Manila[24].

This sub-section presents in brief the review of past studies and the fundamentals/ approach adopted in the development of BOD pollution load estimates and mapping prepared for this Survey.

2.4.1 Review of Past Studies and BOD Pollution Load Estimates

Several past studies on estimation of point and non-point sources of pollution including, to some extent, water quality modeling of rivers within the study area were considered in the development of pollution load estimates and pollution load mapping for this Survey. The major studies reviewed are discussed in the succeeding.

(a) 2003 Philippines Environment Monitor

The environment monitor report commissioned by the World Bank estimated BOD pollution generation[25] for both point and non-point sources in the entire country by regions. The report estimated that around 2.2 million metric tons per year of BOD is generated in the country. Metro Manila, Region IV and Region III account for the highest contributions at 14.8%, 14.0% and 9.5% respectively. Nationally, 48% of the total BOD generation comes from domestic sources, 37% from agriculture, and 15% from industrial sources. The three regions being considered in this study, being the largest urban conurbation in the country, show the highest contributions from domestic and industrial sources. (see **Table 2.4.1)**

Table 2.4.1: Annual BOD generation in NCR, Region III and Region IV

Region	Total BOD generation (in million metric tons/year)	Percent contribution per sector		
		Domestic	Industry	Agriculture
NCR	330,000	58	42	0
Southern Tagalog (R-IV)	314,000	51	14	35
Central Luzon (R-III)	212,700	51	14	35

Source: Philippine Environment Monitor, 2003

In the same study, domestic BOD generation was computed by multiplying the regional population of year 2000 with a BOD factor of 37 grams per person per day (unit pollution load). The BOD factor was taken as the national average and was applied to all regions except Metro Manila. Depending on the income class of households, unit pollution load ranges from 26 to 53 grams per person per day for low and high-income groups, with the latter applied to the Metro Manila area. The total water consumption was set at 120 liters per capita per day (60 lpcd for rural areas), of which 80% was the estimated wastewater generated.

Industrial contribution was estimated by industry type using the WHO Rapid Assessment of Sources of Air, Water, and Land Pollution. The annual amount of BOD generation was calculated by multiplying the annual volume of production output by appropriate effluent factor. The volume of wastewater generation and BOD from agriculture was estimated using animal type and the WHO Rapid Assessment Method. The method uses the annual number of heads of livestock and poultry multiplied by the appropriate effluent factor.

---

24 East Concession Master Plan Update, NJS, 2004

25 Pollution load at source, reduction through on-site and/or off-site treatment facilities including reduction thru natural processes are neglected

(b) 2004 East Concession Master Plan Update, MWCI

A comprehensive computation of actual and projected organic waste loading developed by NJS was prepared for the east concession area of MWSS in 2004. The study also included river water quality projections of selected major rivers within the study area. Not included in the analysis were areas at the south of the MWSS area (i.e. Cavite, Muntinlupa, etc.) and towns outside of Metro Manila (southern towns of Rizal province).

The Approach

Population and Wastewater Projections

Population was projected using a similar approach adopted by SKM in its MWSS master plan study as discussed in the previous sub-section. From the projected population, the corresponding water demand was calculated based on the per capita consumption rate of 71-293 lpcd (average 131 lpcd). Under the study, MWCI expects per capita consumption will increase after improvement of water supply constraints to 198 lpcd in average by the end of concession.

Commercial water consumption on the other hand was calculated based on the method applied in the rate rebasing exercise (based on the ratio of domestic water consumption to commercial water consumption). This ratio was further refined based on the actual water billing record of the MWCI business areas and aerial proportion of each cities/municipalities to each business areas.

Projections of industrial water demand were not calculated since the study assumed that it was not to be discharged to the sewerage system.

In computing for the amount of wastewater generated, the return factor, the ratio of discharged sewage against consumed water, was assumed at 80% for both of domestic and commercial wastewater. Further, to estimate the expected amount of sewage volume to be generated, an infiltration factor was introduced; the infiltration rate under the dry weather was assumed at 10 m^3/ha/d and 7.5 m^3/ha/d for the area with combined and separate sewer system respectively. The results of projections are presented in **Table 2.4.2** below.

Table 2.4.2: Total sewage volume projection in the east concession area

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

Source: East Concession Master Plan Update, 2004

Catchment Areas

The catchment area delineation adopted under the MWCI study followed the catchment boundaries developed under the 1996 JICA Flood Control and Drainage Master Plan for Metro Manila (see **Figure 2.4.1** and **Figure 2.4.2**). Pollution load estimates as well as river water quality projections were developed based on the said catchment delineation.

Calculation of BOD Loading

Under the study, the per capita pollution loads used were adopted from the previous Manila Third Sewerage Project (MTSP) feasibility studies, wherein per capita loads were based on the income groups[26] for each city/municipality under consideration. These values are shown in the table below.

Table 2.4.3: Domestic per capita pollution loads (g-BOD/capita/day)

Income Group	2004			2025		
	Toilet	Sullage	Total	Toilet	Sullage	Total
Low-Income	20	16	36	20	23	43
Middle-Income	20	30	50	20	30	50
High-Income	20	30	50	20	30	50

Source: NJS, 2004

It was assumed that per capita pollution loads increase linearly from year 2004 to 2025, and that by 2025, projection assumes per capita BOD load of 50 g/capita/day for the entire population.

In estimating commercial pollution load, it was assumed that commercial wastewater has the same strength of BOD as domestic wastewater. Thus, commercial BOD loads were calculated from domestic BOD generation applying proportion of commercial wastewater flow to domestic wastewater flow.

In the estimates of pollution load from industrial sources, MWCI study adopted industrial data from the "Industrial Efficiency and Pollution Control Program (IEPC) commissioned by the World Bank in 1992. IEPC report estimated that, in 1990, a total of 573 tons-BOD/day was generated in Metro Manila, of which 304 tons-BOD/day was discharged to rivers. Further, the same report assumed that BOD generation from industrial activities will remain at this level up to year 2025 considering that new industrial development is likely to happen outside of Metro Manila. However, IEPC proposed a pollution abatement strategy that is aimed at reducing the year 2025 BOD discharge to 130 tons/day. This reduction was applied in the NJS study whereby industrial BOD discharge is assumed to decrease linearly from 1995 (304 tons-BOD/day) to 2015 (130 tons-BOD/day) then to stay at this level until 2025.

[26] Composition of low, middle and high-income population was estimated based on "2000 Family Income and Expenditure Survey"

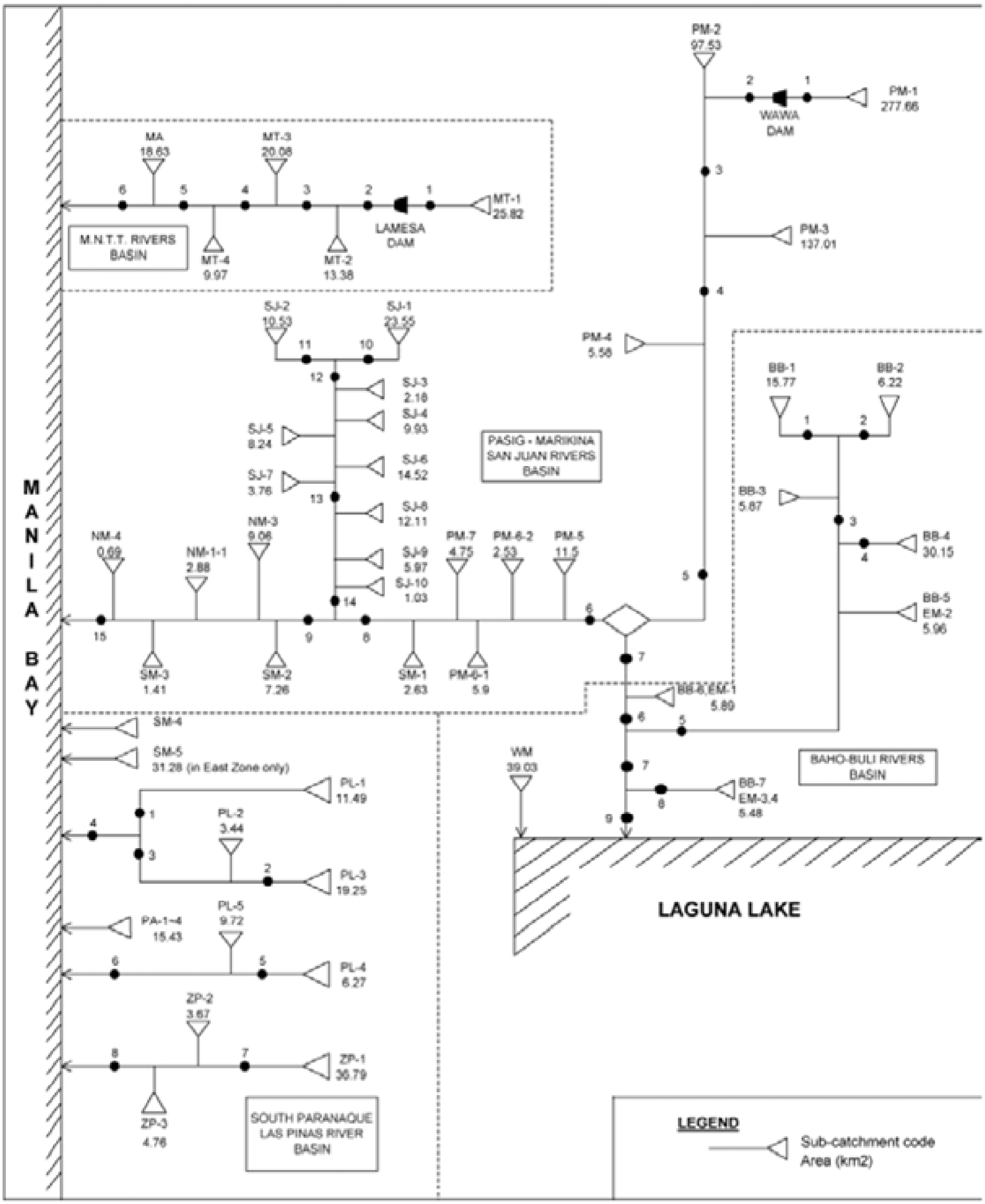
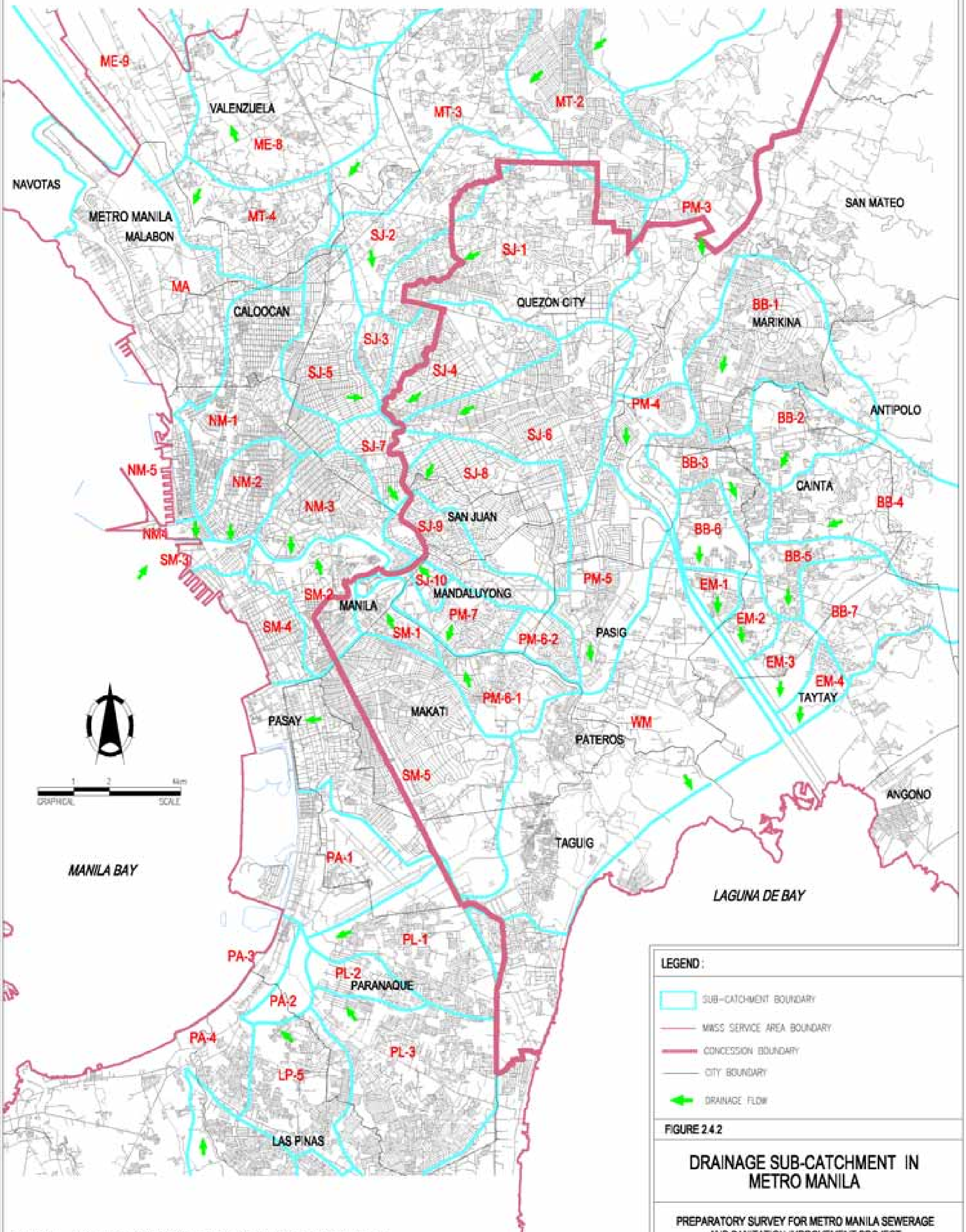


