000$m^3$/d) would be covered by the CMSS. The total length of the sewer line extension might be about 110km with 100 manhole pumps.

**(2) Makati City (including a part of Pasay City)**

MWSI territory of Makati City is a part of the area locating alongside the upstream of Paranaque River (tributary) bordering Pasay City. By installing combined sewer line interception of 4.5km length, total population of **100,000** would be connected CMSS. Fig. 10-1 shows the combined sewer interception line.

**(3) Pasay and Paranaque City**

Large figure of wastewater generated in Pasay and Paranaque City is discharged in the Paranaque River and its tributaries. By installing combined sewer line interception of 13.8km length, total population of **62,000** shall be connected to a new sewage treatment plant with capacity of 8,000$m^3$/d to be established in the reclaimed land near the mouth of Paranaque River .

**(4) Quezon City North**

By installing combined sewer interceptors of 6.3km length of the both sides of Tullahan River, population of **230,000** would be connected to the new established sewage treatment plant with capacity of 30,000$m^3$/d at the sewer line end.

Fig. 10-3 shows Tullahan River Side Combined Interceptors.

Fig. 10-1 Combined Sewer Interception for Makati City

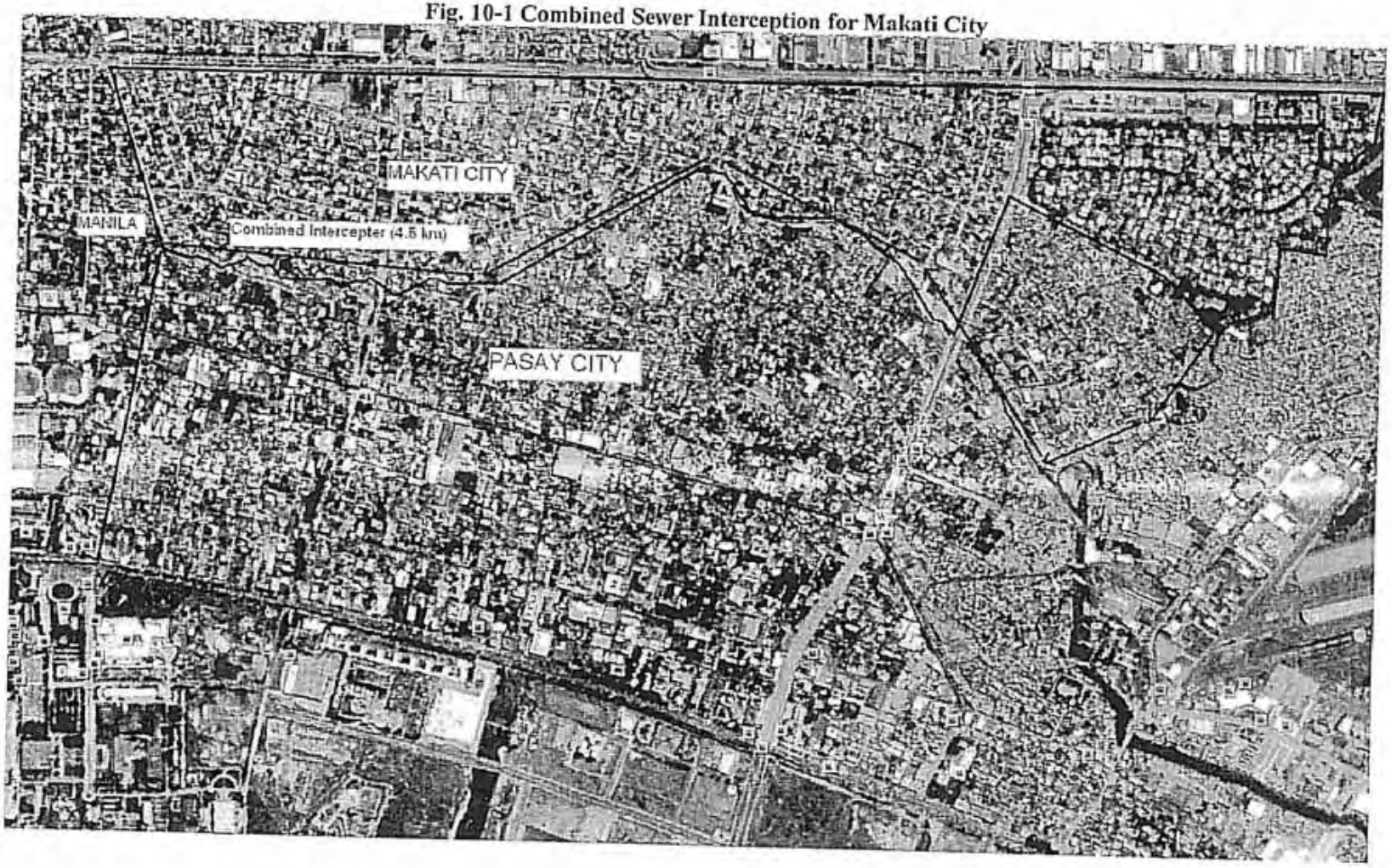


Fig. 10-2 Combined Sewer Interception for Pasay/Paranaque City

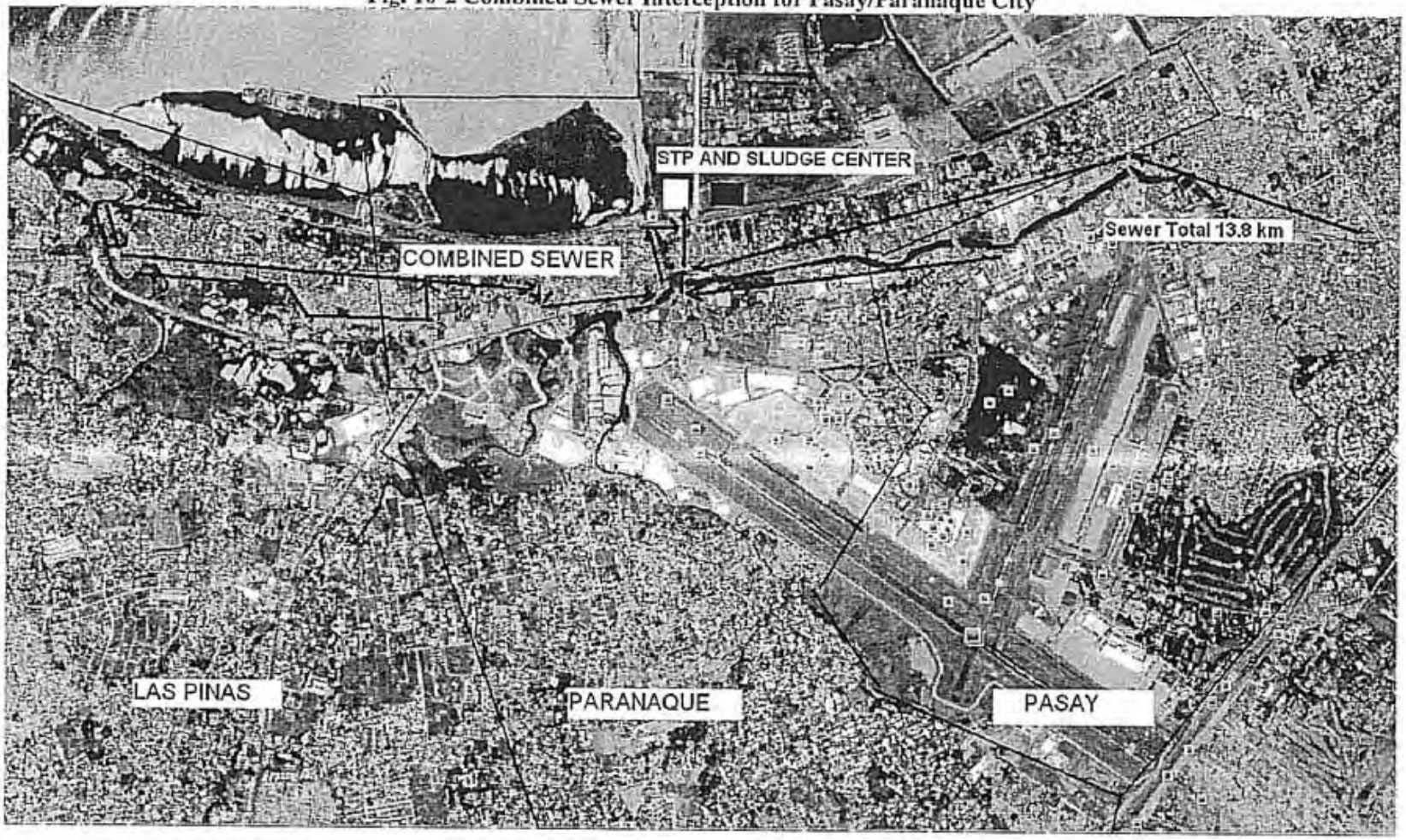
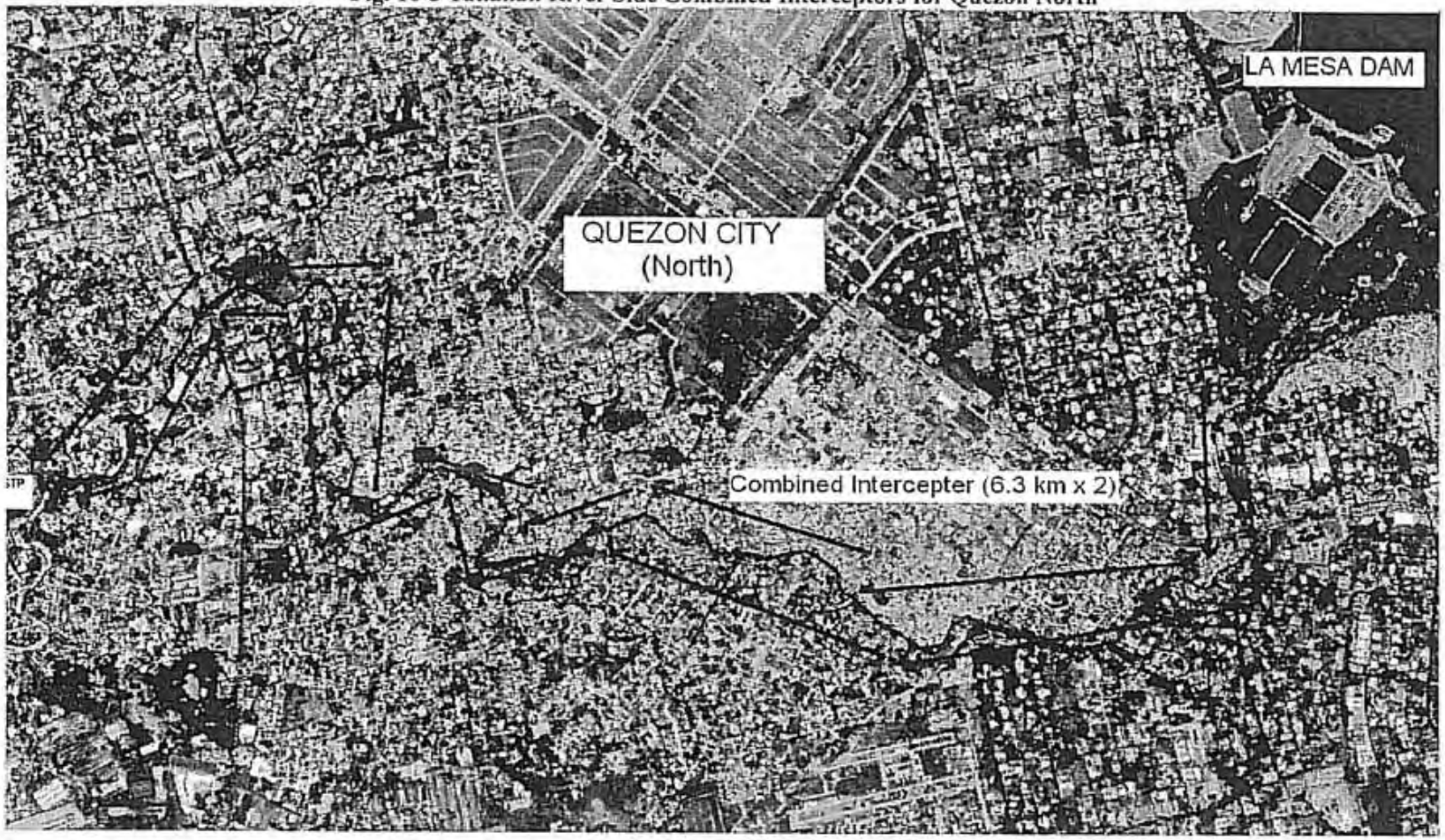


Fig. 10-3 Tullahan River Side Combined Interceptors for Quezon North



### 10.2.2 Establishing New Sewer Collection Systems at Appropriate Positions to realize the Most Effective Size and Locations

Where appropriate river basin or useful creeks for combined sewers are not applicable, and/or residential blocks are separated or scattered in the land area, several smaller sized sewage treatment systems with local combined collection sewer lines shall be adopted to cater for the residential blocking structures, the area terrain and small tributaries or creeks connected to the tributaries.

**(1) Caloocan North**

Judging from the residential block distributions and locations of rivers or creeks, especially the upstream and tributaries of Marilao River, two SBR sewerage systems with capacity of 3,000$m^3$/d (for **46,000** people) and five modular type STPs (Jokasou) with capacity of 650$m^3$/d (for **25,000** people) could be built.

**(2) Valeanzuela**

This municipality with mainly factories occupation might take care for treatment of industrial wastewater and solid waste. Because of factory workers' residential location, two modular type STPs (Jokasou) with capacity of 650$m^3$/d (for **10,000** people) could be built. If the land acquisition is possible, there is a possibility to establish bulk type sewage treatment plants might be established alongside the tributaries of Meycauayan River, but this is the case.

**(3) Malabon**

Because of low land terrain, only one modular type STP (Jokasou) with capacity of 650$m^3$/d (for **5,000** people) could be built.