Figure 2.4.1: Schematic of drainage sub-catchments in Metro Manila

(Source: East Concession Master Plan Update, 2004)



SOURCE : MWCI 2004 SEWERAGE AND SANITATION MASTER PLAN UPDATE

LEGEND :

- SUB-CATCHMENT BOUNDARY
- MWSS SERVICE AREA BOUNDARY
- CONCESSION BOUNDARY
- CITY BOUNDARY
- DRAINAGE FLOW

FIGURE 2.4.2

DRAINAGE SUB-CATCHMENT IN METRO MANILA

PREPARATORY SURVEY FOR METRO MANILA SEWERAGE AND SANITATION IMPROVEMENT PROJECT

Estimates of Pollution Load Generation

A summary of the resulting BOD pollution generation for domestic, commercial and industrial sources for each sub-catchment are presented in **Table 2.4.4**.

Table 2.4.4: Sub-catchment pollution load generation

Sub-Catchments	Pollution Generation (ton-BOD/day)					
	2005			2025		
	Domestic + Commercial	Industrial	Total	Domestic + Commercial	Industrial	Total
Pasig-Marikina	124	32	156	255	19	275
San Juan	104	12	116	113	7	120
South Manila	67	14	81	55	8	63
Malabon-Tullahan	95	16	111	117	10	127
Baho-Buli	40	22	62	68	13	82
Makati	37	2	38	41	1	42
West Manila	34	8	42	54	5	59
Total	**500**	**105**	**606**	**704**	**63**	**767**

Source: East Concession Master Plan Update, 2004

Water Quality Projection

Under the MWCI study, the average water quality of rivers was projected from pollution load generation, specific flow factor and reduction factor using the following formula:

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

RF/f or the return factor relates to the factor applied to gross BOD generation to arrive at the resulting BOD loading into the water body. In the study, estimated reduction factor (RF) for domestic pollution loads was set at 0.6 considering removal by septic tanks (10% removal) and chemical and biological decomposition processes in drains and streams (50% removal). Further, it also adopts a reduction factor (Rf) of 0.5 from chemical and biological decomposition processes in rivers for industrial loads.

SFF or the specific flow factor was based on the historical mean monthly discharge of the subject rivers. Result of the calculation estimates a SFF of 0.057 $m^3/s/km^2$ and 0.13 $m^3/s/km^2$ for the upper catchment and the lower catchment respectively

The results of the projection are shown in **Figure 2.4.3** and **Figure 2.4.4** for years 2005 and 2025 respectively. The 2025 projection only assumed industrial pollution abatement measures proposed by IEPC and did not consider new sewerage development within the study area.

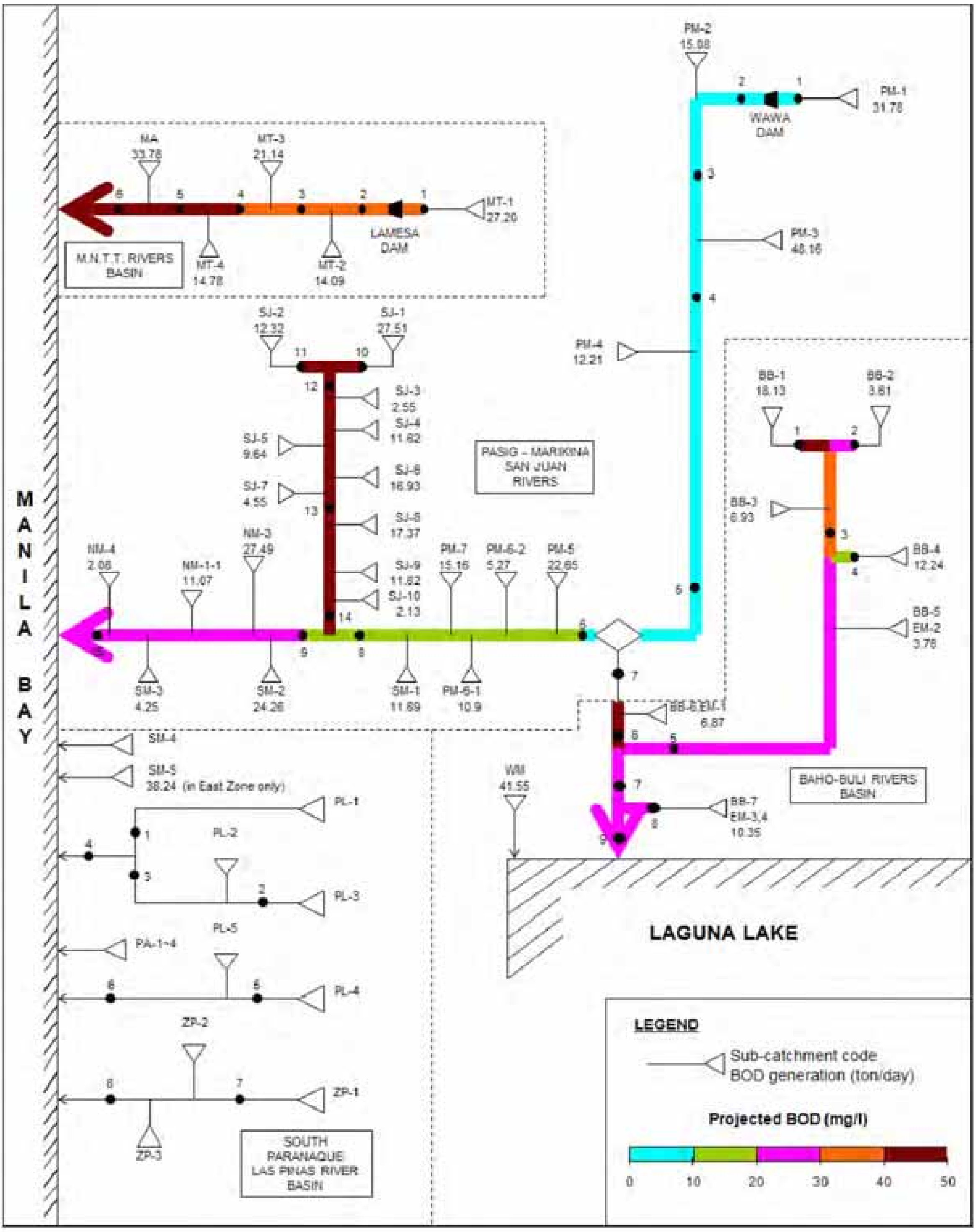
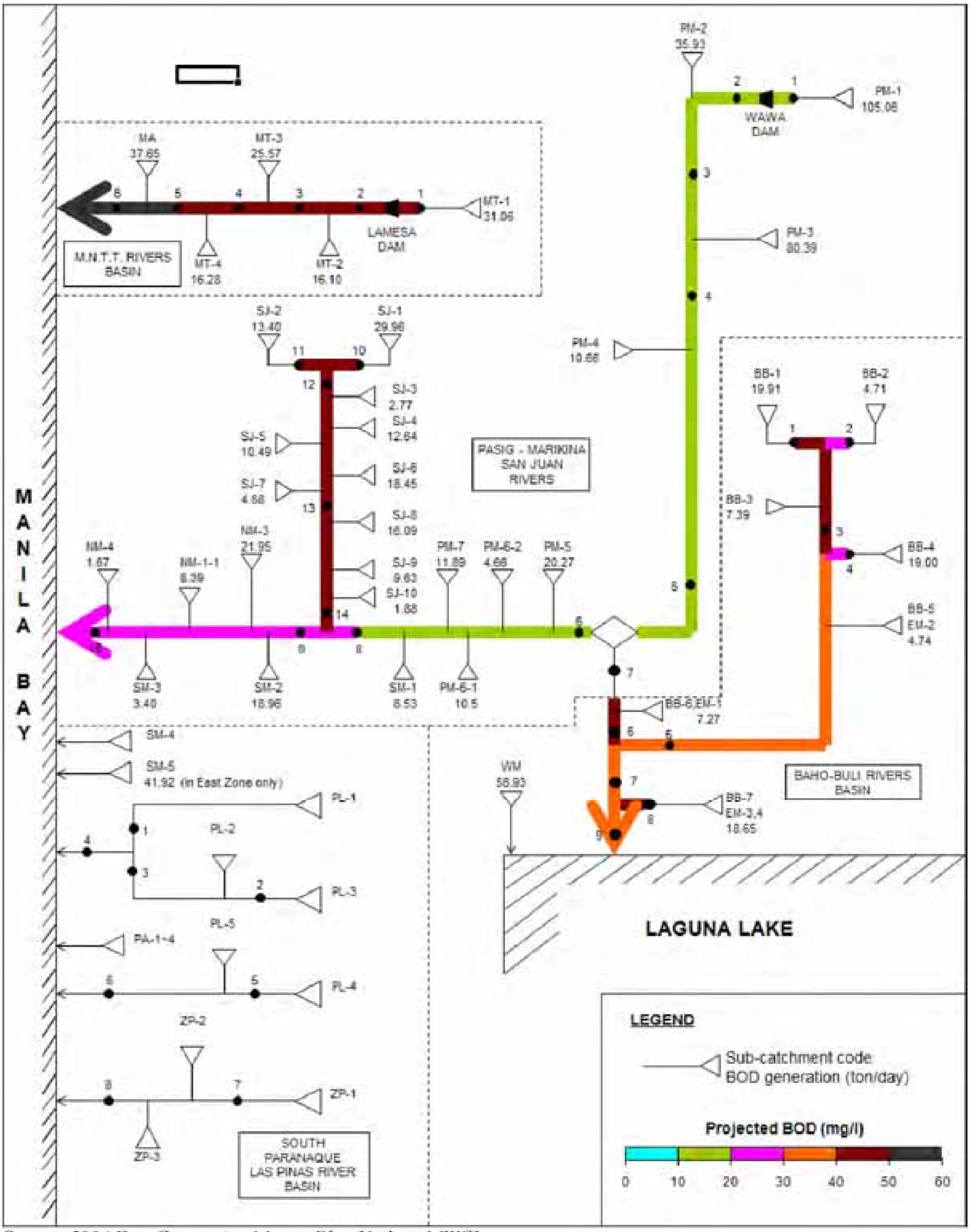


Figure 2.4.3: Projected BOD of rivers in east concession zone (2005)

(Source: 2004 East Concession Master Plan Update, MWCI)



Source: 2004 East Concession Master Plan Update, MWCI

Figure 2.4.4: Projected BOD of rivers in east concession zone (2025)

Conclusion

Results of the East Concession Master Plan study shows that in 2005, the San Juan River and the Baho-Buli Rivers are the most polluted in the East Concession Zone and were correspondingly identified as pollution "hotspots". Moreover, the same pollution trend was seen to be carried over up to year 2025, although BOD levels are only slightly higher than those in 2005.

(b) 2005 MWSS Sewerage and Sanitation Master Plan

Another comprehensive computation of actual and projected organic waste loading was done for the MWSS area in 2005 by SKM. The projections covered both the east and west concession area, however similar to the 2004 East Concession Master Plan Update (NJS study), it was not able to cover the entire MWSS service area. The areas in Cavite Province and towns in south of Rizal Province were excluded in the assessment.

The Approach

Population and Wastewater Projections

As discussed previously, SKM adopted the ratio method of projection to arrive at the projected population for the entire MWSS service area. It should be noted, however, that as mentioned above the actual population in 2007 is already comparable to the 2010 projected population, so the 2010 projections may be taken as actual 2007 or 2008 figures.

As reported in the MWSS Master Plan, a reasonably accurate correlation between per capita consumption and per capita income or family income can be established from past consumption trends if the supply setting is unconstrained. Considering the constrained supply situation which affected the normal growth of domestic water demand, the MWSS study adopted a methodology similar to that used in the Study of Water Resources Development for Metro Manila commissioned by the NWRB and JICA and prepared by Nippon Koei Co., Ltd. and NJS Consultants in 2003.

The NWRB-JICA water resources study assumes that water demand is related to household income, categorized into three income groups: high, middle, and low (according to the 2000 Family Income and Expenditures Survey by the National Statistics Office). Adopting this methodology and applying it to the rate rebasing targets wherein service coverage targets vary linearly per city/municipality, SKM was able to arrive at a system-wide average per capita demand of about 160 lpcd (NCR: 180 lpcd for the high income group, 170 lpcd for middle, and 140 lpcd for low; Rizal and Cavite: 160 lpcd for high, 150 for middle and 140 for the low income group) for years 2010-2015. As reported, with the likely development of a major source prior to 2015 and continued benefits of planned NRW reduction programs, it is expected that more water will become available from 2015 leading to an increase in unit consumption rates. Thus, for the period 2015-2025 for NCR: 220 lpcd for the high-income group, 200 lpcd for middle, and 160 lpcd for low; Rizal and Cavite: 180 lpcd for high, 160 for middle, and 140 for the low income group.

For the non-domestic water demand the average historical commercial and industrial per capita-billed volume of the East Zone was used in computing future commercial and industrial billed volumes for both concessions.

The projected total water demand for 2010 to 2025, which is referred to in the 2005 MWSS study as the sum of domestic, commercial, and industrial water demands, is summarized in **Table 2.4.5**.

Table 2.4.5: Projected water demand for the MWSS service area

Sector	Water Demand in MLD			
	2010	2015	2020	2025
Domestic	2,078	2,736	3,119	3,465
Commercial	889	1,048	1,244	1,438
Industrial	172	204	242	281
Total	**3,139**	**3,988**	**4,605**	**5,184**

Source: 2005 MWSS Master Plan

Wastewater discharge on the other hand, similar to the East Concession Master Plan study, was computed to be 80% of the water demand by each sector. Groundwater infiltration is also considered as part of wastewater generated and is this time calculated by assuming a constant daily infiltration flow rate of 7.5m^3 /hectare.

Table 2.4.6 summarizes the results for the projected wastewater generation for 2010. Noteworthy in this data is the higher wastewater generation in the West Zone neglecting infiltration considering that the East Zone covers a larger underdeveloped area.

Table 2.4.6: 2010 projected wastewater generation in the MWSS service area

Concession Area	Potential Wastewater (MLD)				
	Domestic	Commercial	Industrial	Infiltration	Total
West Zone	1,075	412	77	463	2,028
East Zone	587	317	60	770	1,734
Total	**1,663**	**729**	**137**	**1,233**	**3,762**

Source: 2005 MWSS Master Plan

The trend of a more rapid development in the East Zone and higher service coverage will eventually result to higher wastewater generation compared to the West Zone by 2015. It is projected that from the period 2010-2015, the East Zone, particularly Rizal, will experience a surge in population growth resulting in a 9.2% increase in domestic wastewater generation each year. By 2025, the two concession areas would almost be equally serving the population of 19.2 million people in the entire MWSS area.

Population growth will also result to a rapid expansion of the East Zone's commercial and industrial sectors which will continue to post year-to-year increase in wastewater generation of about 4% until 2025. On the other hand, the West Zone will post only modest increases in its wastewater generation after 2015 due to a decreasing trend in population in several key cities. This, however, is balanced by the continued increase in all sectors in the Cavite area and therefore the West concession area will still post a net positive increase in wastewater generation of 1.0-1.3% per year from 2015-2025.

Table 2.4.7: Projected annual increase in wastewater generation from the MWSS concession areas

MWSS area / sector	Annual percent increase in wastewater generation		
	2010-2015	2015-2020	2020-2025
West Zone			
Domestic	4.8	1.0	0.7
Commercial	3.1	3.0	2.5
Industrial	2.9	3.0	2.4
Infiltration	0.0	0.0	0.0
Total West Zone	**3.3**	**1.3**	**1.0**
East Zone			
Domestic	9.2	5.6	4.1
Commercial	4.4	4.5	3.9
Industrial	4.7	4.7	4.1
Infiltration	0.0	0.0	0.0
Total East Zone	**9.3**	**2.7**	**2.3**

Catchment Areas

The catchment area under the MWSS study only considered the areas covered by the planned sewerage components reflected in the master plan. As presented in the previous sub-sections of this report, it composes of nine major drainage basins that divided into 31 sewerage sub-catchments (see *Calculation of BOD Loading* below).

Calculation of BOD Loading

In the MWSS projections, pollution load for each source was estimated for each of the 31 catchments delineated in the study. In relation to the MWCI projections, MWSS study did consider the proposed sewerage and sanitation improvement projects which will be in place by 2025 while the MWCI study did not. The 2025 pollution load projections assumed compliance to the 1997 Concession Agreement targets on sewerage and sanitation. Thus, the projections somehow represent the indicative environmental benefits which may be attributed to the said agreement targets.

For domestic BOD load, the average per capita BOD load applied to all the population within the MWSS concession area at the following rates: 45.3 grams per capita per day (gpcd) in 2005, 46.5 gpcd in 2015 and 47.7 gpcd in 2025. These figures were derived following similar methodologies adopted in the NJS 2005 estimates for the east concession area.

The estimates for BOD contribution from commercial sources were calculated by assuming that commercial wastewater strength is equivalent to 500 mg-BOD/l. This wastewater concentration was higher than the 250 mg-BOD/l (interpolated value) used in the MWCI 2005 study. The MWSS study attributed this to the treatment design of existing treatment plants which was reported to be currently designed for 400-800 mg-BOD/l influent quality.

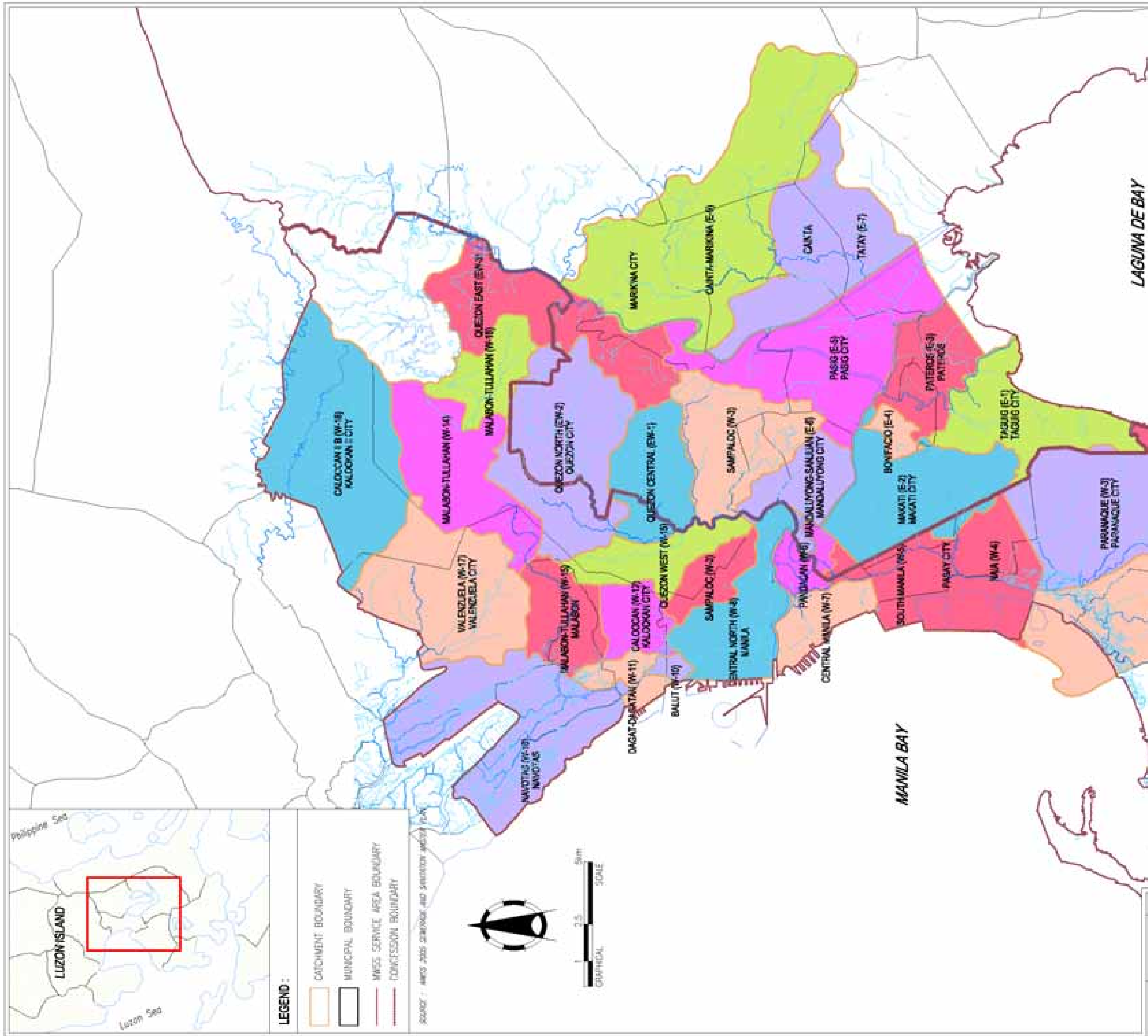


FIGURE 2.4.5

SEWERAGE CATCHMENTS IN THE MWSS SERVICE AREA

PREPARATORY SURVEY FOR METRO MANILA SEWERAGE AND SANITATION IMPROVEMENT PROJECT

Similar to the 2004 MWCI study, the MWSS master plan study gave consideration to the results of the IEPC report and in addition to the existing government regulations (i.e. Environmental Users Fee System of the LLDA) and recently approved environmental laws (i.e. Clean Water Act of 2004). The aforementioned laws and regulations were perceived to result in improved enforcement of effluent standards and thus a corresponding reduction in industrial pollution loads.

While MWCI study adopted the estimated loads under the IEPC report, the MWSS study opted to apply wastewater concentration factor to the computed industrial wastewater generation, which were adjusted to consider sources other than MWSS' scope of service (e.g. deep well). An industrial wastewater concentration of 50 mg-BOD/l was applied for the percentage of wastewater from complying industries (compliance to DENR DAO 35 - Effluent Water Quality Standards) and an average concentration of 1,452 mg-BOD/l for non-complying industries. The assumed average percent compliance to the existing effluent regulations (CWA and EUFS) in 2005 was 40%, with a linear increase to 60% in 2015 and 80% in 2025.

Estimates of Pollution Loading

A summary of the resulting domestic BOD pollution generation which excludes treatment/BOD reduction thru on-site and/or off-site treatment facilities is presented in **Table 2.4.8**. The domestic pollution load generation contribution from the West Zone is projected to decrease from 57% in 2005 to 49% while the East Zone is projected to increase its share of BOD generated from 33% to 44%.