**(4) Navotas**

This small and congestion island has no more space to expand the sewer line collection service.

**(5) Caloocan**

No more space for extension of sewer collection system, except renovation of Dagat-dagatan STP.

**(6) Quezon North**

Because of the land terrain and residential area blocking structures in the Northwest area of the Southwest of Lamesa Dam, two modular type STPs (Jokasou) with capacity of 650$m^3$/d (for **10,000** people) and 60 modular type STPs (Jokasou) with capacity of 260$m^3$/d (for **120,000** people) could be built.

**(7) Pasay**

Because of residential congestion of this municipality, modular type STP shall be installed at many places. Total number of twenty modular type STPs (Jokasou) with capacity of 390$m^3$/d (for **60,000** people) alongside the inland rivers and two SBR with capacity of 3,000$m^3$/d (for **46,000** people) alongside Manila Bay could be established.

**(8) Paranaque**

Because of complicated flows of inland rivers and creeks, only modular type STP would be possible to install. Total number of fourty modular type STPs (Jokasou) with capacity of 650$m^3$/d (for **200,000** people) alongside the inland rivers could be established.

**(9) Laspinas**

Because of the residential block configuration, medium type of STPs shall be installed alongside the inland river. Ten SBRs with capacity of 3,000m$^3$/d (for **230,000** people) could be established.

**(10) Bacoor**
Ten SBRs with capacity of 3,000m$^3$/d (for **230,000** people) could be established alongside Manila Bay and inland rivers.

.

**(11) Imus**
Four SBRs with capacity of 3,000m$^3$/d (for **92,000** people) could be established alongside inland rivers.

**(12) Kawit**
Because of the residential area situation, ten modular type STPs (Jokasou) with capacity of 650m$^3$/d (for **50,000** people) could be built.

**(13) Cavite**
Because of congested peninsula, only modular type STPs could be installed. ten modular type STPs (Jokasou) with capacity of 650m$^3$/d (for **50,000** people) could be built.

### 10.2.3 Total Coverage of Sewer Line Collection Services After Expansion Completed

Total capacity of the sewerage treatment systems with sewer line collection service expansion is 190,900m$^3$/d, which will covers additional people of 1,989,000 including existing CMSS (Tondo sea outfall system) service.
Thus total service coverage of sewer collection will at final stage cover the people of 6,331,461, which means 66.5% of sanitation and sewerage service target people will be covered by the sewer collection service at the final stage of the master plan.

## 10.3 Septage Collection Service after Expansion of Sewer Line Collection

Additional people of 1,989,000 to be serviced by sewer collection system are originally included by the septage collection service in the master plan.
Therefore the septage collection service requirement will be reduced from the original business plan.

### 10.3.1 Reduction of Septage Treatment Capacity Requirement

The people of 1,989,000 will generate septage of 198,900m$^3$/year to be collected. It requires the septage treatment capacity of 553m$^3$/d. That is, this capacity of 553m$^3$/d shall be reduced from the original requirement for septage treatment capacity of 1,550m$^3$/d.

### 10.3.2 Sewage Sludge Generated in Sewage Treatment Process

Sewage treatment plants at the project development to cater for 66.5% population service coverage are shown in Table 10-2 and Table 10-3. The tables also show estimated sludge volume generated in the sewage treatment process.

**Table 10-2 Sewage Treatment Plants and Sledge Generation for 66.6% Coverage**

| Districts | Sewage Treatment Plant | | Sluge Volume Generated | Sludge Solid Volume (Dry Cake) | Note |
|---|---|---|---|---|---|
| | Facilities | Treatment Capacity ($m^3$/d) | ($m^3$/d) | ($m^3$/d) | |
| Caloocan | Dagat-dagatan STP | 130,000 | 2,514 | 17.60 | Digesting/dewater (GG) |
| | Jokasou | 10 x 650 | 10 x 6.2 | 10 x 0.04 | North Sludge Center |
| (Include North) | Alt-SBR | 2 x 3,000 | 2 x 58 | 2 x 0.40 | Do |
| | Alt-Jokasou | 5 x 650 | 5 x 6.2 | 5 x 0.04 | Do |
| Quezon | Tondo connection | - | - | - | - |
| | San Juan Project | - | - | - | Refer table 10-3. |
| | Tullahan River right | 26,000 | 500 | 3.50 | Sludge thickener/dewater |
| | Tullahan River left | 39,000 | 757 | 5.30 | Do |
| | Jokasou | 10 x 650 | 10 x 6.2 | 10 x 0.04 | Dagat-dagatan SpTP |
| | Alt-SBR | 30,000 | 586 | 4.10 | Sludge thickener/dewater |
| | Alt-Jokasou | 60 x 260 | 60 x 2.5 | 60 x 0.02 | North Sludge Center |
| | Alt-Jokasou | 2 x 650 | 2 x 6.2 | 2 x 0.04 | Do |
| Valenzuela | Tullahan River right | 26,000 | 500 | 3.50 | Sludge thickener/dewater |
| | Do | 13,000 | 257 | 1.80 | North Sludge Center |
| | Jokasou | 10 x 650 | 10 x 6.2 | 10 x 0.04 | Do |
| | Alt-Jokasou | 2 x 650 | 2 x 6.2 | 2 x 0.04 | Do |
| Malabon | Tullahan River left | 2 x 13,000 | 2 x 257 | 2 x 1.80 | Sludge thickener/dewater |
| | Jokasou | 2 x 650 | 2 x 6.2 | 2 x 0.04 | North Sludge Center |
| | Alt-Jokasou | 650 | 6.2 | 0.04 | Do |
| Navotas | Navotas West | 26,000 | 500 | 3.50 | Sludge thickener/dewater |
| | Jokasou | 2 x 650 | 2 x 6.2 | 2 x 0.04 | North Sludge Center |
| Manila | Rapid Filter | 2 x 66,000 | 2 x 40 | 2 x 3.9 | South Sludge Center (GG) |
| Makati | Tondo connection | - | - | - | - |
| Pasay | Jokasou | 3 x 650 | 3 x 6.2 | 3 x 0.04 | South Sludge Center (GG) |
| | Alt-Jokasou | 20 x 390 | 20 x 3.7 | 20 x 0.03 | Do |
| | Alt-SBR | 2 x 3,000 | 2 x 58 | 2 x 0.40 | Do |
| Paranaque | Jokasou | 780 | 7.4 | 0.05 | Do |
| | STP | 1,560 | 29 | 0.20 | Do |
| | Alt-Jokasou | 40 x 650 | 40 x 6.2 | 40 x 0.04 | Do |
| Pasay/Paranaque | Alt-SBR | 8,000 | 158 | 1.10 | Do |
| Muntinlupa | STP | 30,000 | 586 | 4.10 | Sludge thickener/dewater |
| | STP | 2,000 | 43 | 0.30 | South Sludge Center (GG) |
| Las Pinas | Jokasou | 2 x 650 | 2 x 6.2 | 2 x 0.04 | Do |
| | Alt-SBR | 10 x 3,000 | 10 x 58 | 10 x 0.4 | Do |
| Bacoor | Alt-SBR | 10 x 3,000 | 10 x 58 | 10 x 0.4 | Do |
| Imus | Alt-SBR | 4 x 3,000 | 4 x 58 | 4 x 0.4 | Do |
| Kawit | Alt-Jokasou | 10 x 650 | 10 x 6.2 | 10 x 0.04 | Do |
| Cavite City | Jokasou | 3 x 650 | 3 x 6.2 | 3 x 0.04 | Do |
| | Alt-Jokasou | 10 x 650 | 10 x 6.2 | 10 x 0.04 | Do |
| Noveleta | | - | - | - | - |
| Rosario | | - | - | - | - |

Note: 1. Alt- means additional ATPs for expanding sewer line collection service to coverage of 66% and more.

2. GG means Methan Gas Generation in future.

**Table 10-3 Sewage Treatment Plants and Sludge Generation for San Juan**

| Basin | Facility Name | System | Capacity ($m^3$/d) | Sluge Volume Generated ($m^3$/d) | Sludge Solid Volume (Dry Cake) ($m^3$/d) | Note |
|---|---|---|---|---|---|---|
| Bagbag-Dario North | BSTP | SBR | 10,400 | 200 | 1.40 | Sludge thikener/dewater |
| Talayan-Balingasa | TSTP | SBR | 15,600 | 300 | 2.10 | Do |
| Cliat-Dario | KTSP | Jokasou | 156 | 2 | 0.01 | North Septage TP |
| | TsSTP | SBR | 1,560 | 30 | 0.21 | Do |
| | SSTP | SBR | 2,210 | 43 | 0.30 | Do |
| | BaSTP | SBR | 5,200 | 100 | 0.70 | Digesting/Dewater |
| | Btstp-1 | Jokasou | 780 | 7 | 0.05 | North Septage TP |
| | BtSTP-2 | SBR | 3,900 | 76 | 0.53 | Do |
| | AsSTP | Jokasou | 1,170 | 11 | 0.08 | Do |
| | SaSTP-1 | Jokasou | 156 | 2 | 0.01 | Do |
| | Legal | Jokasou | 409 | 4 | 0.03 | Do |
| | Grants | Jokasou | 621 | 6 | 0.04 | Do |
| | Congressional | Jokasou | 567 | 5 | 0.04 | Do |
| | Roosevelt | Joksou | 93 | 1 | 0.01 | Do |
| Sanfrancisco-Marabro | AsSTP-1 | Jokasou | 286 | 3 | 0.02 | Do |
| | AsSTP-2 | Jokasou | 546 | 5 | 0.04 | Do |
| | SaSTP-2 | SBR | 2,860 | 56 | 0.39 | Do |
| | VSTP | SBR | 1,300 | 26 | 0.18 | Do |
| | P-PSTP | SBR | 2,600 | 50 | 0.35 | Do |
| | SS-STP | SBR | 4,550 | 87 | 0.61 | Dagat-dagatan SpTP |
| San Juan | TJSTP | SBR | 7,800 | 150 | 1.05 | Sludge thickener/dewater |
| | AISn-STP | SBR | 3,900 | 76 | 0.53 | Dagat-dagatan SpTP |
| | SISs-STP | SBR | 5,200 | 100 | 0.70 | Sludge thickener/dewater |

### 10.3.3 Sewerage Sludge Treatment System

**(1) Basic Conception**

The sewage treatment plants with capacity of 10,000$m^3$/d and more, sludge thickeners and dewaterers shall be installed in the treatment sites, and the sludge capacity less than 10,000$m^3$/d generated in the smaller sized plants, shall be collected by the sludge collection vehicles transporting the sludge to sludge treatment centers.

**(2) Establishing New Sludge Treatment Centers**

The septage treatment plants' capacity to be prepared for the collected septage in case that the sewerage service coverage is 45.6% of final target population in 2021, should be reduced in proportion with the increasing rate of sewerage service coverage from 45.6% to 66.5%. The reduction rate of the septage treatment plants would be 553$m^3$/d in total. Thus 325$m^3$/d and 163$m^3$/d of the partial volume of sludge generated by the treatment plants in San Juan River Basin shall be transported to treat in the North SpTP and Dagat-dagatan SpTP.

The raw sludge of about 2,769m3/d generated by the sewage treatment plants in the whole service area, except STPs in San Juan River Basin and 10 Jokasou in Quezon North should be treated by the sewerage sludge treatment center to be additionally installed.

The raw sludge of 480$m^3$/d generated in the Northern Municipalities from Cloocan shall be treated at North Sludge Center with capacity of 480$m^3$/d to be located in the same site of North SpTP plant. This plant contains sludge thickening tanks, sludge digesters and sludge dewaterers.

The raw sludge of 2,280$m^3$/d generated in the Southern Municipalities from Manila shall be treated at South Sludge Center with capacity of 2,280$m^3$/d to be located in the same site of Pasay-Paranaque STP. This plant contains sludge thickening tanks, sludge digesters and sludge

dewaterers In future, methane gas generation system would be installed. The sludge produces methane gas through sludge digestion process. The methane gas generation rate is assumed 8,460$m^3$/d and the electric power rate generated by gas generation would be 650kwh, which could supply full electrical power demand by the plant.

### 10.4 Additional Plants and Cost Estimation in Alternative 1

Additional plants and cost estimation for expansion of sewerage service expansion to 66.5% are shown in Table 10-4.