Table 2.4.8: Projected domestic BOD load generation from the MWSS concession areas for the period 2010-2025

Catchment	2005		2015		2025	
	tons-BOD/ day	%	tons-BOD/day	%	tons-BOD/day	%
West Zone	309	57	347	58	383	49
East-West Boundary	52	10	56	9	58	7
East Zone	182	33	200	33	343	44
Total	**543**	**100**	**603**	**100**	**784**	**100**

Source: MWSS 2005

Improvement in sanitation and implementation of planned sewerage programs will reduce net pollution load reaching the river systems in Metro Manila. The loads presented in Figure 2.4.6 were adjusted to calculate the "net" pollution load as reduced by septic tank treatment and the existing sewerage system. The existing septic tanks were estimated to conservatively remove 10% of the pollution load being discharged by every household. The MWSS Master Plan (2005) suggested another 10% improvement should these septic tanks be regularly desludged and maintained regularly at least once every five (5) years.

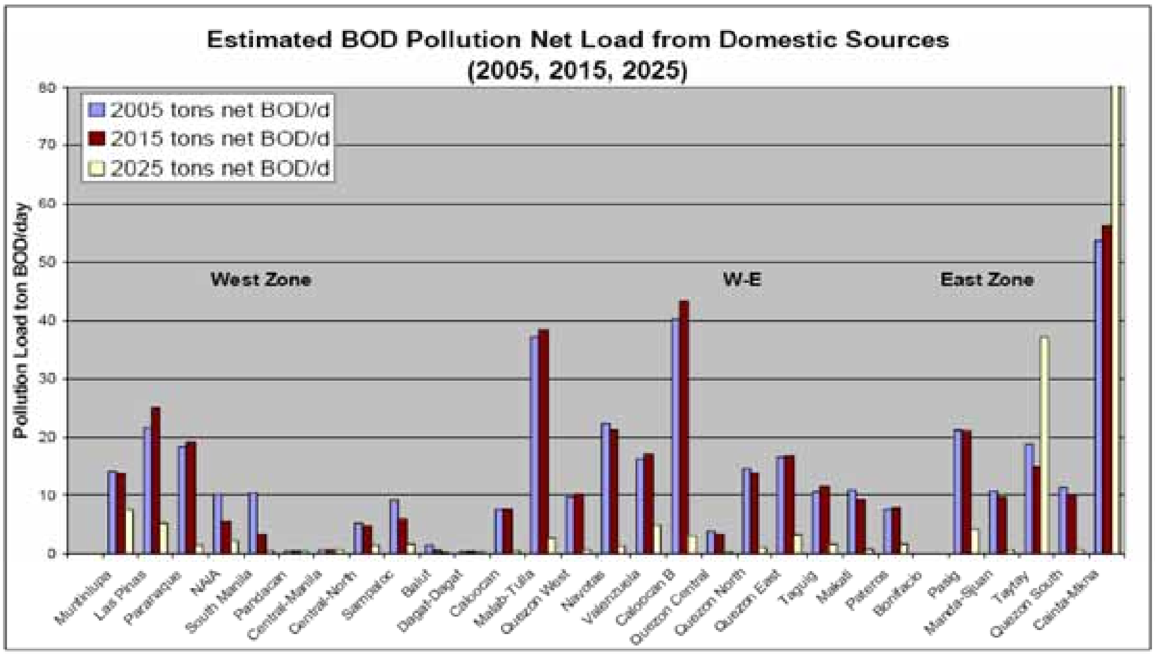


Figure 2.4.6: Projected net domestic BOD load from the MWSS concession areas for the period 2010-2025

(Source: MWSS 2005)

Considering that about 12% of the MWSS service area is currently sewered with some treatment works, the total pollution load served by these facilities will be significantly reduced. It is assumed that these facilities can remove about 95% of the load, leaving about 5% of the load still being received by the river systems. Since most of the programmed sewerage programs are concentrated in the West Zone, its contribution to net domestic BOD load will be reduced from 225 tons/day to 35 tons/day or 17% total domestic BOD. Infrastructure development in the East Zone will not be able to account for the rapid increase in population and will result to a projected increase in net BOD load from 144 tons/day to 166 tons/day or 81% of the total net domestic BOD load in the MWSS area.

As in the domestic sector, the net commercial BOD loading was calculated based on the existing sewerage systems in 2005 and the proposed sewerage improvement projects in 2015 and 2025 **(Table 2.4.9)**. Lower sewerage program targets in the East Zone are reflected in only a minor decrease in commercial BOD load.

Table 2.4.9: Projected net commercial BOD load from the MWSS concession areas for the period 2010-2025.

Catchment	2005		2015		2025	
	tons-BOD/day	%	tons-BOD/day	%	tons-BOD/day	%
West Zone	67	42	76	37	19	22
East-West Boundary	14	9	18	9	3	3
East Zone	77	49	112	54	64	75
Total	**158**	**100**	**206**	**100**	**86**	**100**

For industrial BOD load calculation, it was assumed that increasing compliance by industries on DENR targets will take effect from 2005 to 2025. The projected industrial water usage will remain almost constant from 2015 to 2025 but an increase in compliance from 40% to 80% is projected. This results to a decrease in net industrial BOD load from 262 tons/day to 106 tons/day. The West Zone will remain to have a larger share of industrial BOD load with an estimated 63 tons/day output in 2025. (see **Table 2.4.10)**

Table 2.4.10: Projected net industrial BOD load from the MWSS concession areas for the period 2010-2025

Catchment	2005 (40% compliance)		2015 (60% compliance)		2025 (80% compliance)	
	tons-BOD/day	%	tons-BOD/day	%	tons-BOD/day	%
West Zone	138	53	115	55	63	59
East-West Boundary	21	8	17	8	8	7
East Zone	103	39	77	37	35	34
Total	262	100	209	100	106	100

The percentage compliance is estimated from the number of industrial firms in the area that will have sufficient treatment facilities to be able to meet the 50mg/l BOD effluent standard.

2.4.2 Pollution Load Assessment and Mapping under the Present Survey

The review of previous studies has shown the approximate values of the extent of BOD pollution loads coming from point and non-point sources within the study area. Further, the results of the projections have already indicated several "*hotspot*" areas where water quality management interventions or more particularly plans/measures to address domestic, commercial, and industrial wastewater pollution must be undertaken.

For this Survey, a similar pollution load assessment in terms of projecting pollution loads from different sources was conducted to update/refine the projections developed in previous studies. The approach and the corresponding results of the projections are discussed in the subsequent subsections.

(a) Estimates of BOD Pollution Loads in the Manila Bay Watershed

Estimate of Pollution Generation

An update of the projections prepared under the environment monitor report commissioned by the World Bank was developed to have an estimate of the total BOD pollution load generated within the Manila Bay watershed based on the latest NSO Census (2007).

This Study has applied similar per capita BOD pollution load factors for domestic sources adopted in the World Bank report. In order to estimate loads from industrial and agricultural sources, it was assumed that the ratio of the said sources to that of the total domestic loads remained the same for Regions III and IV. For NCR, it was assumed that the ratio of domestic to industrial pollution load is already at 0.6:0.4 (based from the 2005 MWSS projections); wherein in the 2003 World Bank estimates it was set at 52% domestic and 48% industrial.

Results of the updated estimates shows that roughly 53% of the pollution load generated within the Manila Bay watershed can be attributed to the domestic, commercial, and industrial activities taking place within Metro Manila (see **Table 2.4.11**, **Figure 2.4.7** and **Figure 2.4.8)**

Table 2.4.11: Approximate BOD pollution load generation from point and non-point sources within the Manila Bay watershed, 2007

Region	2007 NSO population* (in millions)	Total pollution generation (in million metric tons-BOD/year)				% of total load
		Domestic	Industry	Agriculture	Total	
NCR	11.55	240,300	160,200	-	400,500	53%
Central Luzon (R-III)	5.85	79,000	21,700	54,200	154,900	21%
Southern Tagalog (R-IV)	7.38	99,600	27,300	68,400	195,300	26%
Total Manila Bay Watershed	**24.78**	**418,900**	**209,200**	**122,600**	**750,700**	**100%**

**approximated based on the cities/municipalities encompassed by the watershed*

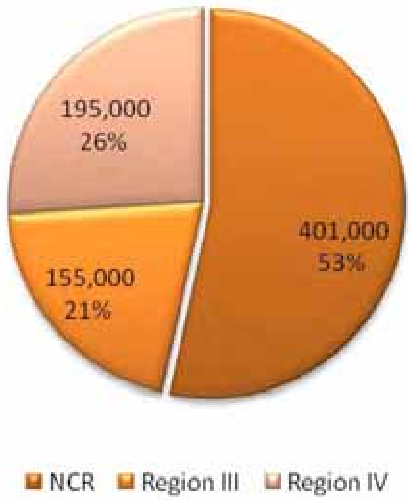


Figure 2.4.7: Manila Bay watershed BOD pollution load distribution per regions (in tBOD/year)

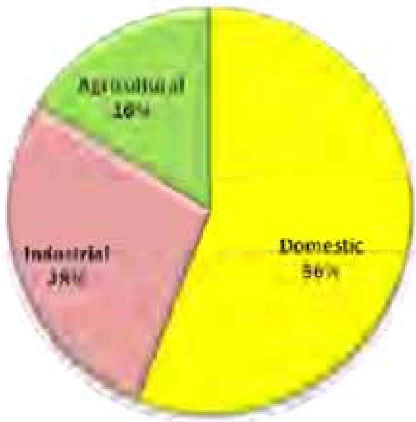


Figure 2.4.8: Manila Bay watershed BOD pollution load distribution by sources

<u>Estimates of BOD Loading into the Manila Bay</u>

A rough estimate of the total BOD pollution load entering the Manila Bay would entail a long period of study to account for several factors that would affect the transport of pollution loads from source to sink. Factors such as BOD reduction thru chemical and biological decomposition processes in drains, creeks, and rivers would be very difficult to assume considering the extent of the drainage area of the Bay.

However, just for discussion purposes, an estimate of BOD pollution loading focused mainly on the contribution from the coastal towns[27] surrounding the Manila Bay was conducted. As mentioned in the Section 2.1.4, these coastal towns accounts for roughly 30% of the watershed population as of year 2007.

In the estimates, a similar approach was adopted in computing for BOD generation as discussed above. In estimating pollution loads from domestic sources, a 10% reduction was introduced to populations served by individual septic tank systems and another 50% reduction thru natural processes (similar with the MWCI and MWSS studies). For agricultural and industrial sources,

[27] Assuming the total population of cities/municipalities surrounding the bay. For Metro Manila, only the towns of Navotas and Malabon and the cities of Manila, Caloocan, Pasay, Paranaque, and Las Pinas were included.

a 50% reduction of the gross generation was applied to account for the decomposition processes in drains and rivers/tributaries draining into the Manila Bay.

Results of the estimates shows that for regions with coastal towns fronting the Bay, 75% percent of the pollution load is discharged from Metro Manila alone (see **Table 2.4.12**). It should be noted that only seven coastal towns of Metro Manila were included in the estimates.

Table 2.4.12: Rough estimates of BOD pollution load contribution from coastal towns into the Manila Bay

Coastal areas	2007 Population*	Total pollution loading (in million metric tons-BOD/year)	% of total load
Coastal cities/Mun. of Metro Manila	5.14	84,800	75%
Coastal cities/Mun. of Region III	1.32	16,800	15%
Coastal cities/Mun. of Region IV	0.93	11,900	10%
Total coastal towns of Manila Bay	**7.39**	**113,500**	**100%**

** taken as total city/municipal population*

Conclusion

The rough estimates clearly shows that the domestic and industrial activities contributes the largest at 42% in terms of BOD pollution load generated compared with the other two Regions encompassed by the Manila Bay watershed. Moreover, in terms of BOD loading into the Bay, the coastal towns of NCR accounts for approximately 75% of the total loading considering only the contributions from coastal cities/municipalities fronting the Bay. It can therefore be concluded that interventions focused on the areas of Metro Manila to address pollution loads from entering Manila Bay would have the most effect in the improvement of the Bay's water quality.