**Table 10-4 Additional Plants and Cost Estimation for Alternative 1**

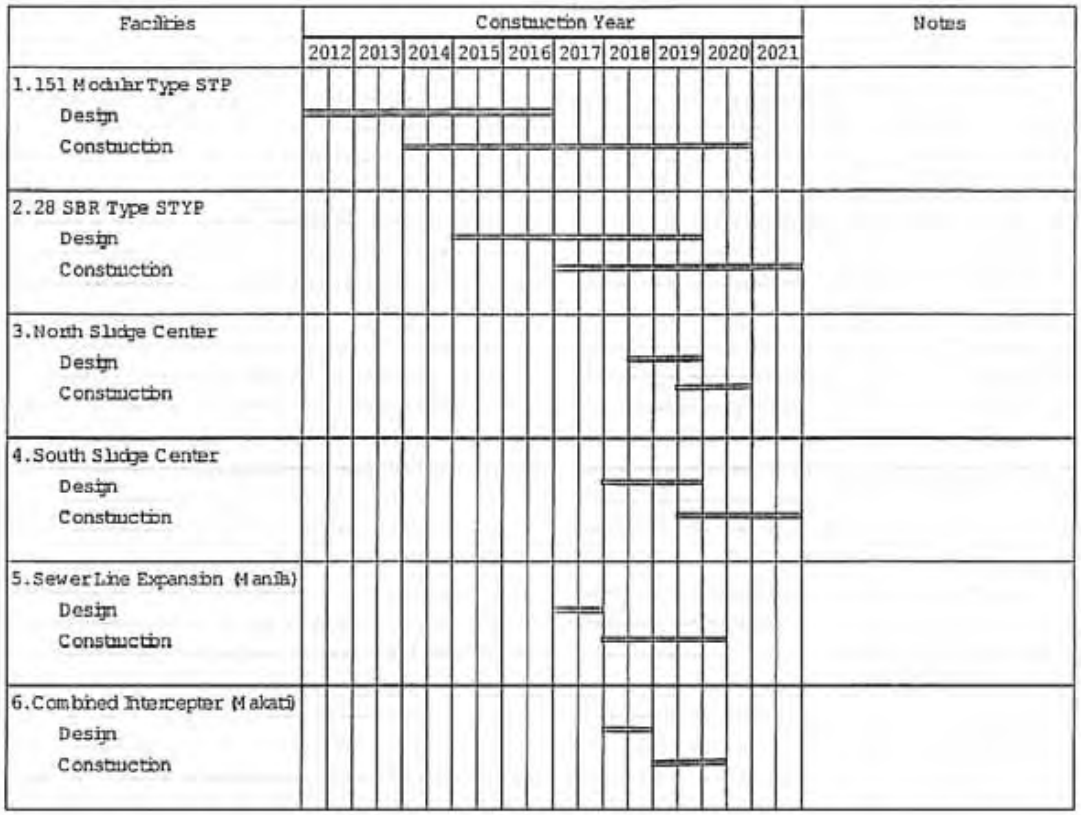
| Districts | Sewage Treatment□Plant | | Sluge | Cost | Note |
|---|---|---|---|---|---|
| | Facilities | Treatment Capacity ($m^3$/d) | Treatment Caopacity ($m^3$/d) | (Million Pesos) | |
| Caloocan North | Alt-Jokasou | 5 x 650 | | 5 x 74 | |
| Quezon | Alt-SBR | 30,000 | | 1,509 | Sludge thickener/dewater |
| | Alt-Jokasou | 60 x 260 | | 60 x 51 | |
| | Alt-Jokasou | 2 x 650 | | 2 x 74 | |
| | North Sludge Center | | 480 | 323 | |
| Valenzuela | Alt-Jokasou | 2 x 650 | | 2 x 74 | |
| Malabon | Alt-Jokasou | 650 | | 74 | |
| Navotas | - | - | - | | - |
| Manila | Sewer Expansion | 80,000 | - | 980 | 110km with 100 MHP |
| Makati | Tondo connection | 26000 | | 36 | Combined sewer: 4.5km |
| Pasay | Alt-Jokasou | 20 x 390 | | 20 x 59 | |
| | Alt-SBR | 2 x 3,000 | | 2 x 151 | |
| Paranaque | Alt-Jokasou | 40 x 650 | | 40 x 74 | |
| | South Sludge Center | | 2,280 | 1,524 | GG in future |
| Pasay/Paranaque | Alt-SBR | 8,000 | | 402 | |
| Muntinlupa | - | - | | | - |
| Las Pinas | Alt-SBR | 10 x 3,000 | | 10 x 151 | |
| Bacoor | Alt-SBR | 10 x 3,000 | | 10 x 151 | |
| Imus | Alt-SBR | 4 x 3,000 | | 4 x 151 | |
| Kawit | Alt-Jokasou | 10 x 650 | | 10 x 74 | |
| Cavite City | Alt-Jokasou | 10 x 650 | | 10 x 74 | |
| Noveleta | - | - | - | | - |
| Rosario | - | - | - | | - |
| Total | | 290,900 | 2,760 | 18,120 | |

Note: 1. **Alt-** means additional ATPs for expanding sewer line collection service to coverage of 66% and more.
2. GG means Methan Gas Generation in future.
3. MHP means manhole pump.

### 10.5 Project Implementation Schedule

In order to expand the sewerage service coverage to 66.5%, 151 modular type STO, 28 SBR type STP, 2 Septage Treatment Plants, and sewer line expansion in Manila and combined type interceptor in Makati shall be required additionally to establish.
Fig. 10-4 shows the construction implementation schedule.

**Fig. 10-4 Project Implementation Schedule for Additional Projects**




## 10.6 Budgetary Schedule

Overall budgetary schedule in case of 66.5% sewerage service coverage is shown in Table 10-5 here under.

**Table 10-5 Overall Budgetary Schedule for 66.5% Coverage of Sewerage Service**

in MPhP

| Project Category | 5 Year Budget | Budgetary Yaearly Schedule | | | | |
|---|---|---|---|---|---|---|
| "009 - 2011 | | - | - | 2009 | 2010 | 2011 |
| Seweage Project | 3,366 | - | - | 458 | 1,076 | 1,832 |
| Sanitation Project | 30 | - | - | 0 | 0 | 30 |
| Subtotal | 3,396 | - | - | 458 | 1,076 | 1,862 |
| 2012 - 2016 | | 2012 | 20113 | 2014 | 2015 | 2016 |
| Seweage Project | 10,426 | 71 | 486 | 2,858 | 5,386 | 5,785 |
| Sanitation Project | 100 | | | 10 | 30 | 60 |
| Subtotal | 14,686 | 71 | 486 | 2,868 | 5,416 | 5,845 |
| 2017 - 2021 | | 2017 | 2018 | 2019 | 2020 | 2021 |
| Seweage Project | 9,887 | 1,922 | 3,868 | 5,142 | 6,476 | 4,592 |
| Sanitation Project | 150 | 70 | 100 | 190 | 893 | 745 |
| Subtotal | 23,998 | 1,992 | 3,968 | 5,332 | 7,369 | 5,337 |
| 2009 - 2021 | | | | | | |
| Grand Total Budget | 42,080 | | | | | |

## 10.7 Polluted Load Reduction

In case of 66.5% sewerage service coverage, the following improvement of polluted material reduction would be expected.

### (1) CMSS Treatment Expansion

Total 106,000$m^3$/d for the population of 523,000 in Manila and Makati will be connected to CMSS. Therefore 102mg/l on BOD base would be reduced. This value is not much different from

the most effective septic tank function. That is, this service ensure and enhance the seepage treatment effect. In the sense, the reduction of polluted materials would not be different from the original business plan.

**(2) Additional Sewage Treatment Plants**

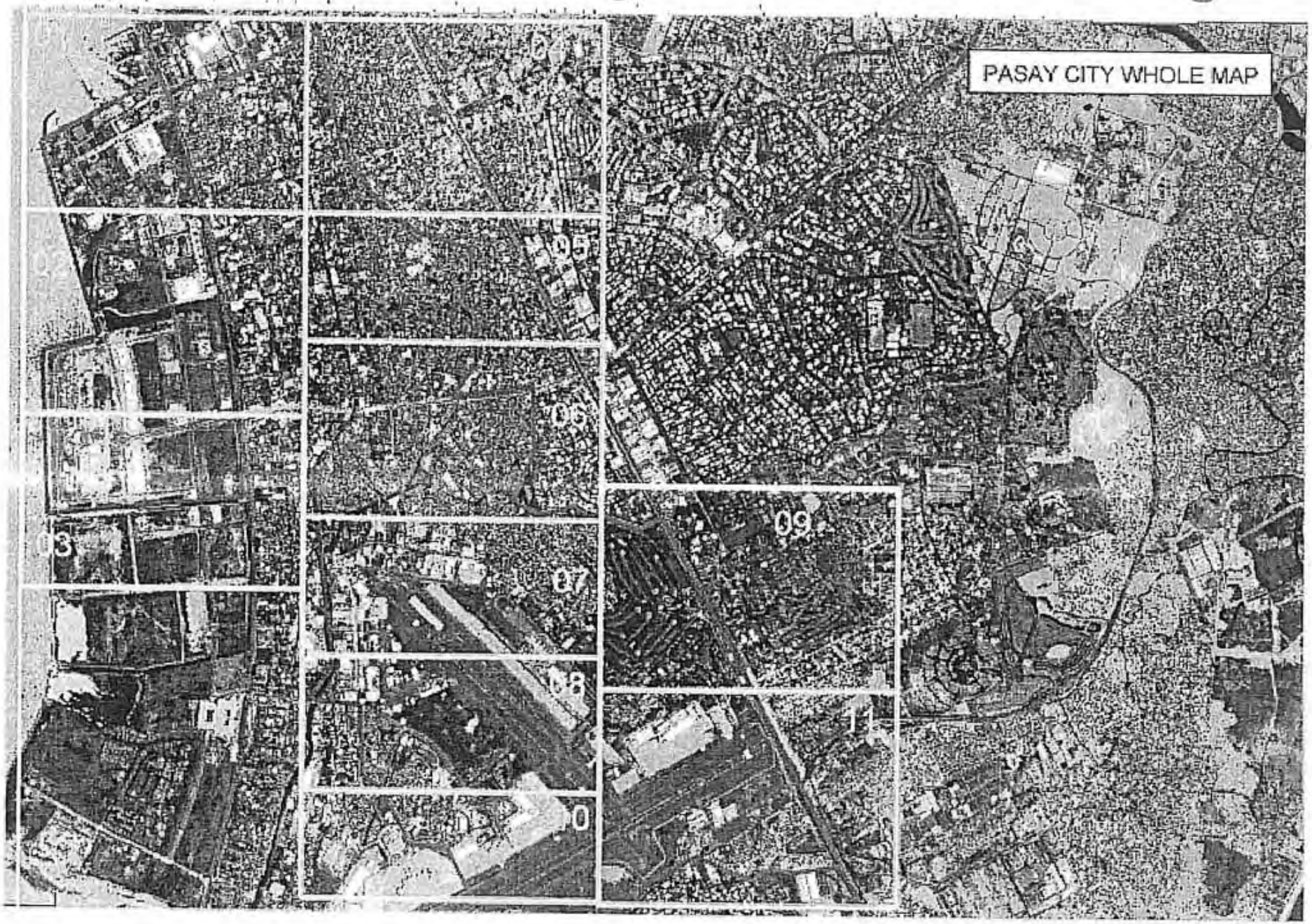
Additional population of 1,466,000 will be serviced by the sewerage treatment systems. The wastewater volume generated by this additional people, 190,580$m^3$/d is improved to treat from 40mg/l of effluent water quality to 20mg/l on BOD base, that is, 20mg/l reduction of polluted materials will additionally be got rid of. This means additional 3,800kg /day will be reduced.

**(3) Final Reduction Volume of Polluted Materials**

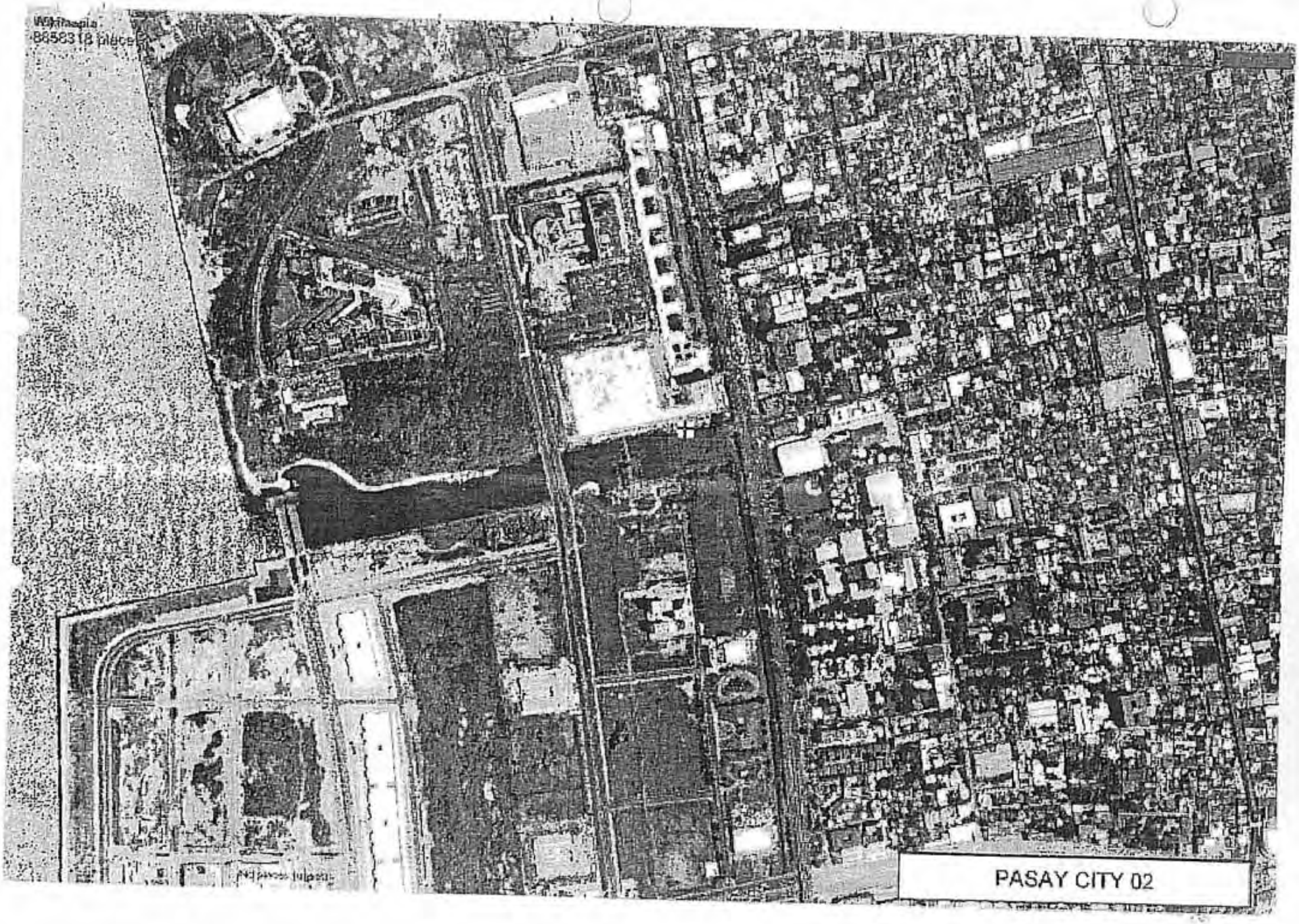
The first business plan will reduce 67,828 tons/year, thus in the case of 66,5%, total 69,215 tons/year will be reduced at the final stage of the project.