(b) Estimates of BOD Loading Distribution within the MWSS Service Area

Taking-off from the studies previously conducted in estimating the BOD pollution loading for both east and west concession areas of MWSS, this Survey attempts to provide a more comprehensive assessment of the extent of pollution contribution within the study area. This was done by taking into account the entire MWSS service area, wherein in previous studies portions of Rizal Province as well as Cavite Province were left out in the projections.

The Study Approach

Catchment Areas, Population and Wastewater Projections

This Survey has adopted the catchments developed in the MWSS study wherein the service area was delineated into nine major basins and further subdivided into 31 drainage/sewerage catchments. In addition, in order to account for the BOD pollution loads generated within Cavite and Rizal Provinces, three additional basins were developed:

- East Concession Area: Upper Marikina Basin subdivided into 4 catchments, and South Rizal Basin subdivided into 2 catchments;
- West Concession Area: Cavite Basin subdivided into 2 catchments.

The Upper Marikina Basin was just adopted from the recent MWCI Marikina River Basin Sewerage Master Plan prepared by NJS in 2008. The South Rizal and Cavite Basins on the other hand were delineated based, to some extent the drainage patterns but more particularly from the municipal boundaries (considering that there are still no existing sewerage plans for these areas).

In projecting the population and potential wastewater generation, the projections developed under the MWSS study was adopted with the exception of the figures used for the Upper Marikina Basin wherein the estimates were based on the recent Marikina River Basin Master Plan. In estimating the pertinent figures per catchment (*population, water demand, wastewater*), city/municipal level figures (MWSS Study) were distributed per catchment adopting specific derived unit area value using the latest CAD map of the Survey Area.

The details of the revised catchments and its corresponding land area and projected population are presented in **Table 2.4.13**.

Table 2.4.13: Catchment areas and projected population (1/3)

Zone / major basin / sewerage catchment	Land area (km^2)	Projected population	
		2010	2025
I WEST ZONE (MWSI)			
1.1 Pasong Diablo/Magdaong/Sucat Basin	**39.5**	**475,180**	**559,577**
1.1.1 Muntinlupa (W-1)	39.5	475,180	559,577
1.2 Paranaque Basin	**92**	**1,345,139**	**1,757,564**
1.2.1 Las Pinas (W-2)	39.3	576,749	842,445
1.2.2 Paranaque (W-3)	36.5	519,377	656,578
1.2.3 Pasay-NAIA (W-4)	16.6	249,013	258,541
1.3 South Manila Basin (Part)	**21.8**	**780,092**	**670,994**
1.3.1 South Manila (W-5)	10.5	351,628	301,253
1.3.2 Pandacan (W-6)	3.0	136,221	119,196
1.3.3 Central Manila (W-7)	7.1	272,443	238,391
1.3.4 Part of Makati (E-2)	1.16	19,800	12,154
1.4 North Manila Basin	**32.3**	**994,149**	**929,432**
1.4.1 Central North (W-8)	17.2	612,996	536,380
1.4.2 Sampaloc (W-9)	6.5	170,211	158,767
1.4.3 Balut (W-10)	1.4	68,111	59,598
1.4.4 Caloocan A (W-12)	7.2	142,831	174,687
1.5 Tullahan Basin	**50.3**	**1,169,531**	**1,318,870**
1.5.1 Dagat-Dagatan (W-11)	5.2	129,012	141,799
1.5.2 Malabon-Tullahan (W-13)	9.9	294,925	319,623
1.5.3 QC-Novaliches (W-14)	20.3	490,666	560,667
1.5.4 Malabon (W-19)	14.9	254,928	296,781

Table 2.4.13: Catchment areas and projected population (2/3)

Zone / major basin / sewerage catchment	Land area (km^2)	Projected population	
		2010	2025
1.6 Meycauyan Basin	**100.5**	**1,948,916**	**2,248,208**
1.6.1 Navotas (W16)	31.3	561,309	580,917
1.6.2 Valenzuela (W-17)	28.4	554,487	655,357
1.6.3 Caloocan B (W-18)	40.8	833,120	1,011,934
1.7 San Juan Basin (Part)	**30.9**	**1,274,995**	**1,526,354**
1.7.1 Quezon Central (EW-1)	5.3	67,981	79,142
1.7.2 Quezon North (EW-2)	14.9	271,923	316,566
1.7.3 Quezon West (W-15)	10.8	935,091	1,130,646
1.8 Marikina-Antipolo Basin (Part)	**12.2**	**271,923**	**316,566**
1.8.1 Quezon East (EW-3)	12.15	271,923	316,566
1.9 Cavite Basin	**139**	**1,001,005**	**1,231,999**
1.9.1 Cavite-Rosario (CW-1)	14.1	205,112	293,546
1.9.1 Cavite-Kawit (CW-2)	125.0	795,893	938,453
II EAST ZONE (MWCI)			
2.1 San Juan Basin	**59**	**971,922**	**851,982**
2.1.1 Quezon Central (EW-1)	9.8	135,394	101,725
2.1.2 Quezon North (EW-2)	18.3	243,708	183,105
2.1.3 Quezon South (E-8)	20.7	305,315	273,665
2.1.4 Mandaluyong-San Juan (E-6)	10.4	287,505	293,487
2.2 Marikina-Antipolo Basin	**132**	**2,220,453**	**3,470,489**
2.2.1 Quezon East (EW-3)	12.15	152,423	133,966
2.2.2 Pasig (E-5)	32.9	742,875	1,108,358
2.2.3 Taytay (E-7)	28.4	472,002	822,304
2.2.4 Cainta-Marikina (E-9)	58.2	853,153	1,405,861
2.3 South Manila Basin	**25**	**396,741**	**354,152**
2.3.1 Makati (E2)	22.04	261,260	226,832
2.3.2 Pandacan (W-6)	2.25	99,353	93,368
2.3.3 South Manila (W-5)	1.17	36,128	33,952
2.4 Taguig Basin	**36**	**822,395**	**1,106,835**
2.4.1 Taguig (E-1)	18.8	460,067	653,669
2.4.2 Pateros (E-3)	14.95	320,065	416,473
2.4.3 Bonifacio (E-4)	2.49	42,263	36,693

Table 2.4.13: Catchment areas and projected population (3/3)

Zone / major basin / sewerage catchment	Land area (km^2)	Projected population	
		2010	2025
2.5 Upper Marikina Basin	**143**	**325,543**	**690,877**
2.5.1 Rodriguez (UM-1)	35	85,639	166,977
2.5.2 Maly (UM-2)	30	39,810	84,775
2.5.3 Ampid (UM-3)	24	98,341	220,360
2.5.4 Nangka (UM-4)	54	101,753	218,765
2.6 South Rizal Basin	**318**	**869,328**	**1,747,170**
2.6.1 Rizal South-West (SR-1)	67.5	517,234	1,021,564
2.6.2 Rizal South-East (SR-2)	250	352,094	725,606

In projecting for the BOD pollution load generated within the 12 basins, the specific per unit BOD generation factors applied for domestic, commercial, and industrial sources used in the MWSS study were adopted.

In the estimates of the BOD pollution loading the following reduction factors was adopted:

- For pollution generated from domestic and commercial sources a 10% reduction was applied to account for the reduction due to on-site treatment (applied only for population served by individual septic tanks). For the 2025 projections it was assumed that areas already covered by septage management would have increased on-site treatment efficiency, and thus a 20% reduction was applied based on the assumptions made in the MWCI study of 2004.
- It is also assumed that a 20% reduction be incorporated to compensate for the BOD decomposition in drains/creeks (applied to all pollution sources).
- For areas covered by off-site sewage treatment facilities (qualified as capable of at least treating influent wastewater to an acceptable 50 mg/l effluent quality) a 90% reduction was applied[28] (not applied to industrial pollution loads).

Development of Scenarios

Two scenarios were developed to assess the resulting extent of pollution per catchment:

- Scenario 1 assumes that no new sewerage and sanitation projects will be implemented between 2010 and 2025; and
- Scenario 2 on the other hand looks at the possible reduction in pollution loads given that several projects (refer to **Table 4.4.1** and **Table 4.4.3**) will be implemented by the two concessionaires of MWSS.

Existing and planned sewerage and sanitation coverage were estimated based on the 2008 Business Plan prepared by MWSI and the sewerage master plans prepared for the east concession by MWCI. The extrapolated sanitation and sewerage percent for both scenarios are presented in **Table 2.4.14**.

[28] Derived based on an average per capita water demand of 160 lpcd, wastewater return factor of 80%, BOD generation factor of 40g/capita, and an STP effluent quality of 30mg-BOD/l.

Table 2.4.14: Estimated Sewerage Coverage by Basin

Major Basins	Percent Population Served by Sewerage Systems				Year 2025 Percent Sanitation Coverage	
	Scenario 1		Scenario 2			
	2010	2025	2010	2025	Scenario 1	Scenario 2
Pasong Diablo/Magdaong/Sucat Basin	0.11	0.11	0.11	0.52	-	0.80
Paranaque Basin	-	-	-	0.40	-	0.80
South Manila Basin	-	-	-	0.90	0.45	0.80
North Manila Basin	-	-	-	0.75	0.80	0.80
Tullahan Basin	0.10	0.10	0.10	0.90	-	0.80
Meycauayan Basin	-	-	-	0.10	-	0.80
San Juan Basin	0.30	0.30	0.30	0.90	0.80	0.80
Cavite Basin	-	-	-	0.02	0.00	0.10
Marikina-Antipolo Basin	0.20	0.20	0.20	0.90	0.80	0.68
Taguig Basin	-	-	-	0.90	0.80	0.80
Upper Marikina Basin	-	-	-	0.60	0.65	0.80
South Rizal Basin	-	-	-	-	-	-

Result of the Projections

Table 2.4.15 summarizes the net BOD loads from the MWSS area. The West Zone accounts for 554.0 tons/day while the East Zone contributes 363.8 tons/day for the 2010 projection. The highest total contributions in the West Zone come from the Meycauayan and South Manila Basins. A better measure is the BOD load density as it is indirectly reflective of the degree of BOD pollution in the corresponding receiving body of water (i.e. larger catchment area usually drained by a larger volume river). In terms of pollution load density, the North and South Manila Basins have the highest values. Both basins are located along the Manila Bay coast with a good portion of the catchment draining into the downstream section of the Pasig River. The San Juan Basin also shows high pollution density except that BOD sources going into the San Juan River are separated into 2 basins on both concession zones. The Marikina-Antipolo Basin has the largest net BOD load in the East Zone but the Taguig Basin will have a higher BOD density value. The former drains into the downstream section of the Marikina River which connects to the Pasig River while the Taguig Basin feeds into the Laguna de Bay.

Table 2.4.15: 2010 projected BOD pollution loading by source

Zone / Major Basin		Year 2010 BOD Pollution Loading (tons-BOD/day)				Pollution Load Density (kg-BOD/day/ km^2)
		Domestic	Commercial	Industry	Total	
I	**WEST ZONE (MWSI)**	**297.1**	**136.1**	**120.8**	**554.0**	**1,068**
1.1	Pasong Diablo/Magdaong/Sucat Basin	16.2	3.4	8.7	28.2	714
1.2	Paranaque Basin	40.8	12.0	6.4	59.1	640
1.3	South Manila Basin (Part)	20.2	36.0	12.3	68.6	3,148
1.4	North Manila Basin	33.3	49.9	17.3	100.5	3,112
1.5	Tullahan Basin	35.9	10.7	20.2	66.8	1,329
1.6	Meycauayan Basin	65.6	12.9	33.4	111.9	1,113
1.7	San Juan Basin (Part)	42.1	6.8	19.9	68.8	2,225
1.8	Marikina-Antipolo Basin (Part)	8.9	2.9	2.1	14.0	1,151
1.9	Cavite Basin*	34.1	1.6	0.5	36.1	260
II	**EAST ZONE (MWCI)**	**177.6**	**90.8**	**95.4**	**363.8**	**510**
2.1	San Juan Basin	31.8	24.0	5.3	61.1	1,032
2.2	Marikina-Antipolo Basin	73.3	35.4	37.9	146.5	1,113
2.3	South Manila Basin	13.2	10.2	7.2	30.6	1,203
2.4	Taguig Basin	21.5	16.0	13.4	50.9	1,407
2.5	Upper Marikina Basin	11.1	1.9	28.0	40.9	286
2.6	South Rizal Basin	26.7	3.4	3.6	33.7	106
	TOTAL MWSS SERVICE AREA	**474.7**	**226.9**	**216.2**	**917.8**	**745**

Table 2.4.16 and **Figure 2.4.9** presents the expected reduction in pollution load as a result of implementing selected sewerage projects within the MWSS service area. While **Figure 2.4.10** to **Figure 2.4.12** shows the breakdown of pollution loads per catchment including its corresponding pollution load density map.