**ATTACHMENT**

# SATELLITE PHOTO
# OF
# PASSAY AND PARANAQUE


PASAY CITY WHOLE MAP

PASAY CITY 01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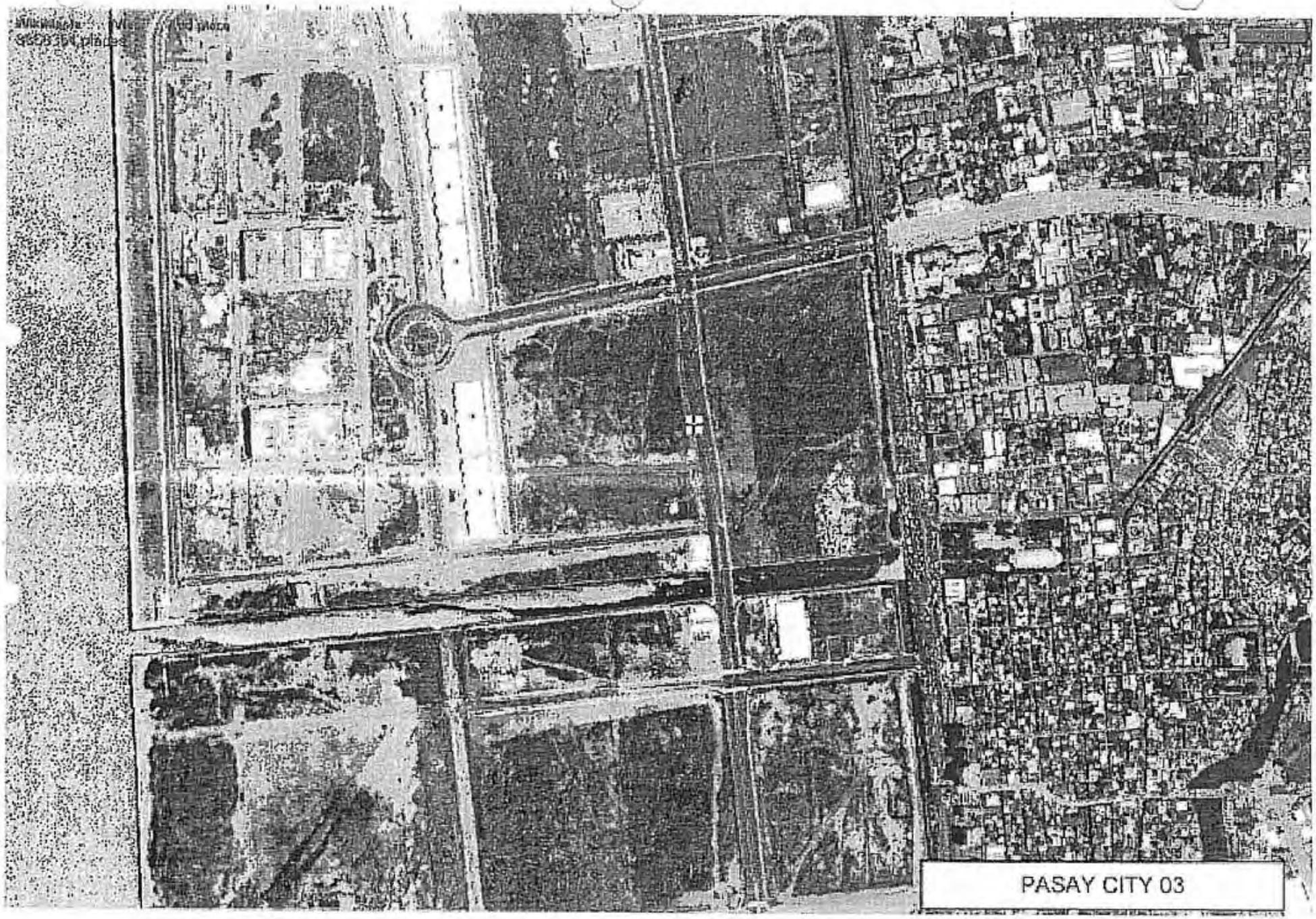
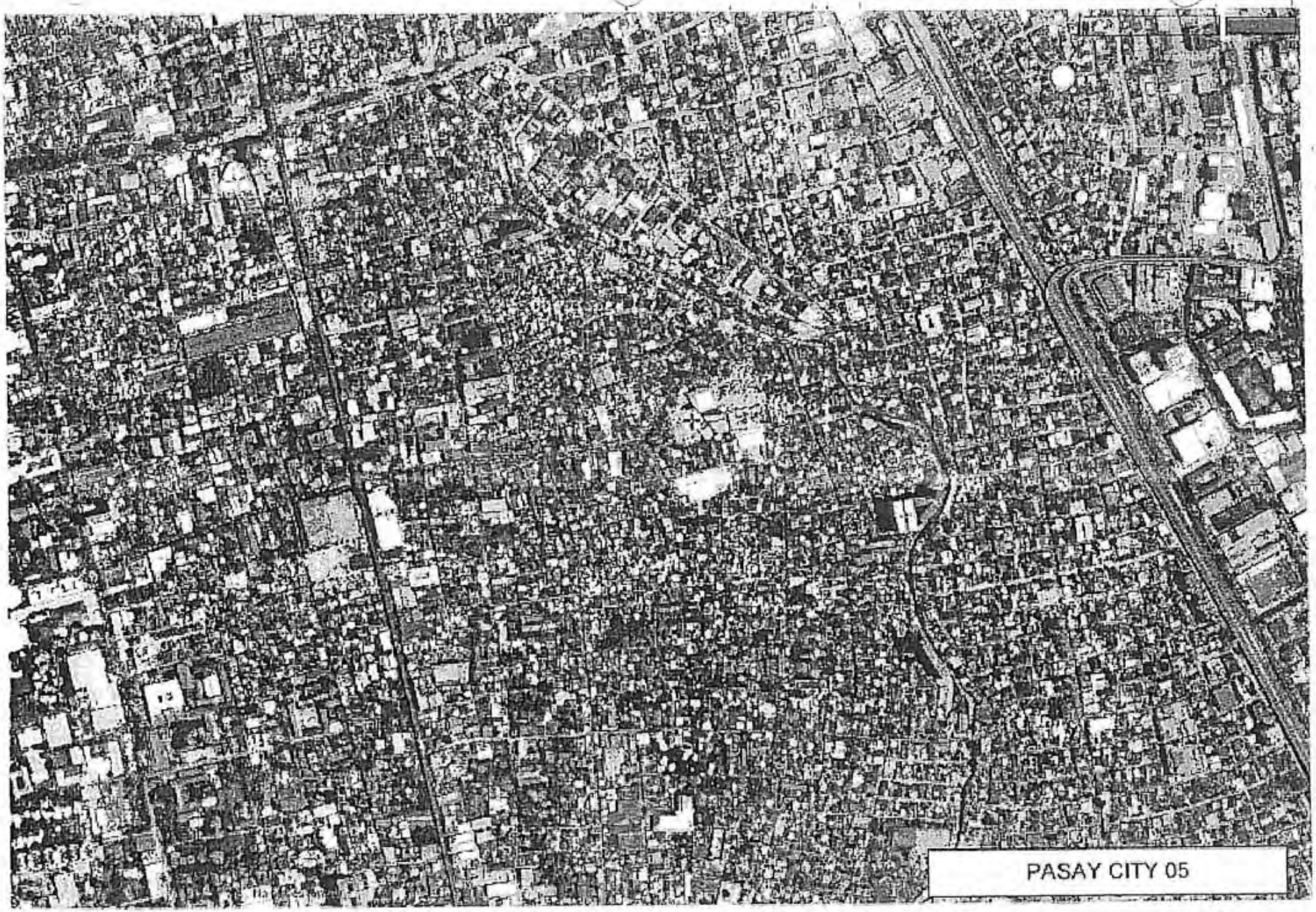

PASAY CITY 03

PASAY CITY 04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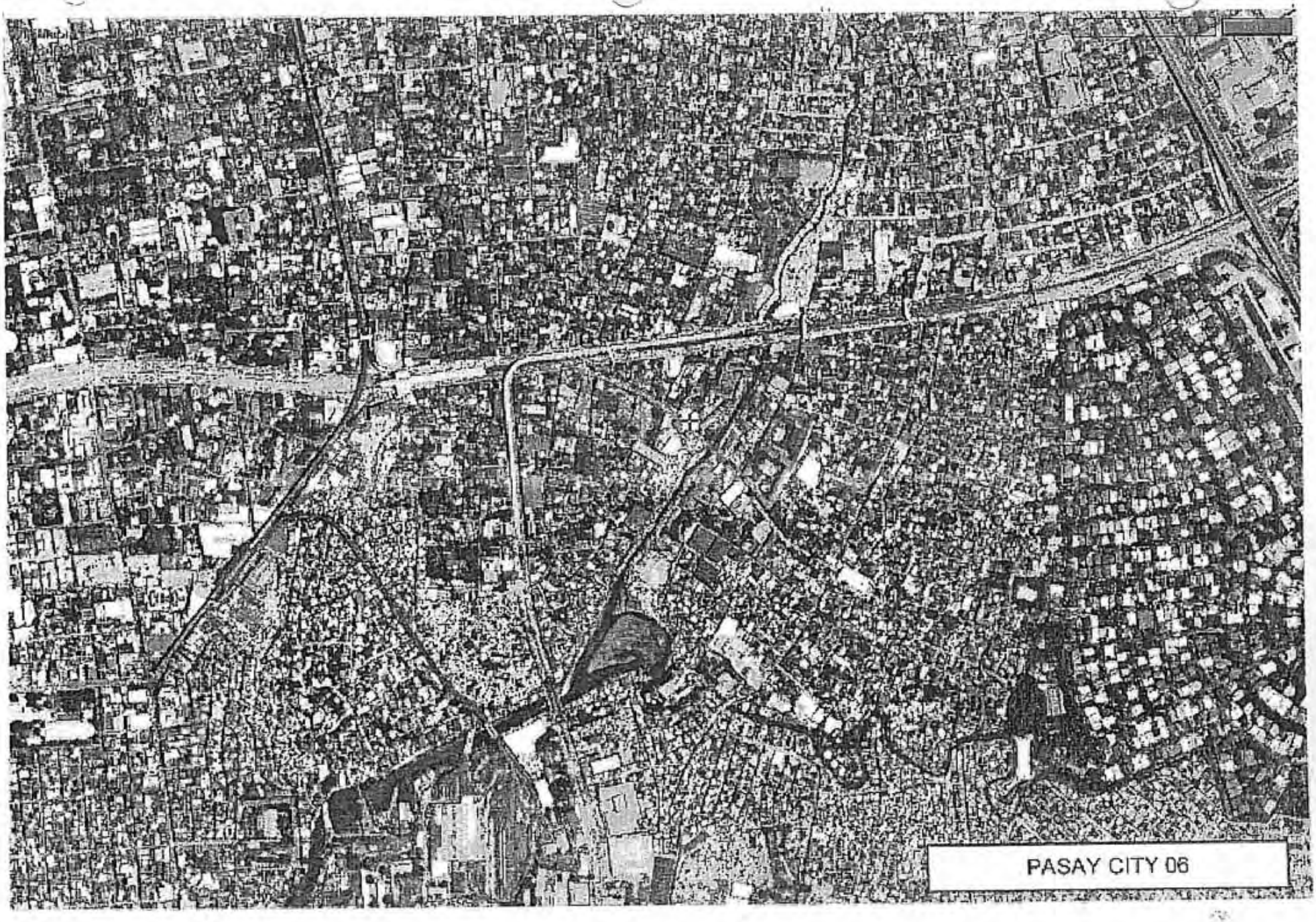
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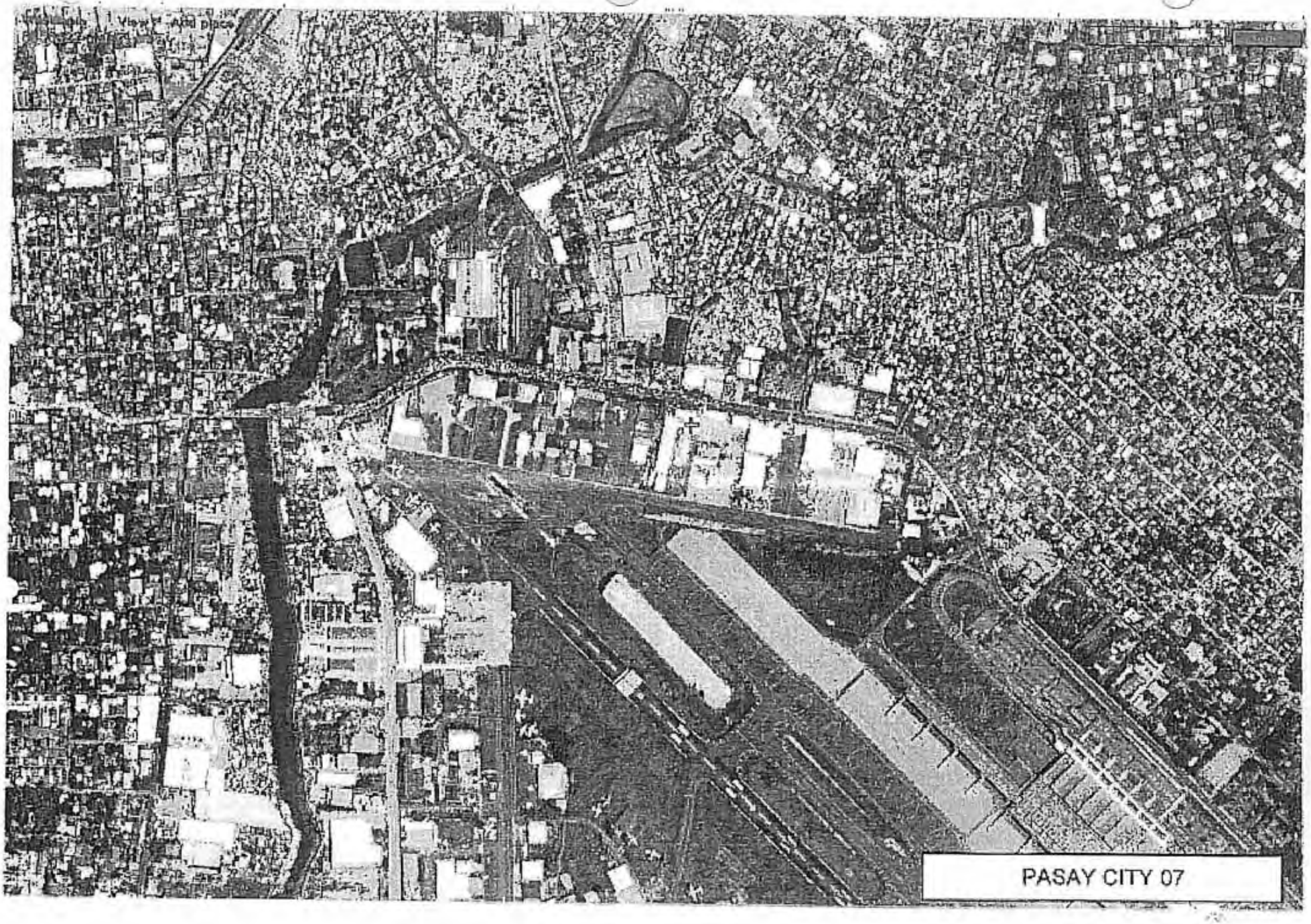
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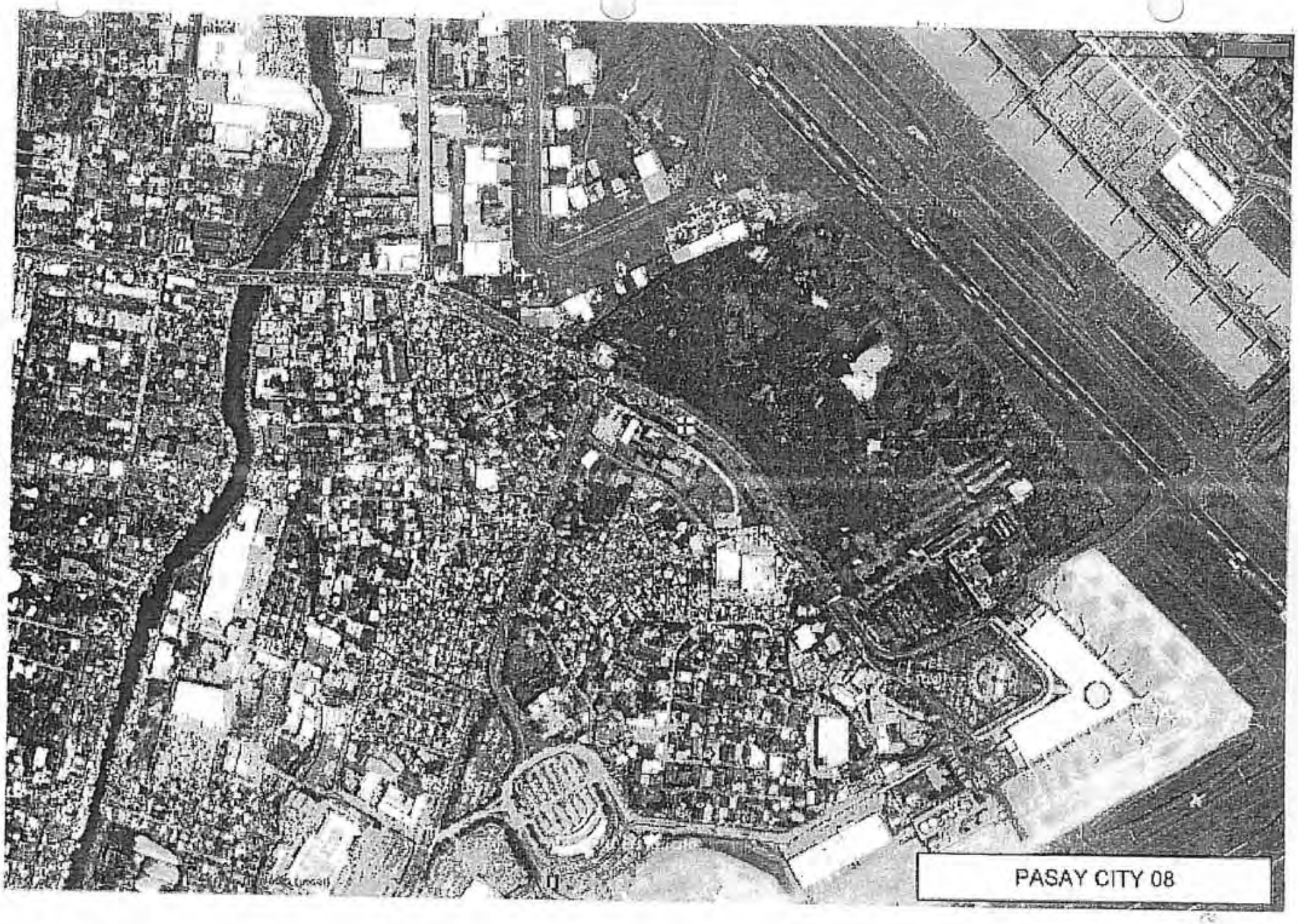
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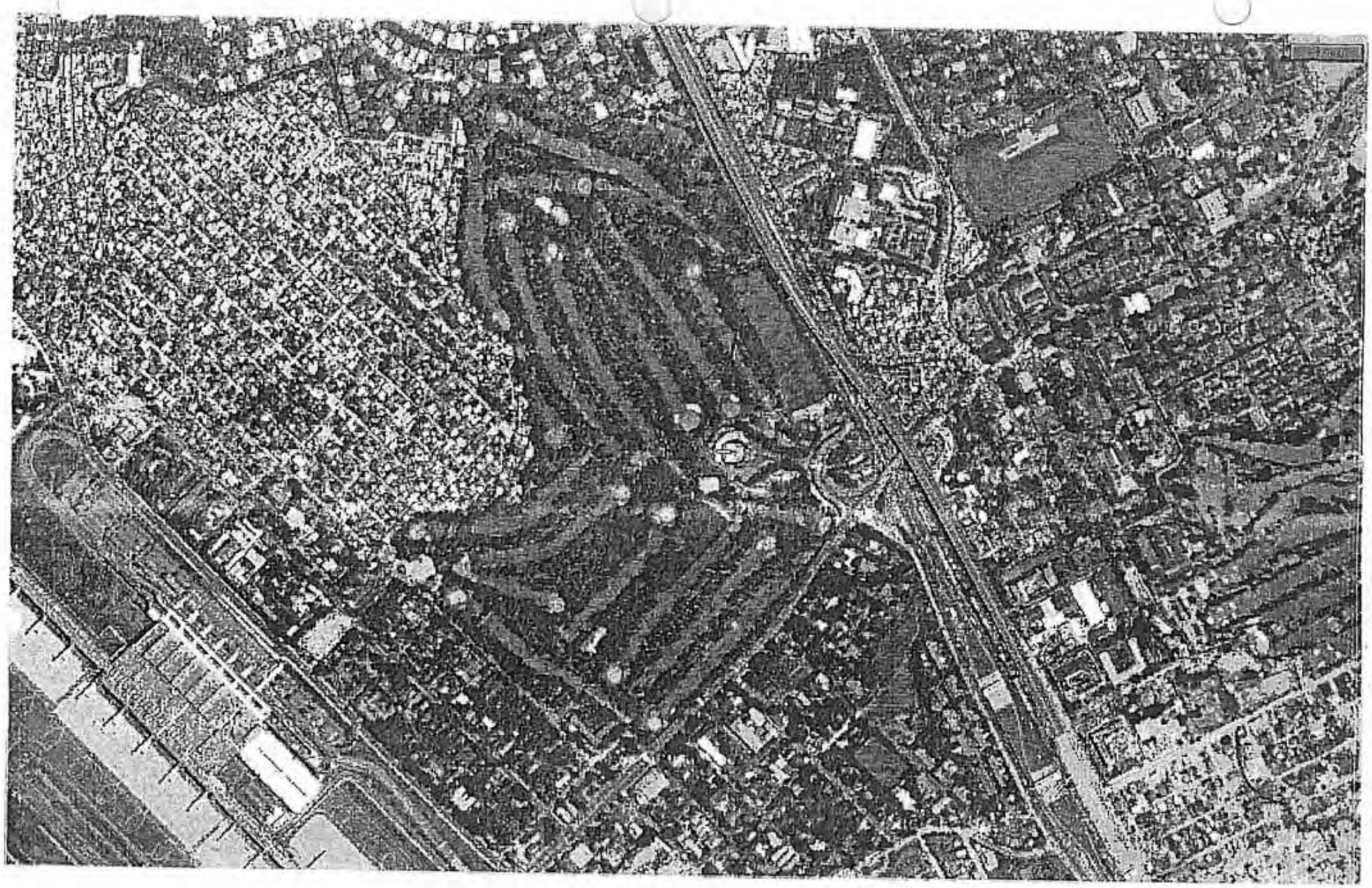