Scenario 1 in 2025 (no intervention) shows an increase in net BOD load for the entire area to have increased from 918 in 2010 to 1,068 tons-BOD/day in 2025. The **Marikina-Antipolo Basin**, which is one of the fastest growing population and urbanization, contribute the largest share of BOD load. A huge increase in net BOD load will also be expected in the **South Rizal** and **Upper Marikina Basins**. These three basins, therefore, should be the focus of intensive sewerage planning. If planned were successfully implemented on schedule (Scenario 2), a huge reduction in overall BOD loading will be realized in the entire MWSS area (44%), most notably in the East Zone which will post a 52% decrease in net BOD load by year 2025. Locally, huge improvements can be expected in San Juan, Marikina-Antipolo and South Manila Basins, all posting more than 70% reduction in net BOD load.

Table 2.4.16: Comparison of projected BOD pollution loading

Zone / Major Basin			BOD Pollution Loading (tons-BOD/day)			Year 2025 % Reduction due to Interventions
			Yr 2010	Year 2025		
				Scenario 1	Scenario 2	
I	WEST ZONE (MWSI)		554.0	597.8	374.2	37%
	1.1	Pasong Diablo/Magdaong/Sucat Basin	28.2	28.0	16.4	42%
	1.2	Paranaque Basin	59.1	81.0	73.9	9%
	1.3	South Manila Basin (Part)	68.6	74.2	36.2	51%
	1.4	North Manila Basin	100.5	109.9	35.6	68%
	1.5	Tullahan Basin	66.8	66.1	21.7	67%
	1.6	Meycauayan Basin	111.9	111.1	95.9	14%
	1.7	San Juan Basin (Part)	68.8	65.6	34.5	47%
	1.8	Marikina-Antipolo Basin (Part)	14.0	16.0	15.0	6%
	1.9	Cavite Basin	36.1	45.9	45.1	2%
II	EAST ZONE (MWCI)		363.8	470.0	225.6	52%
	2.1	San Juan Basin	61.1	47.4	12.3	74%
	2.2	Marikina-Antipolo Basin	146.5	187.6	53.4	72%
	2.3	South Manila Basin	30.6	21.2	6.2	71%
	2.4	Taguig Basin	50.9	53.1	19.7	63%
	2.5	Upper Marikina Basin	40.9	77.8	51.0	34%
	2.6	South Rizal Basin	33.7	83.0	83.0	0%
	TOTAL MWSS SERVICE AREA		**917.8**	**1,067.8**	**599.8**	**44%**

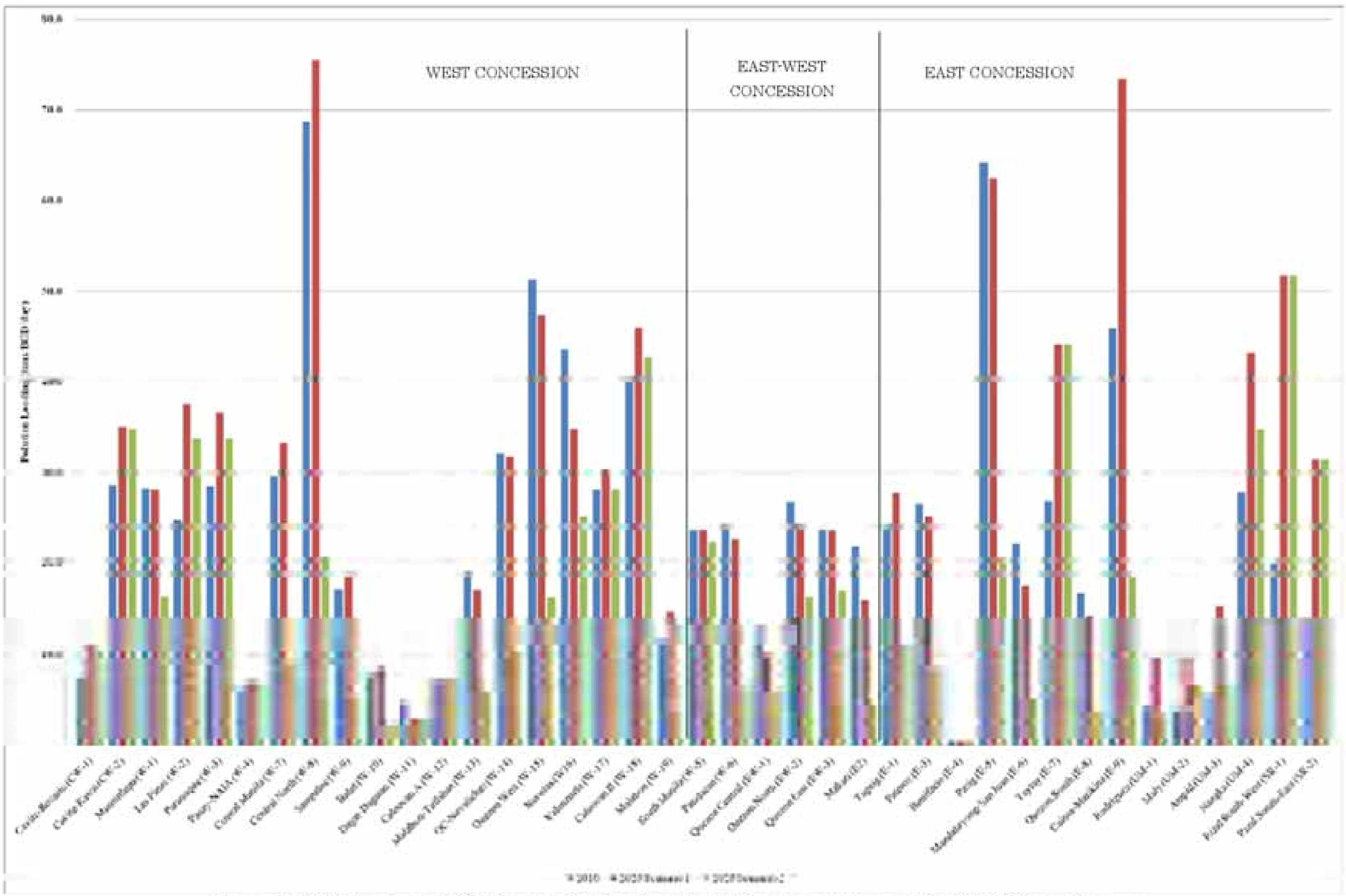
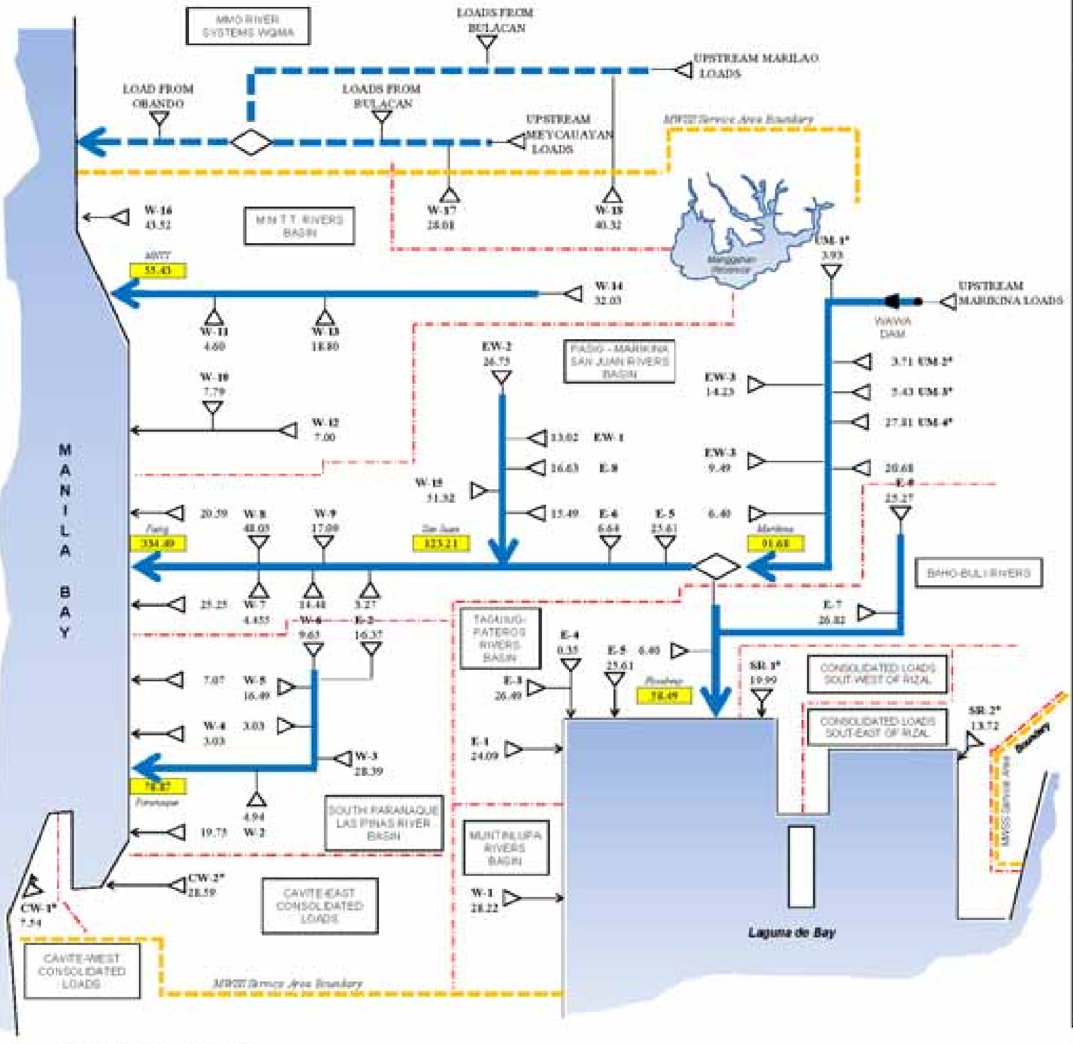


Figure 2.4.9: Projected BOD pollution load contribution by catchment in MWSS service area