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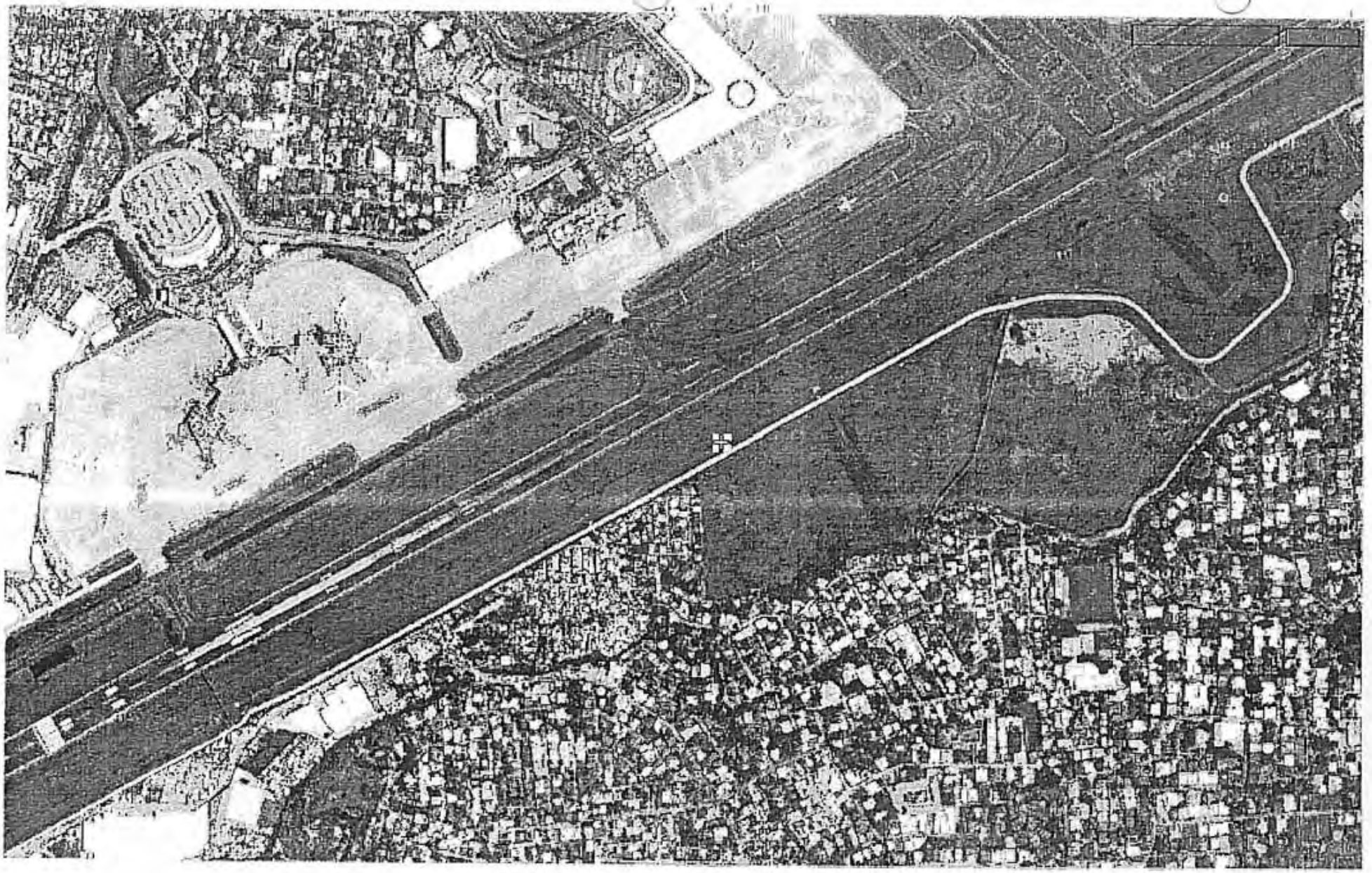
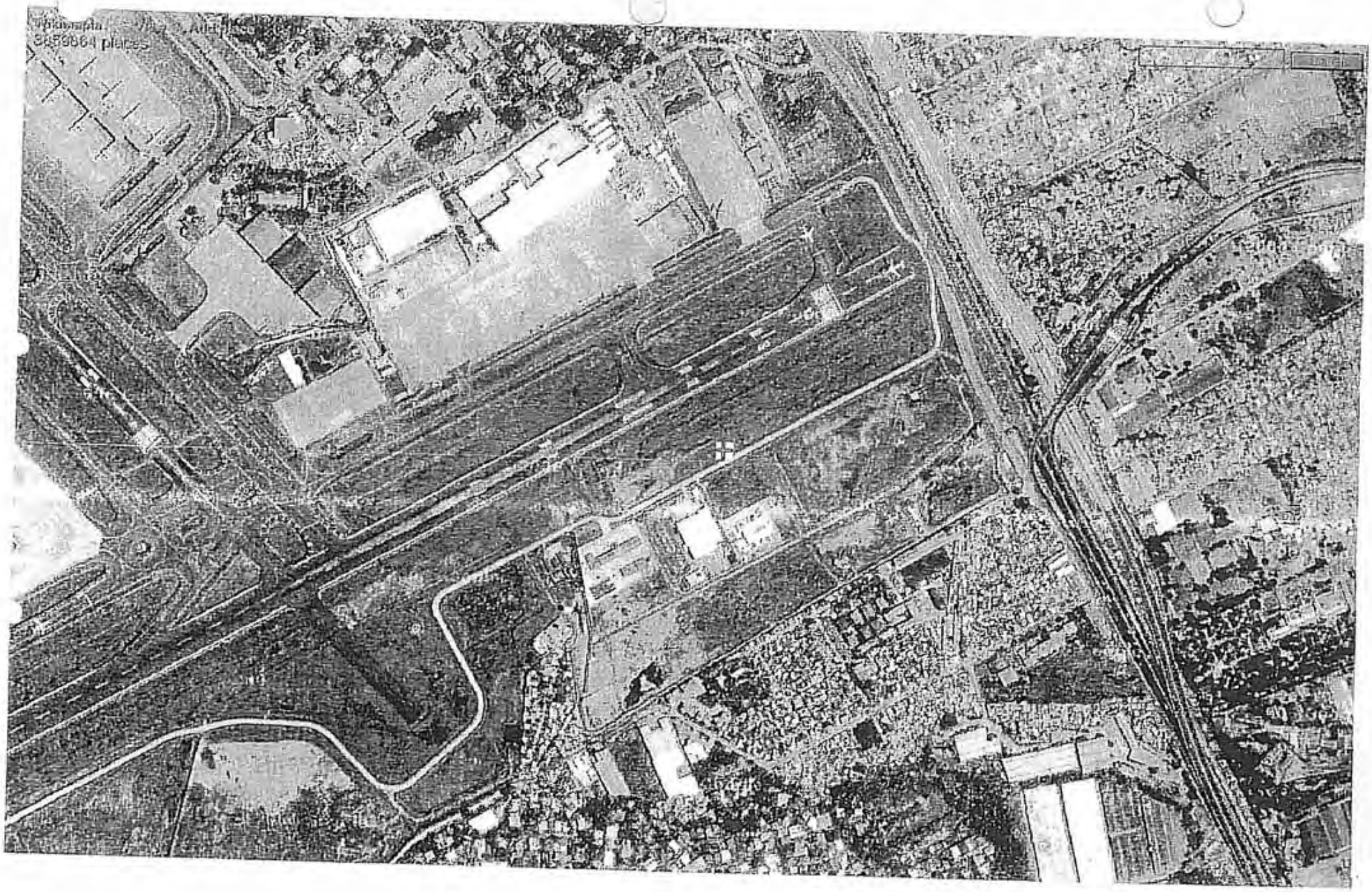
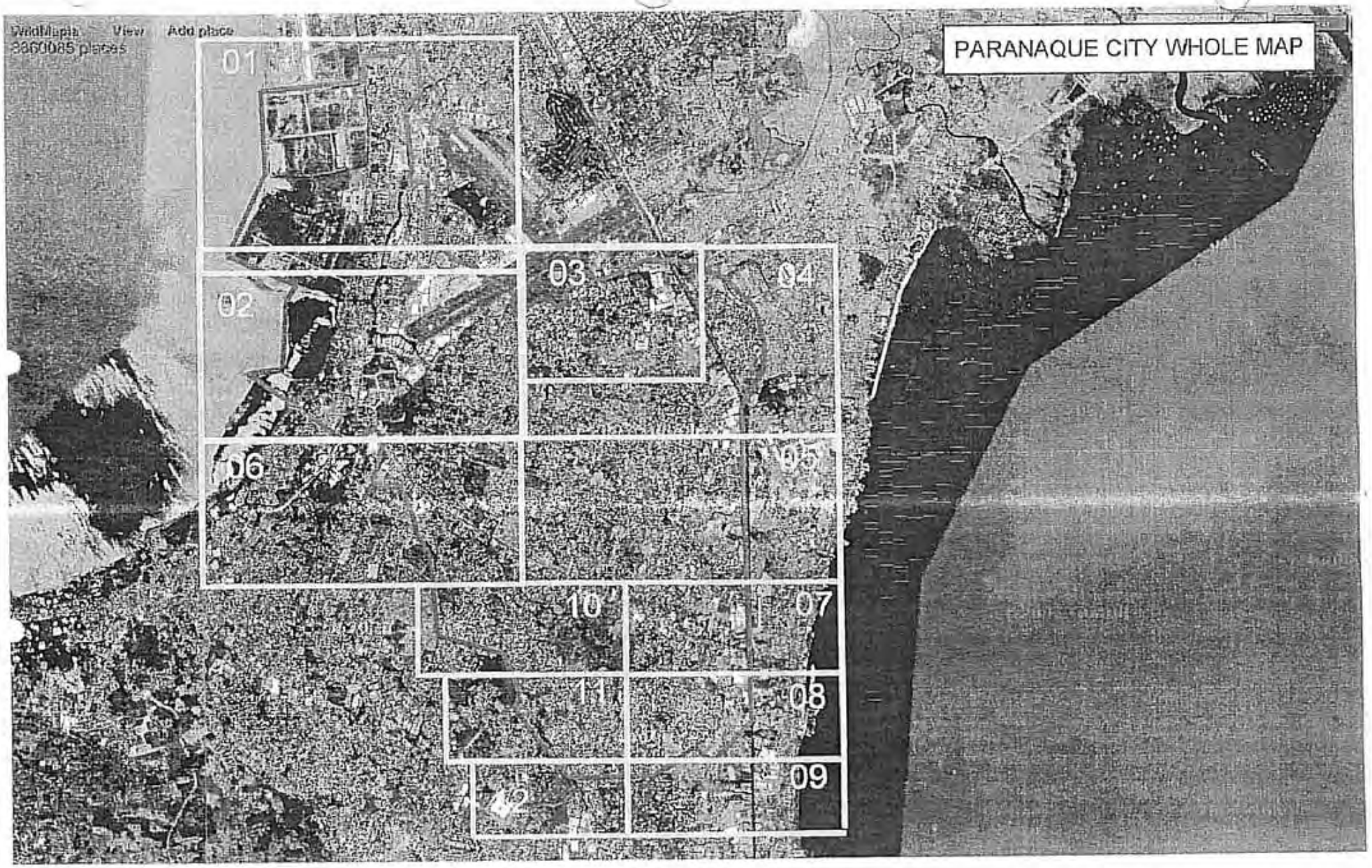


Replaces (area)

PASAY CITY 10




PASAY CITY 11

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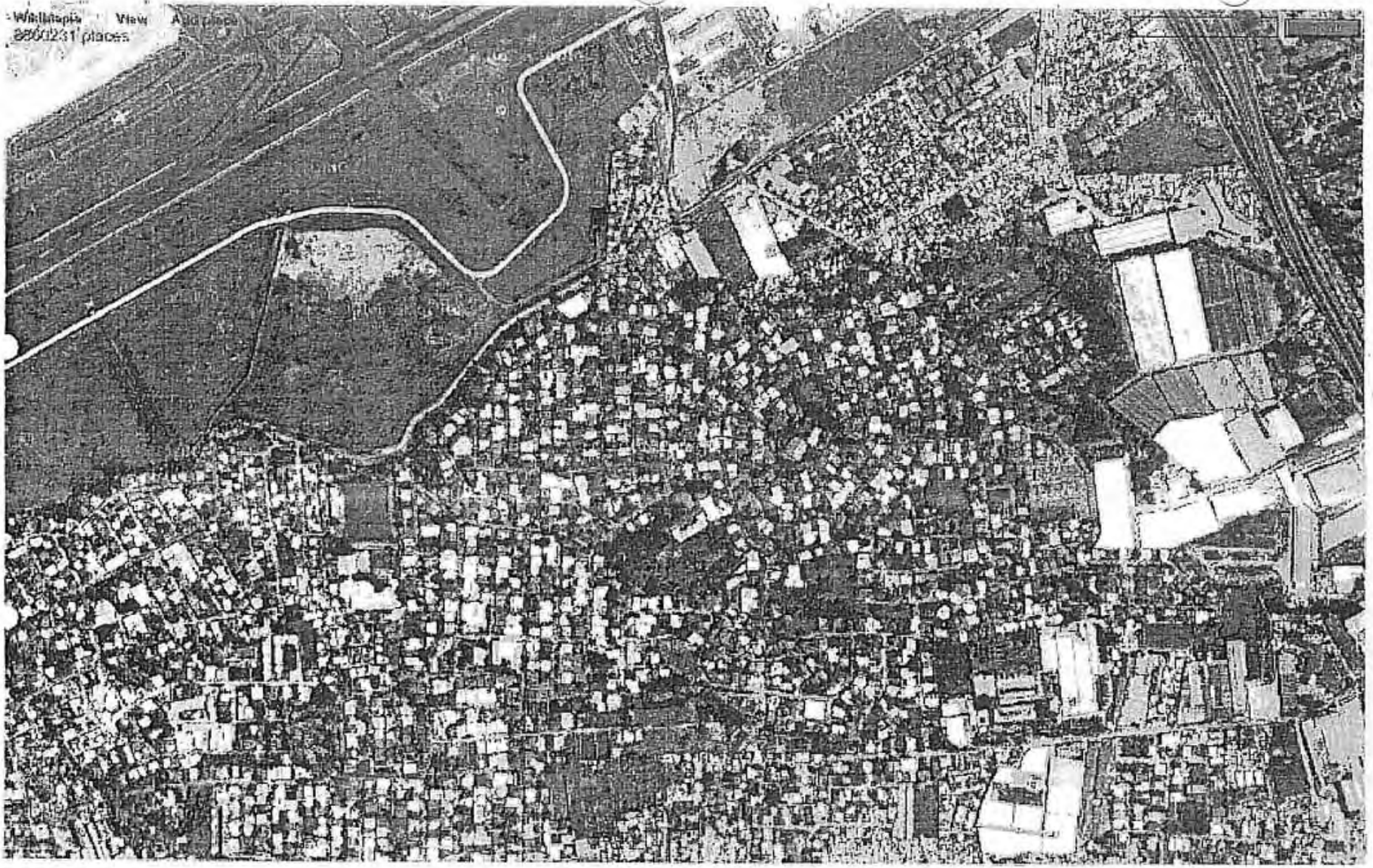
PARANAQUE CITY 01

No places (reset)

PARANAQUE CITY 02

No places (under)

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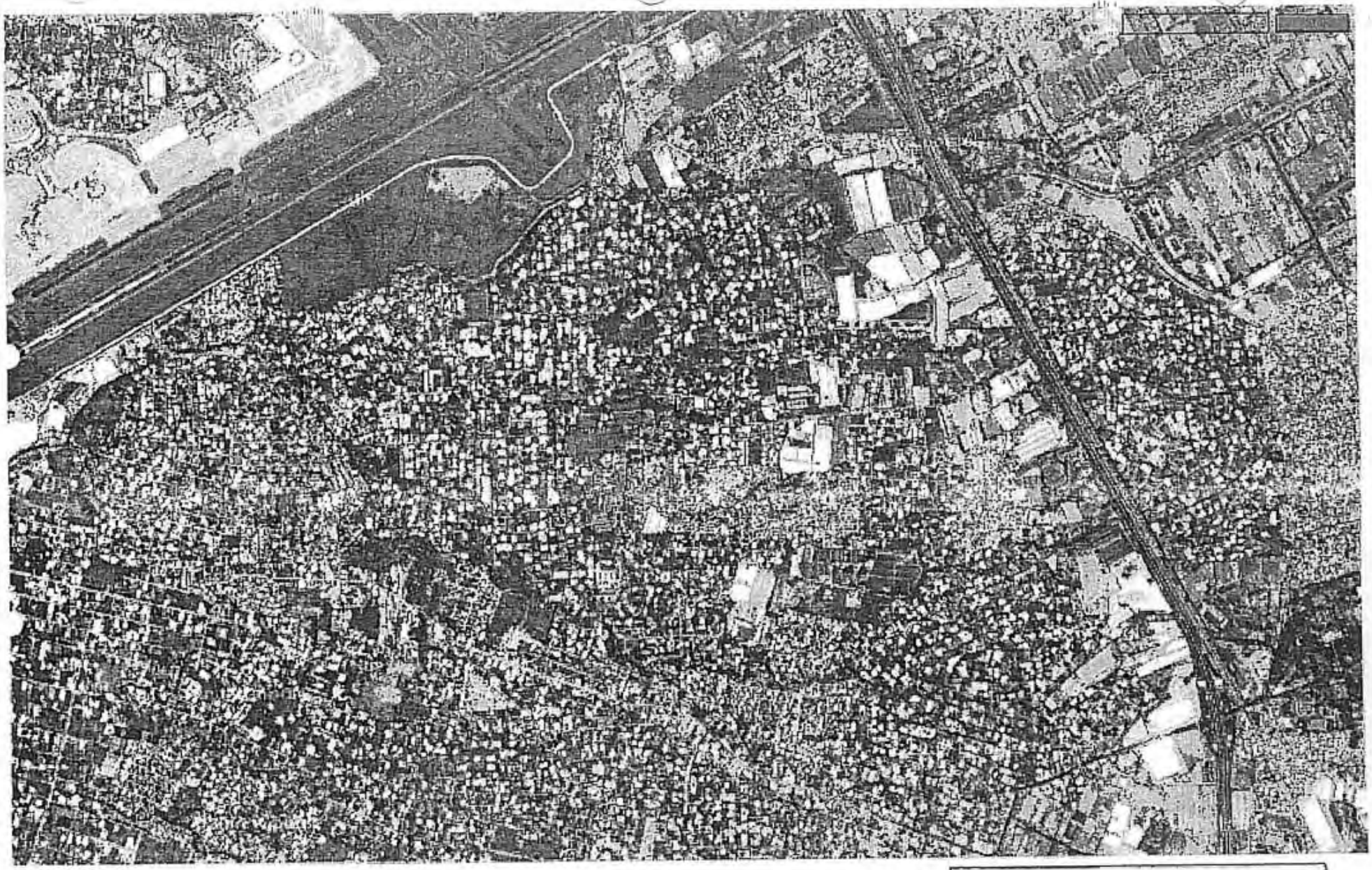

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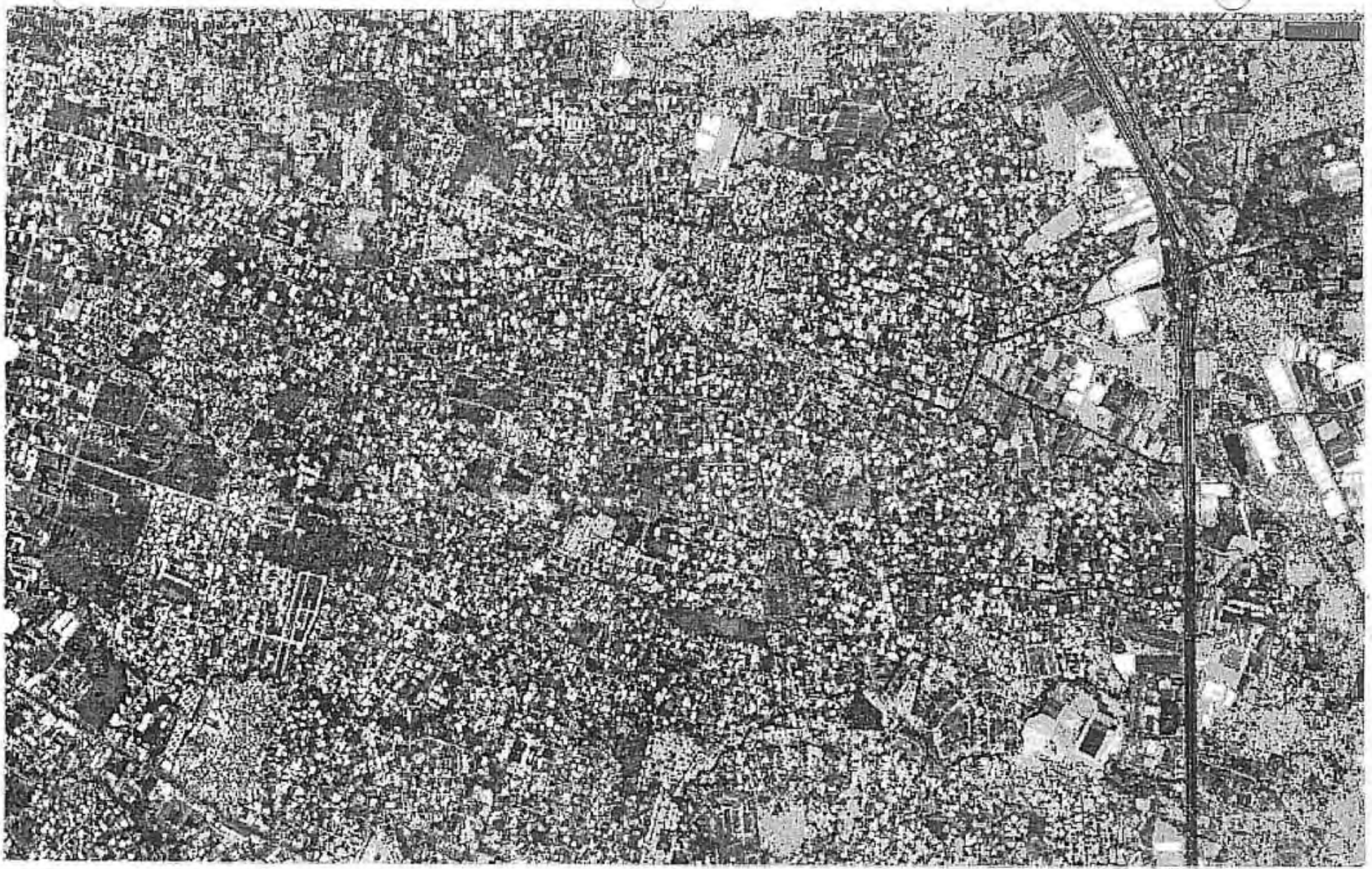

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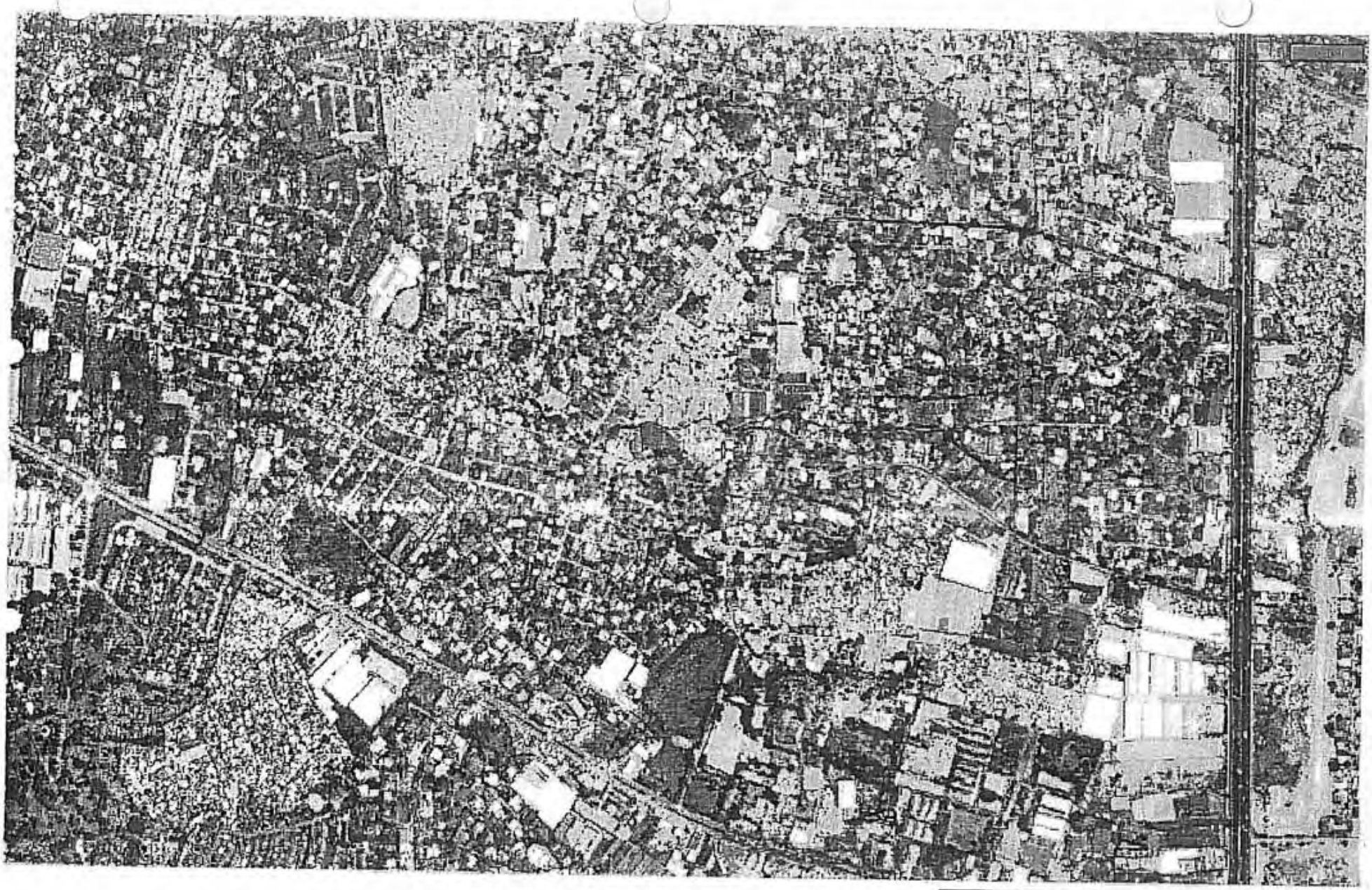

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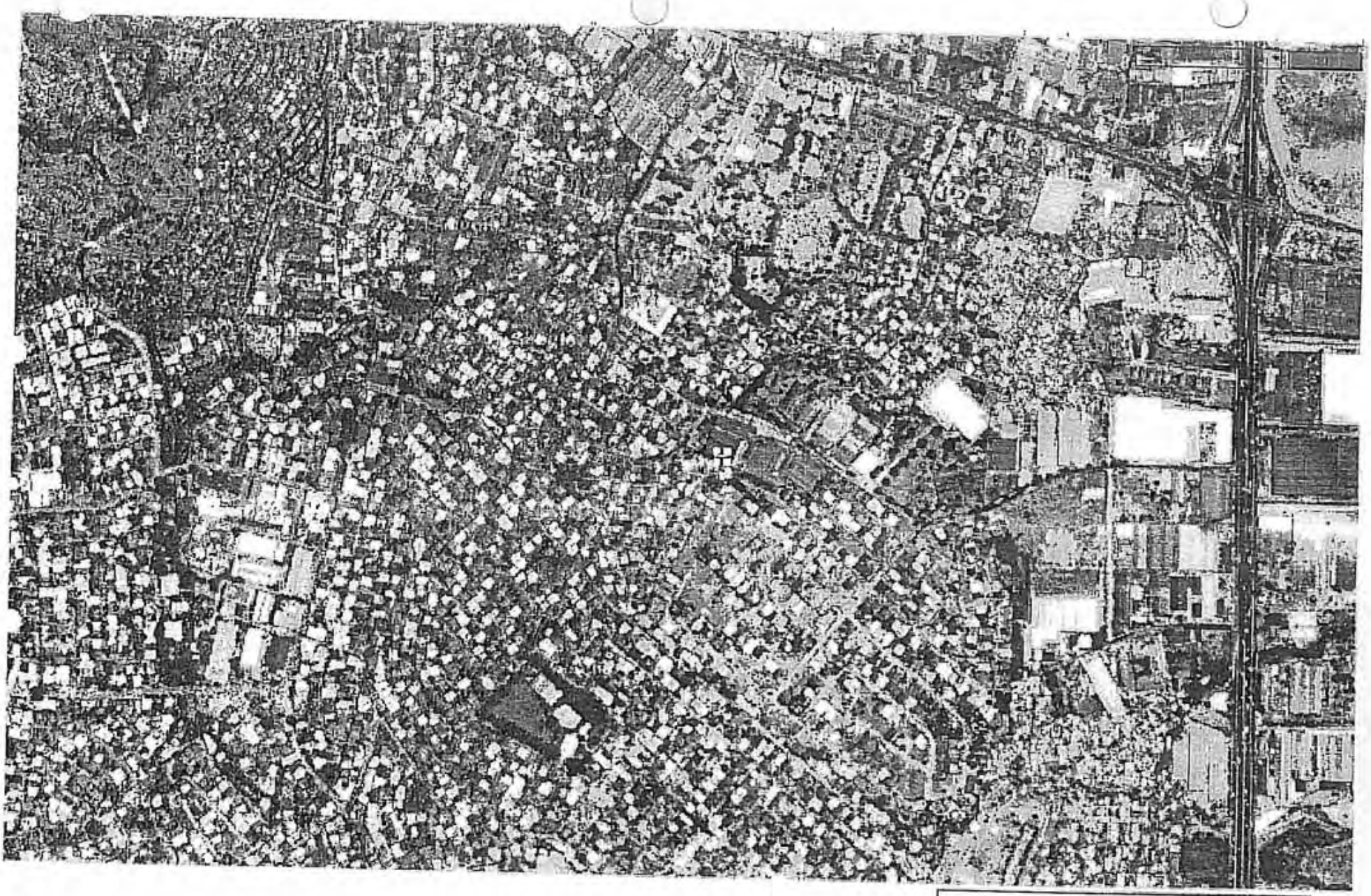