SCHEMATIC OF POLLUTION LOAD CONTRIBUTION PER SUB-CATCHMENT

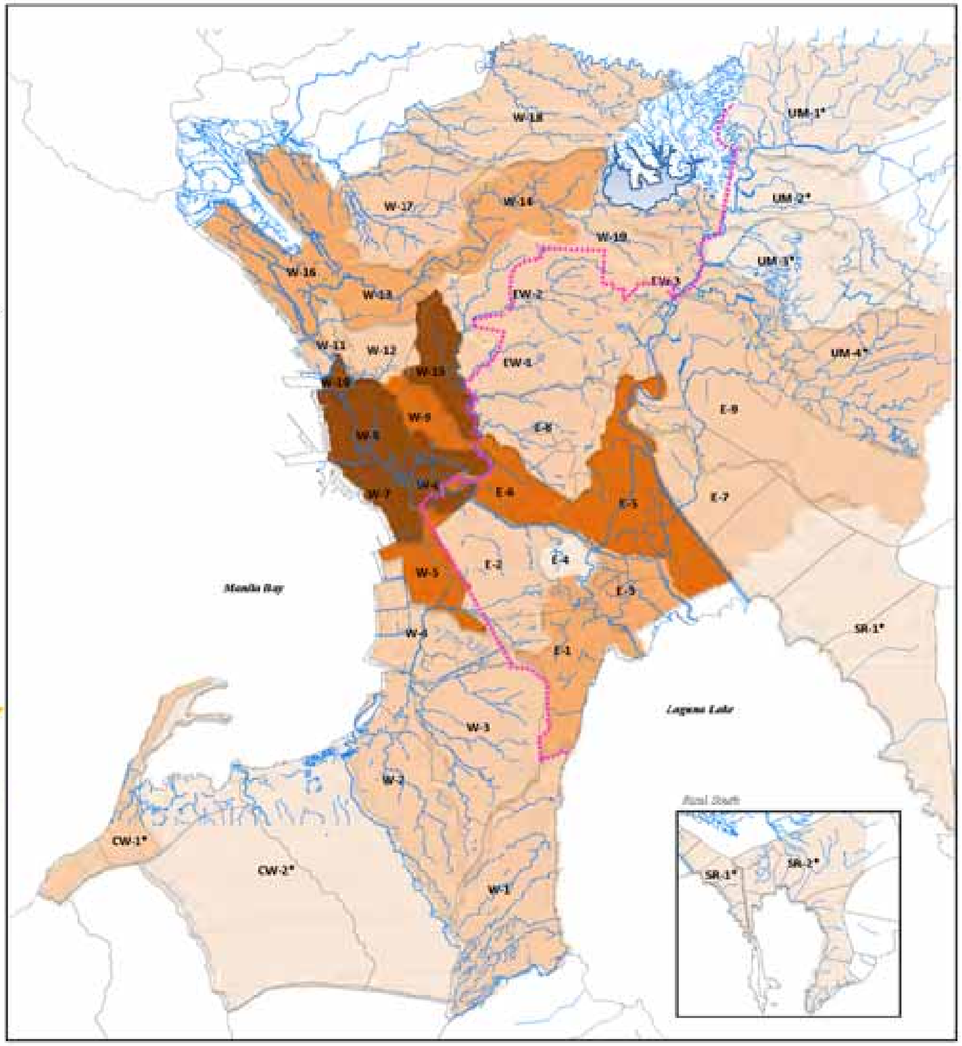
LEGEND

- Sub-catchment code / BOD generation (ton/day)
- Value: Resultant Load (assumes floodway closed & neglects load red'n thru natural processes)
- Major River
- MWSS Service Area Boundary
- Basin Boundary
- ** Catchments not Classified under the MWSS Master Plan*

Figure 2.4.10

MWSS Service Area Projected BOD Pollution Load Contribution (Year 2010)

PREPARATORY SURVEY FOR METRO MANILA
SEWERAGE AND SANITATION IMPROVEMENT PROJECT



POLLUTION LOAD DENSITY MAP

Pollution Load (kg-BOD/day/km2)

LEGEND

- 500-below
- 500-1,000
- 1,000-2,000
- 2,000-3,000
- 3,000-Above
- Municipal Boundary
- Rivers/Creeks
- MWSS Concession Boundary

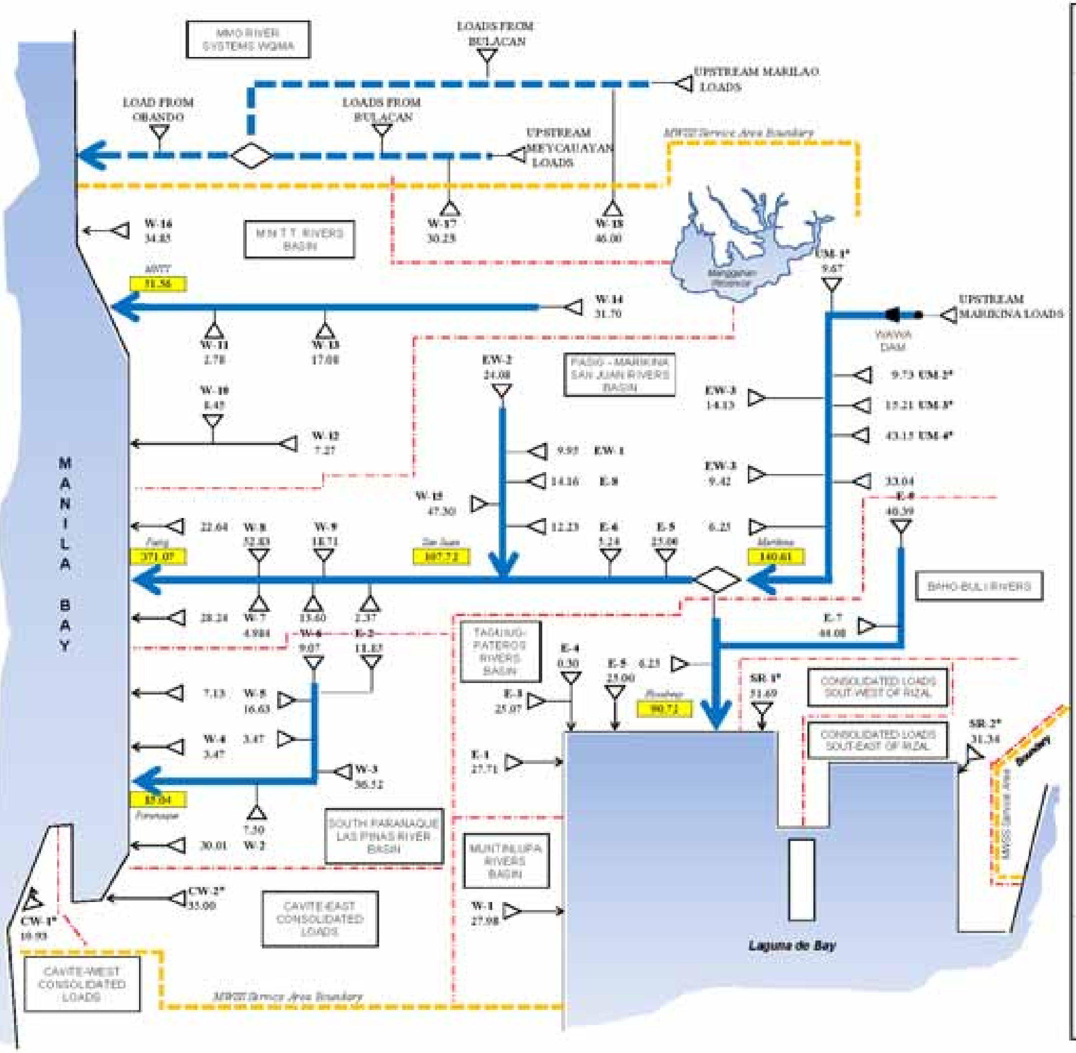
1. Pasig/ Dishin/Mgling/ Sucat
Muntinlupa (W-1)
2. Paranaque Basin
Las Pinas (W-2)
Paranaque (W-3)
Pasay-NAIA (W-4)
3. South Manila Basin
South Manila (W-5)
Pandacan (W-6)
Central Manila (W-7)
Part of Makati (E-2)

4. North Manila Basin
Central North (W-8)
Sampaloc (W-9)
Balut (W-10)
Caloocan A (W-12)
5. Tullahan Basin
Dagat-Dagatan (W-11)
Malabon-Tullahan (W-13)
QC-Novaliches (W-14)
Malabon (W-19)
6. Meycauayan Basin
Navotas (W16)
Valenzuela (W-17)
Caloocan B (W-18)

7. San Juan Basin
Quezon Central (EW-1)
Quezon North (EW-2)
Quezon West (W-15)
Mandaluyong-San Juan (E-6)
Quezon South (E-8)
8. Mar'-Antipolo Basin
Quezon East (EW-3)
Pasig (E-5)
Taytay (E-7)
9. Taguig Basin
Taguig (E-1)
Pateros (E-3)

10. Upper Mar' Basin*
Rodriguez (UM-1)
Rodriguez - Maly (UM-2)
San Mateo-Ampid (UM-3)
Antipolo-Nangka (UM-4)
11. Cavite Area*
Cavite-Rosario (CW-1)
Cavite-Kawit (CW-2)
12. South Rizal Area*
Rizal South-West (SR-1)
Rizal South-East (SR-2)

Fig. 2.4.10



SCHEMATIC OF POLLUTION LOAD CONTRIBUTION PER SUB-CATCHMENT

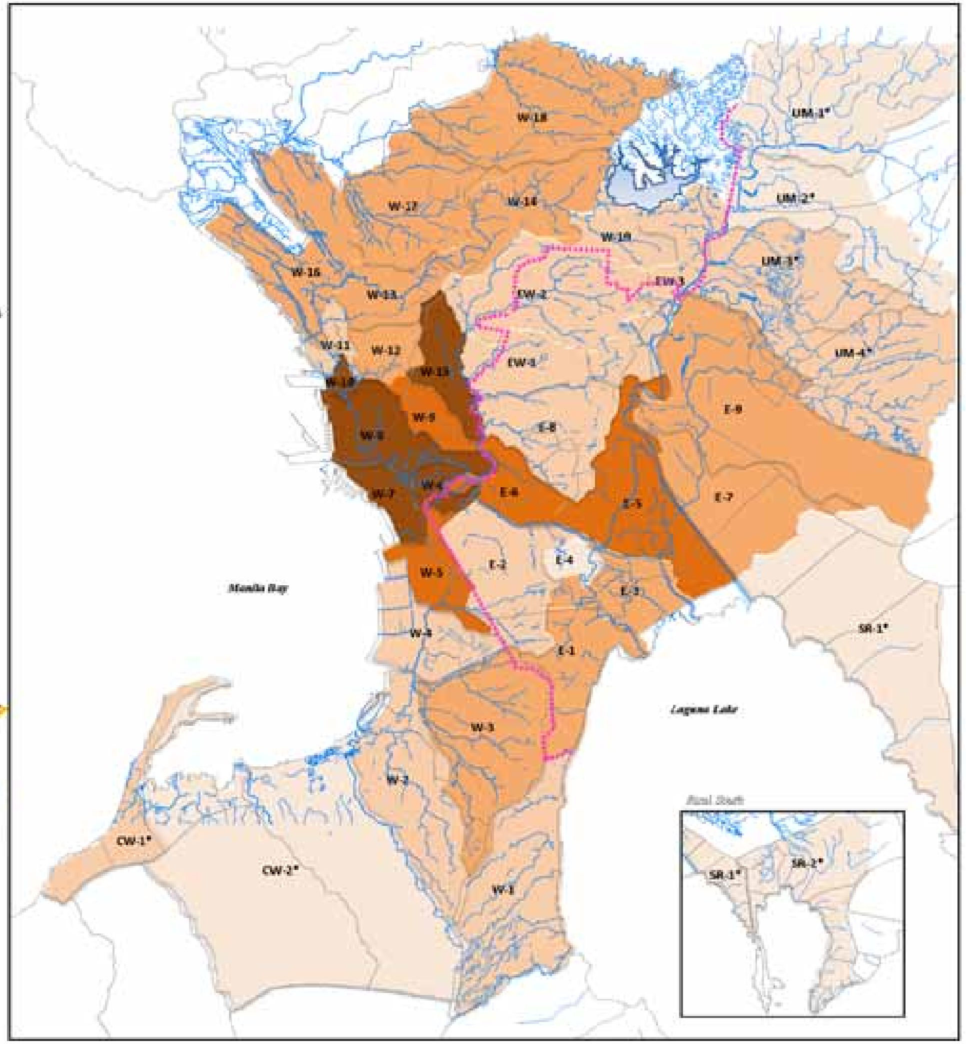
LEGEND

- Sub-catchment code / BOD generation (ton/day)
- Value — Resultant Load (assumes floodway closed & neglects load r'dtn' thru natural processes)
- Major River
- MWSS Service Area Boundary
- Basin Boundary
- ***Catchments not Classified under the MWSS Master Plan***

Figure 2.4.11

SCENARIO 1: Year 2025 MWSS Service Area Projected BOD Pollution Load Contribution (No Additional Sewerage Systems Developed)