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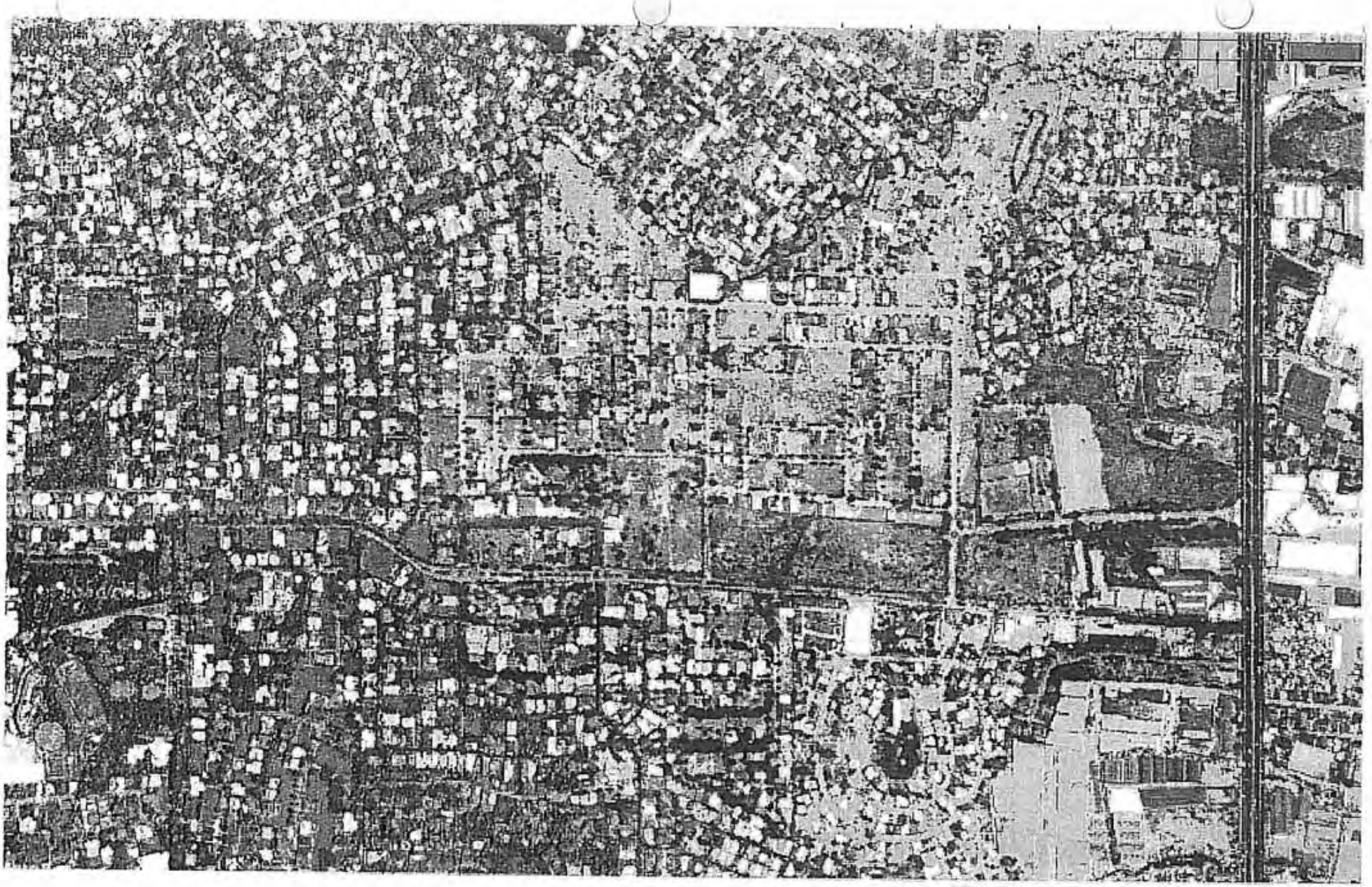

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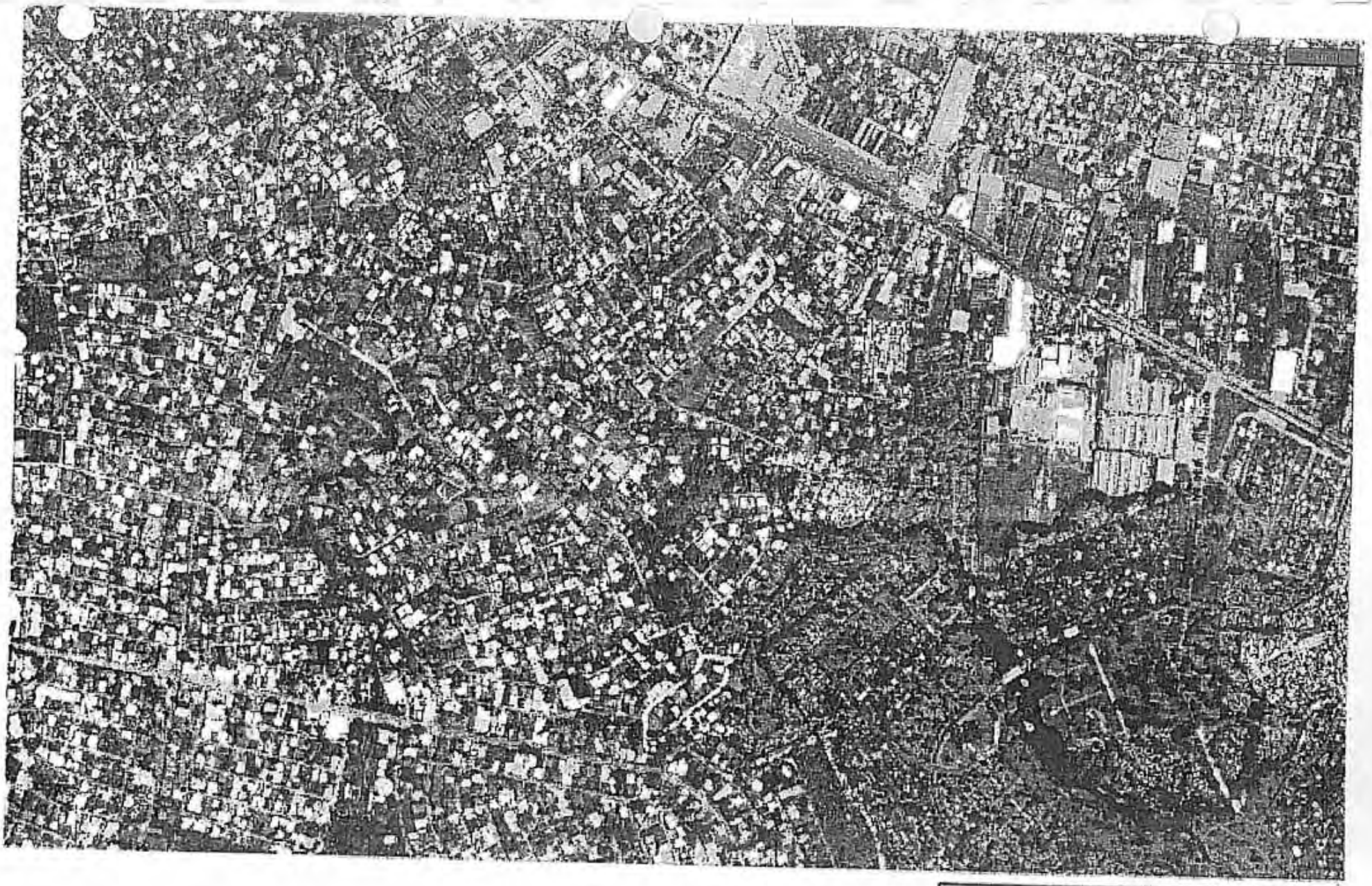

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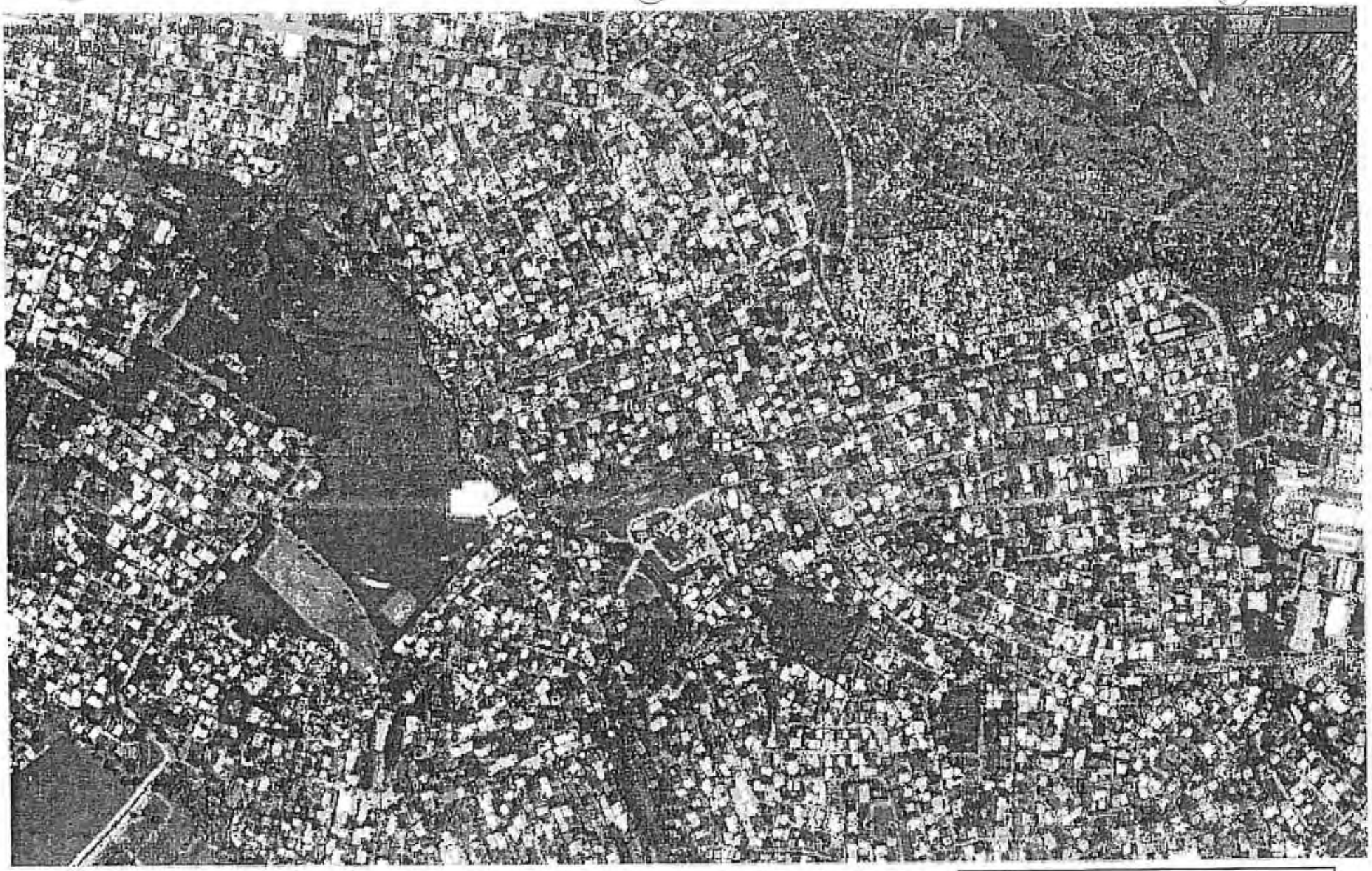

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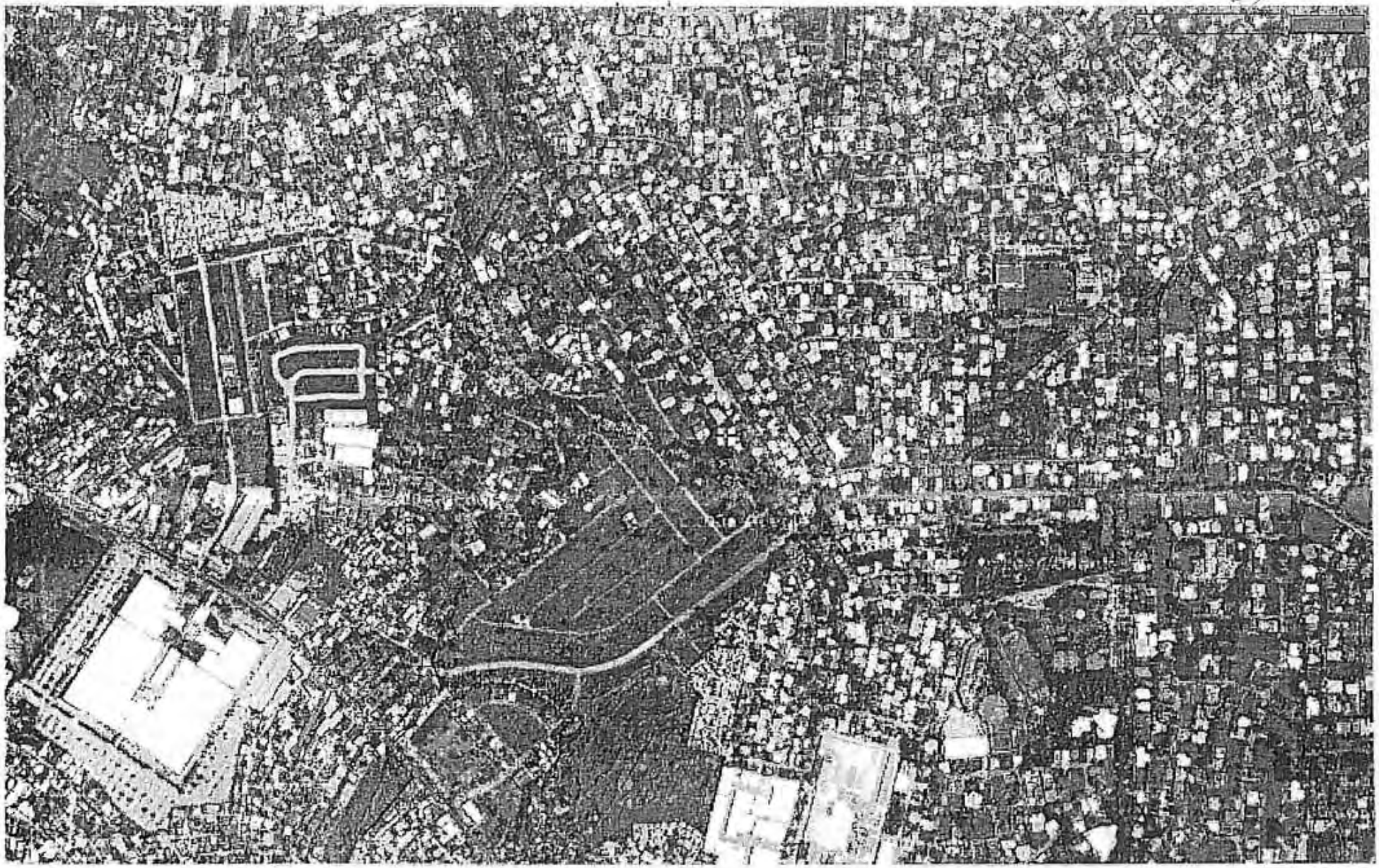

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