PREPARATORY SURVEY FOR METRO MANILA
SEWERAGE AND SANITATION IMPROVEMENT PROJECT



POLLUTION LOAD DENSITY MAP

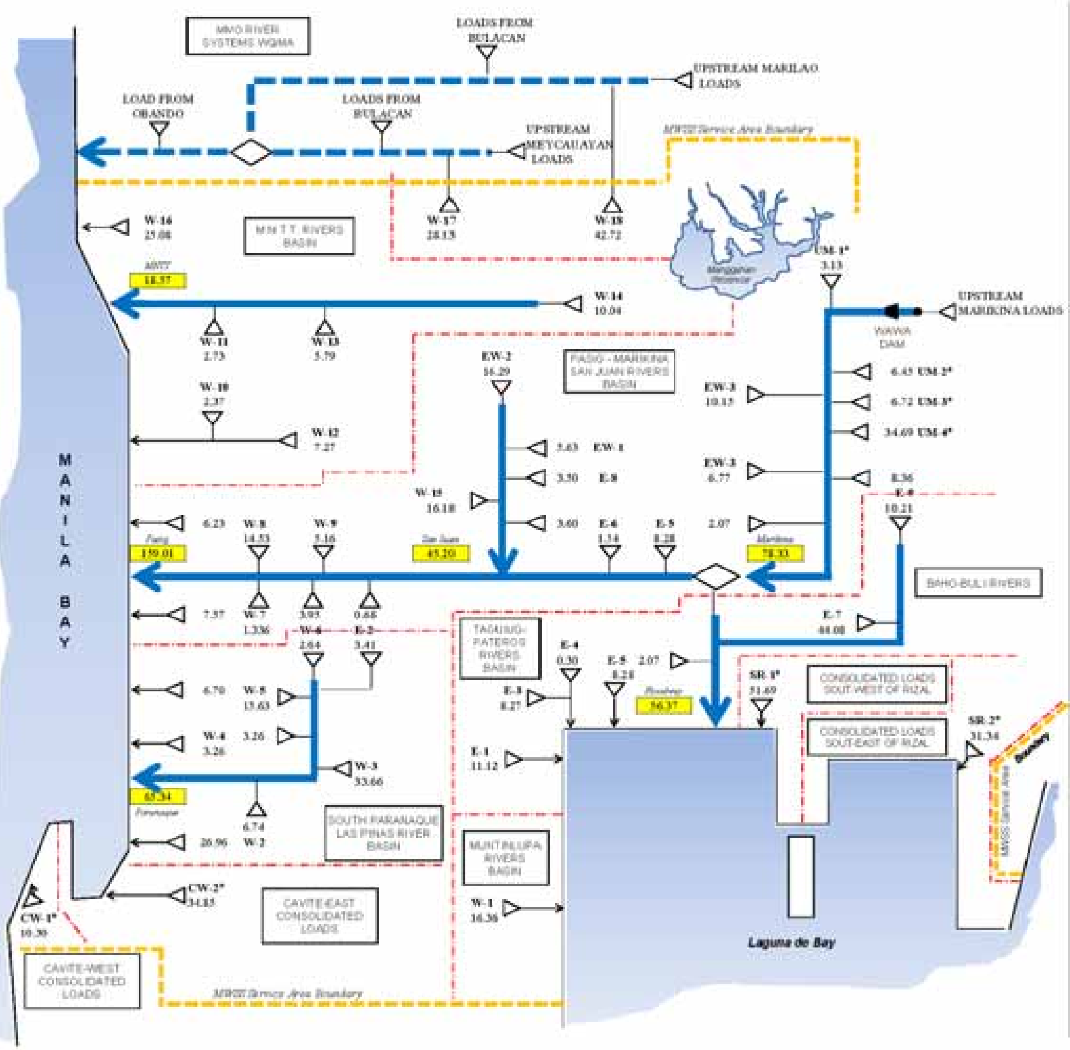
Pollution Load (kg-BOD/day/km2)

LEGEND

- 500-below
- 500-1,000
- 1,000-2,000
- 2,000-3,000
- 3,000-Above
- Municipal Boundary
- Rivers/Creeks
- MWSS Concession Boundary

1. Parañaque-Las Piñas Basin — Muntinlupa (W-1)
2. Paranaque Basin — Las Pinas (W-2), Paranaque (W-3), Pasay/NAIA (W-4)
3. South Manila Basin — South Manila (W-5), Pandacan (W-6), Central Manila (W-7), Part of Makati (E-2)
4. North Manila Basin — Central North (W-8), Sampaloc (W-9), Balut (W-10), Caloocan A (W-12)
5. Tullahan Basin — Dagat-Dagatan (W-11), Malabon-Tullahan (W-13), QC-Novaliches (W-14), Malabon (W-19)
6. Meycauyan Basin — Navotas (W16), Valenzuela (W-17), Caloocan B (W-18)
7. San Juan Basin — Quezon Central (EW-1), Quezon North (EW-2), Quezon West (W-15), Mandaluyong-San Juan (E-6), Quezon South (E-8)
8. Mar'-Antipolo Basin — Quezon East (EW-3), Pasig (E-5), Taytay (E-7)
9. Taguig Basin — Taguig (E-1), Pateros (E-2)
10. Upper Mar' Basin* — Rodriguez (UM-1), Rodriguez - Maly (UM-2), San Mateo-Ampid (UM-3), Antipolo-Nangka (UM-4)
11. Cavite Area* — Cavite-Rosario (CW-1), Cavit-Kawit (CW-2)
12. South Rizal Area* — Rizal South-West (SR-1), Rizal South-East (SR-2)

Fig. 2.4.11

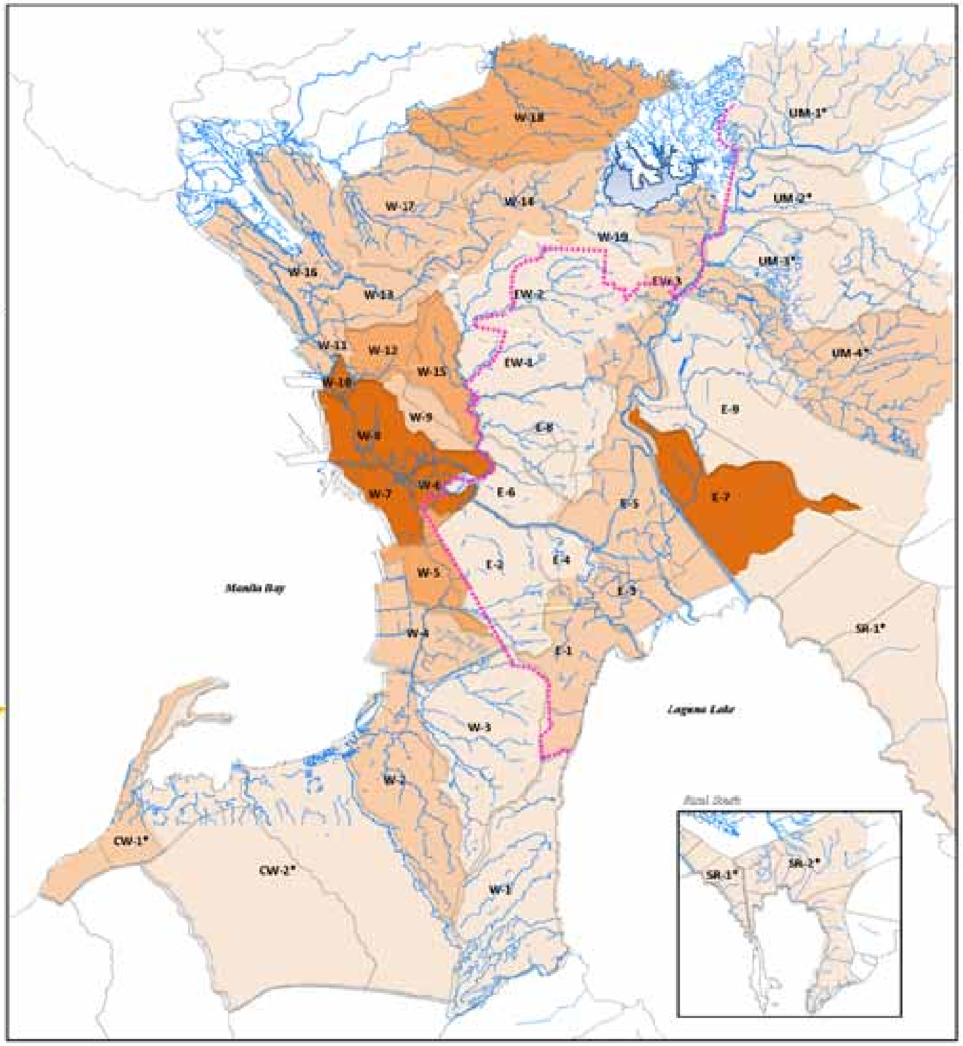


SCHEMATIC OF POLLUTION LOAD CONTRIBUTION PER SUB-CATCHMENT

LEGEND

- Sub-catchment code / BOD generation (ton/day)
- Value: Resultant Load (assumes floodway closed & neglects load r/du/ thru natural processes)
- Major River
- MWSS Service Area Boundary
- Basin Boundary
- ** Catchments not Classified under the MWSS Master Plan*

Figure 2.4.12
SCENARIO 2: Year 2025 MWSS Service Area Projected BOD Pollution Load Contribution (With Sewerage Development)
PREPARATORY SURVEY FOR METRO MANILA SEWERAGE AND SANITATION IMPROVEMENT PROJECT



POLLUTION LOAD DENSITY MAP

Pollution Load (kg-BOD/day/km2)

LEGEND

- 500-below
- 500-1,000
- 1,000-2,000
- 2,000-3,000
- 3,000-Above
- Municipal Boundary
- Rivers/Creeks
- MWSS Concession Boundary

1. Parag' Dishla/Mgting'/ Sucat
Muntinlupa (W-1)

2. Paranaque Basin
Las Pinas (W-2)
Paranaque (W-3)
Paray-NAIA (W-4)

3. South Manila Basin
South Manila (W-5)
Pandacan (W-6)
Central Manila (W-7)
Part of Makati (E-2)

4. North Manila Basin
Central North (W-8)
Sampaloc (W-9)
Balut (W-10)
Caloocan A (W-12)

5. Tullahan Basin
Dagat-Dagatan (W-11)
Malabon-Tullahan (W-13)
QC Novaliches (W-14)
Malabon (W-19)

6. Meycauyan Basin
Navotas (W16)
Valenzuela (W-17)
Caloocan B (W-18)

7. San Juan Basin
Quezon Central (EW-1)
Quezon North (EW-2)
Quezon West (W-15)
Mandaluyong-San Juan (E-6)
Quezon South (E-8)

8. Mar'-Antipolo Basin
Quezon East (EW-3)
Pasig (E-5)
Taytay (E-7)

9. Taguig Basin
Taguig (E-1)
Pateros (E-3)

10. Upper Mar' Basin*
Rodriguez (UM-1)
Rodriguez - Maly (UM-2)
San Mateo-Ampid (UM-3)
Antipolo-Nangka (UM-4)

11. Cavite Area*
Cavite-Rosario (CW-1)
Cavit-Kawit (CW-2)

12. South Rizal Area*
Rizal South-West (SR-1)
Rizal South-East (SR-2)

Fig. 2.4.12

Conclusions

In aid of determining which catchment areas need to be prioritized, **Table 2.4.17** summarizes the results of various BOD load measures with the top 3 catchment basins listed for each concession area. BOD load volume is based on net BOD loading into their respective receiving bodies of water, BOD load density is based on net BOD load relative to the size of the catchment area, and BOD load increase looks at basins with the highest projected population growth from 2010-2025 and will most likely need a comprehensive sewerage and sanitation program to anticipate the future growth.

Table 2.4.17: Priority areas based on different measures used

BOD load volume	BOD load density	BOD load increase
West Zone		
North Manila Basin (W8)	North Manila Basin	Paranaque Basin
San Juan Basin (W15)	South Manila Basin	Cavite Basin
Meycauayan Basin (W18)	San Juan Basin	Pasong Diablo-Muntinlupa Basin
East Zone		
Marikina-Antipolo Basin (E5,E9)	Taguig Basin	Upper Marikina Basin
South Rizal Basin (SR1)	Marikina-Antipolo Basin	South Rizal Basin
Upper Marikina Basin (UM4)	San Juan Basin	Marikina-Antipolo Basin

Both the 2004 MWCI Master Plan and MWSS Master Plan (2005) used BOD load volume per catchment basin in order to identify priority areas. BOD load density may be a better measure as BOD loading is normalized by the catchment area. This measure reflects the concentration of BOD sources and therefore may result in a portion of the receiving body of water that is extremely polluted. These areas are also characterized by high population densities and industrial establishments adjacent to housing area. Locating a sewage treatment facility in such area will therefore be able to service more residents without investing too much on sewage canals as compared to a facility that services far apart sources.